FROM THE SURFACE WATER TO THE DEEP SEA BED: FISH, THE REAL MASTERS OF THE AQUAWORLD

AN INAUGURAL LECTURE, 2015/2016

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UNIVERSITY OF IBADAN

FROM THE SURFACE WATER TO THE DEEP SEA BED: FISH, THE REAL MASTERS OF THE AQUA WORLD

An inaugural lecture delivered at the University of Ibadan

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By

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The Vice-Chancellor, Deputy Vice-Chancellor (Administration), Deputy Vice-Chancellor (Academic), Registrar, Librarian, Provost of the College of Medicine, Dean of the Faculty of Science, Dean of the Postgraduate School, Deans of other Faculties and of Students, Directors of Institutes, Distinguished Ladies and Gentlemen.

Preamble

It is with great honour and humility that I stand before you to deliver the eighteenth of the 2015/2016 inaugural lectures of this Great University on behalf of the Faculty of Science. This is a land mark presentation, for I represent the first grandson of our teachers' teachers and son of our teachers to present an inaugural lecture in the Department of Zoology of the nation's Premier University. Other inaugural lectures from the Department include:

- F.M.A. Ukoli: Order Among Parasites 1975
- S.A. Toye: Biological Success 1980
- M. Nwagwu: The Third Face of The Coin 1991
- S.O. Fagade: In the Belly of our Waters 1998
- T.G. Okorie: Lady Mosquito: A Tribute to a Great General 2006
- A.T. Hassan: Environmental Biology – An Adaptive Course in Zoology, University of Ibadan Experience 2009

My inaugural lecture coming after seventeen years on the Professorial Chair suggests that inaugural lectures from the Department of Zoology do not come too soon like others. Either by the letter "Z" which comes after others or increased number of Professors in the Faculty of Science. Things have changed so much that more slots are now allocated to the Faculty of Science. I thank the Dean of Science Professor A.A. Onilude who used seniority to slot me in this year over other younger vibrant and eager colleagues. To my other colleagues, my prayer is that yours will come at the anointed time soon in the name of God Almighty: "THE PERFECT TIMER".

The lecture will cover:

- Biology of representative fish species in the marine, estuarine and fresh water environment
- Limnology of inland waters as it relates to aquatic health, fisheries and aquatic pollution
- The practical application of fish biology in the culture of fish species for production of fish for mankind
- The quality of the inland aquatic ecosystem through toxicological studies
- My contribution to knowledge through books, manuals and monographs
- The biodiversity and evaluation of our resources through abundance, conservation as well as pollution to prevent elimination of vital resources and ensure sustenance for future generation

Zoology

Zoology is the study of animal life with topics ranging in size from the molecules studied in the laboratories to the animal societies and ecological studies by field observers. It also ranges in time to physiological and reproductive processes taking less than a second to evolutionary histories extending over many millions of years. Zoology is a science close to human concern as humans are animals. The closeness often poses a problem for Zoologists who must carefully avoid the temptation of too closely linking animal behaviour to human behaviour: the fallacy of anthropomorphization, they say.

Contemporary Zoology is to a great extent the sum total of those works done by biologists pursuing research with animal materials. All History of Biology started with Aristotle's Zoology, one of the earliest studies of the natural world, a true defining moment in scientific history. Aristotle's methods and theories seem a little primitive to modern humanity with its genome codes; however his work was a quantum leap in the building of human knowledge. Every modern biologist is advised to study Aristotle's Zoology as a perfect example of how to build up a store of knowledge based upon careful observation. It is this brilliant mind behind

Aristotle's Zoology that cemented his place as 'The Father of Zoology'.

Aristotle the pupil of Plato took great interest in the natural world including many aspects of meteorology and geography but his greatest contribution to science was in the field of natural history and biology. Aristotle used empirical methods and techniques in protoscientific method – a meticulous approach that handed out the template for future researchers in the field. Others like the following just to mention a few submitted landmark concepts and findings:

- Carolus Linnaeus 1758 submitted the Systemanaturae involving Taxonomic Principles of Animals and Plants.
- Jean Baptiste de Lamarch 1809 submitted Philosophezoologique: Environment as a factor in evolution.
- Georges Cuvier 1817 submitted Classification and com-parative study of animal structure.
- Charles Darwin 1839- Concept of organic evolution.
- William Harvey 1628- Essay on the motion of heart and blood.

Although the study of animal life is ancient, its scientific incarnation is relatively modern. Mirrors of transition from natural history to biology was at the start of the 19^{th} Century since Hunter and Cuvier amongst a host of others shaped areas of modern Zoology into: anatomy, physiology, histology, embryology, teratology and ethology.

Modern Zoology first arose in German and British universities. Zoology and the future changed with the growing knowledge of genetics and DNA. The greatest challenge to modern Zoology is the extinction of animal species and habitats under the banner of BIODIVERSITY with a timeline starting from 340BC to 1992AD when Edward O. Wilson published the plea for biodiversity: "The Diversity of life". Zoology has become a career, vocation and way of life for different people.

Post Graduate Training and Job

In 1980, The University of Lagos offered me and a phycologist, Professor Dike Nwankwo admission and pioneer graduate students in the planned Department of Marine Science, a Research Assistantship in the then ongoing Funiwa5 oil blow-out investigation and an opportunity to earn an EPA certificate of the Department of Environment, Washington DC. From my NYSC base in Akure, I passed Ibadan to Akoka, Lagos to pursue postgraduate work. Five years later, I moved back to Ibadan as Dr. Alex Ugwumba at 8.00pm on April 14th 1985 to resume duty the next day April 15th in the Department of Zoology, University of Ibadan. Earlier on the 14th night, I met my teacher Professor M. Nwagwu, Head of Department who actually came to Lagos on the 13th of April to serve me the third and last/final letter of Appointment. I saw Professor Nwagwu in the Office at 8.00pm since I knew their routine. He took me in his green Volvo to the Staff Club where I met Professor F.M.A. Ukoli of Blessed memory and Professor A.O. Anya who was from the University of Nigeria, Nsukka. When I was introduced, Professor Anya's comment was 'ooh the best brains are best preserved in alcohol'. This meant many things, but then to me it was a preservation method in the course, BIO 214 "Biological techniques". Then a phone call from Professor S.A. Toye to ask if I had arrived. It was then I knew the Professors all planned to bring me back to Ibadan.

Research: Journey, Thrust and Focus

My Ph.D research on the Biology of the Ten-pounder *Elops larceta* (Val.) in three aquatic habitats: Lekki Lagoon (fresh water), Lagos Lagoon (brackish water) and the coastal waters off Lagos Coast (marine) showed a link between the three habitats with the fish species in the three ecosystems. The juveniles of the species were found in the freshwater and brackish water only while the adults were encountered only in the marine habitat. The study thus provided me with the unique opportunity and experience to master the three major aquatic habitats in nature and thus predisposed and initiated my future research in fisheries, no matter the habitat.

My training in 1983 and acquisition of a Certificate in Waste Management by Environmental Protection Agency of the Department of Environment, Washington DC equipped my research in environmental management and pollution studies. Thus in most of my studies, I have preached and maintained environmental friendliness. Hence for over two decades, I have been involved as a specialist/resource person in various Environmental Impact Assessment studies which had yielded amongst others, some of the best manuscripts in reputable journals, keynote speaker in scientific meetings, chapters in books amongst others I may not be able to mention here.

Contributions to the Biology of Fish

The terms fish, fishing and fisheries need a brief mention here. Fish to some, refers to the most dominant aquatic vertebrates in the aquatic faunal assemblages. The term however not only refers to fin fish but also other aquatic animals such as gastropods, bivalves, shrimp/prawns and crabs known as shell fish.

Fishing is one of man's most ancient food gathering endeavours using appropriate tools aimed at catching fish. This involves the use of definite gears, crafts and catching methods with some regularity. This is often based on the type of water as well as fishing or selectively exploiting particular species.

Fisheries is in fact the economic terminology encompassing the state of commercially important aquatic resources, their exploitation, utilisation, conservation and management to avoid wastages of potential food stocks and loss of opportunity to create wealth and enhance welfare.

The manuscript: Ugwumba (1989) on the distribution and growth of the ten pounder *Elops lacerta* (Val) in the aquatic environment in Lagos, Nigeria revealed the spatial distribution and growth patterns of the species. The ten-pounder spends at least a year in the lagoons and those in the third year of life occurred mainly in the coastal marine waters. The ecological separation of adults in the marine and juveniles in the lagoons was established to pave way for an efficient ten-pounder fishery management and exploitation (tables 1 and 2).

Table 1: Monthly Percentage Occurrence of different Sizes in Sample of *E. lacerta* caught in Lekki Lagoon, Lagos Lagoon and off the Lagos Coast

Month	Lekki			Lagos Lagoon			Off the Lagos Coast		
	Small (5-13cm) N=688	Medium (14-24cm) N=728	Large (25-35cm) N=0	Small (5-13cm) N=684	Medium (14-24cm) N=399	Large (25-35cm) N=0	Small (5-13cm) N=0	Medium (14-24cm) N=246	Large (25-35cm) N=384
December 1980	45.0	55.0	0	55.7	44.2	0	0	30.3	69.7
January 1981	37.8	61.2	0	69.2	30.8	0	0	30.0	60.0
February	38.9	61.1	0	48.2	51.8	0	0	20.8	79.2
March	40.0	60.0	0	51.1	49.9	0	0	25.0	75.0
April	58.5	41.6	0	61.5	38.5	0	0	40.5	59.5
May	58.7	41.3	0	71.4	28.6	0	0	44.5	55.5
June	83.5	16.5	0	80.8	19.2	0	0	66.7	31.3
July	65.5	35.5	0	64.7	35.3	0	0	68.8	31.2
August	37.5	62.5	0	88.5	11.5	0	0	31.0	69.0
September	45.6	54.4	0	85.7	14.3	0	-	-	-
October	37.6	62.4	0	83.3	16.7	0	-	-	-
November	48.3	51.7	0	80.6	19.4	0	0	36.4	63.6
December	36.8	63.2	0	57.1	49.9	0	0	38.1	61.9
January 1982	34.1	65.9	0	68.8	31.2	0	-	-	-
February	38.7	61.3	0	44.1	55.9	0	0	31.0	69.0
March	43.9	56.1	0	35.5	64.5	0	0	25.0	75.0
April	51.0	49.0	0	45.5	54.5	0	0	41.7	58.3
May	52.4	47.6	0	64.0	36.0	0	0	60.3	39.7
June	69.4	30.6	0	77.5	22.5	0	0	70.1	29.9
July	73.5	26.5	0	70.6	29.4	0	0	40.2	59.8
August	29.0	71.0	0	72.7	27.3	0	0.	40.2	59.8
September	27.5	72.5	0	80.0	20.0	0	0	22.2	77.8
October	42.0	58.0	0	50.3	49.7	0	0	31.8	69.2
November	47.4	52.6	0	41.2	58.8	0	0	20.9	79.1
December	47.6	52.4	0	20.3	79.7	0	0	40	60

N =Sample size

Table 2: Growth Rates with Time in *E. lacerta*

Location	Age and Mean Size					
	0-1yr	**1yr**	**1-2yr**	**2yr**	**2-3**	**3yr**
Lekki Lagoon	5.8-15.3cm	15.3cm	15.4-24.4cm	-	-	
Lagos Lagoon	6.2-15.1cm	15.2cm	15.3-24.2cm	-	--	-
Off Lagos Coast	-	-	16.6-25.5cm	25.6cm	26.6-34.1cm	35.1cm

Location	Standard length range (cm)	Total weight range (g)
Lekki Lagoon	5.8-24.4	3.8-177.8
Lagos Lagoon	6.2-23.3	4.0-161.6
Off Lagos Coast	16.6-34.1	59.9-451.5

In Ugwumba (1991) on the food and the feeding habit of the ten-pounder *Elops lacerta* (Val) in the fresh, brackish and marine waters in Lagos, the species was documented as a purely predatory fish which preyed on fish, crustaceans and insects. The food items consumed reflect the most available in the different habitats. A very successful predator was established feeding on the most available food and switching to another when not available thus reducing competition (tables 3 – 5).

The reproductive biology of the ten-pounder published in Ugwumba and Ikusemiju (1992) confirmed the occurrence of different size groups/life history stages in the three respective environments. In the twenty five months study duration, adults were only recorded in the marine environment off Lagos coast. Ripe individuals were captured all year round off. Lagos coast. Sexually immature specimens were only encountered in the lagoons. It was evident that the species spawned in the marine environment off Lagos coast and juveniles migrate and abound in the lagoon systems prior to another seasonal spawning migration. Figures 1 to 3 describe the gonad maturation cycle of the species.

The Croaker species arguable the most popular single commercial group of species in the Nigerian coastal waters was inundated with taxonomic/racial/differential speculations. My first Ph.D student, Dr. Augustina O. Anyanwu, then a Principal Research Officer in Nigerian Institute for Oceanography and Marine Research (NIOMR), Lagos and later retired as Director and Head of Fisheries Resources, clarified the problems in three publications (Anyanwu and Ugwumba 2002a&b, 2003). The studies employed morphometric, meristic and electrophoresis techniques to separate and confirm the different Croaker (*Pseudotolithus*) species in the Nigerian coastal waters and paved way for effective sustainable exploitation and management of the resources.

Table 3: Summary of the Food Items of *E. lacerta* from Lekki Lagoon

Food item	Numerical Method		Frequency Method		Volumetric Method	
	Number	%	Number	%	Volume (60)	%
PISCES						
P. afzeluisi	1,720	38.8	461	33.0	262.4	44.3
E. lacerta	400	9.0	151	10.8	80.6	13.6
E. vittata	89	2.0	50	3.6	30.6	5.2
T. guineesis	53	1.2	15	1.1	6.0	1.0
C.senegalensis	6	0.1	4	0.3	0.3	0.1
Unidentified fish	326	7.4	162	11.6	45.8	7.7
Fish parts	663	15.0	440	31.5	44.8	7.6
Fish larvae	17	0.4	5	0.4	0.72	0.1
CRUSTACEA						
Macrobrachium sp	81	1.8	4	0.3	9.00	1.5
Mysis sp.	35	0.8	18	1.3	1.5	0.3
Diaptomus sp	22	0.5	18	1.3	1.5	0.3
Daphnia sp	3	0.1	1	0.1	0.03	0.01
Crustacean parts	123	2.8	48	3.4	4.8	0.8
INSECTA						
Notonecta sp	101	2.3	55	3.9	3.9	0.7
Trichopteran larvae	112	2.5	34	2.4	3.9	0.7
Chironomid larvae	290	6.5	45	3.2	5.2	0.9
Chaoborid larvae	180	4.1	19	1.4	2.7	0.5
Ceratopogonid larvae	9	0.2	8	0.6	0.9	0.2
Anisopteran nymph	11	0.2	9	0.6	0.9	0.2
Insect parts	178	4.0	68	4.9	6.8	1.1
Nematode worm	13	0.3	8	0.6	0.2	0.03
Unidentified mass	-	-	1395	98.5	81.2	13.7

Table 4: Summary of the Food Items of *E. lacerta* caught in Lagos Lagoon

Food items	Numerical Method		Frequency Method		Volumetric Method	
	Number	%	Number	%	Volume(cc)	%
PISCES						
E. fimbriata	701	17.1	149	14.7	131.5	20.4
E. lacerta	335	8.2	125	12.3	61.9	9.6
E. vittata	93	2.3	54	5.3	38.7	9.6
P. regani	70	1.7	22	2.2	8.1	6.0
T.lepturus	17	0.4	8	0.8	2.0	0.3
C. hippos	4	0.4	2	0.2	4.4	0.7
C. senegalensis	31	0.8	9	0.9	3.2	0.5
Unidentified fish	274	6.7	83	8.2	31.3	4.9
Fish parts	414	10.1	149	14.7	27.3	4.2
Fish larvae	1	0.02	1	0.1	0.2	0.02
CRUSTACEA						
Penaeus sp.	773	18.9	233	23.0	129.8	20.2
Macrobrachim sp.	172	4.2	34	3.4	17.0	2.6
P. hastatus	11	1.0	16	1.6	4.0	0.6
Mysis sp.	108	2.6	27	2.7	5.3	0.8
Diaptomus sp.	2	0.05	2	0.2	0.007	0.01
Calanus sp.	407	10.0	26	2.6	2.6	0.4
C. latimanus	9	0.2	4	0.4	0.9	0.1
GASTROPOD						
N. glabrata	3	0.1	3	0.3	0.4	0.1
P. aurita	1	0.02	1	0.1	0.06	0.01
Shrimp part	554	13.5	162	16.0	30.2	4.7
INSECTA						
Insect parts	19	0.5	8	0.8	3.1	0.5
Nematode worm	48	1.2	26	2.6	1.1	0.2
Plant material	11	0.3	5	0.5	0.4	0.1
Unidentified Mass	-	-	1,013	93.5	140.2	21.8

Table 5: Summary of the Food Items of *E. lacerta* caught off Lagos Coast

Food Items	Numerical Method		Frequency Method		Volumetric Method	
	number	%	number	%	number	%
PISCES						
I. africana	51.0	1.7	19.0	3.1	24.4	3.6
E. lacerta	41.0	1.4	8.0	1.3	11.2	1.6
B. auritus	7.0	0.2	4.0	0.7	6.8	1.0
P. senegalensis	1.0	0.03	1.0	0.2	1.3	0.2
Fish scales	75.0	2.5	18.0	2.9	1.1	0.2
Unidentified	18.0	0.6	13.0	2-1	5.5	0.8
CRUSTACEA						
P. atlantica	271.0	9.1	94.0	15.4	147.3	21.5
P.duorarum	52.0	1.7	38.0	6.2	75.8	11.1
P. hastatus	946.0	31.7	149.0	24.4	254.0	37.1
Mysis sp.	60.0	2.0	1.0	0.2	1.0	0.1
Cyclop sp.	3.0	0.1	2.0	0.3	0.1	0.01
Shrimp parts	353.0	11.8	72.0	11.8	21.5	3.1

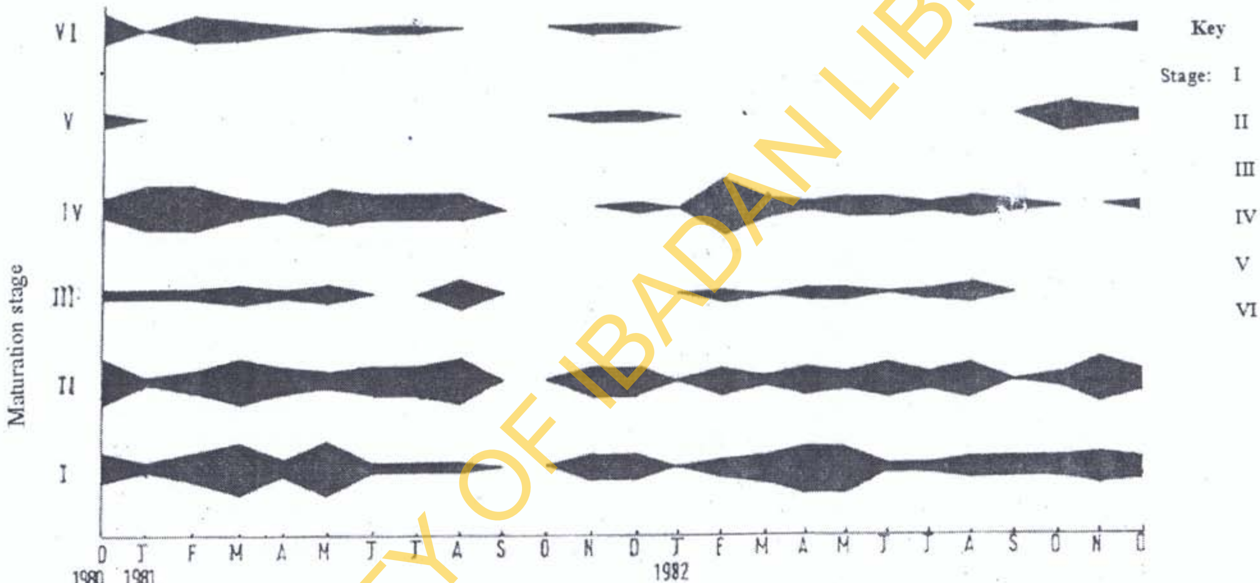


Fig. 1: Seasonal maturation cycle in female *E. lacerta* shown by percentage in monthly sample of fish at each maturation stage.

Source: Ugwumba and Kusemiju (1992)

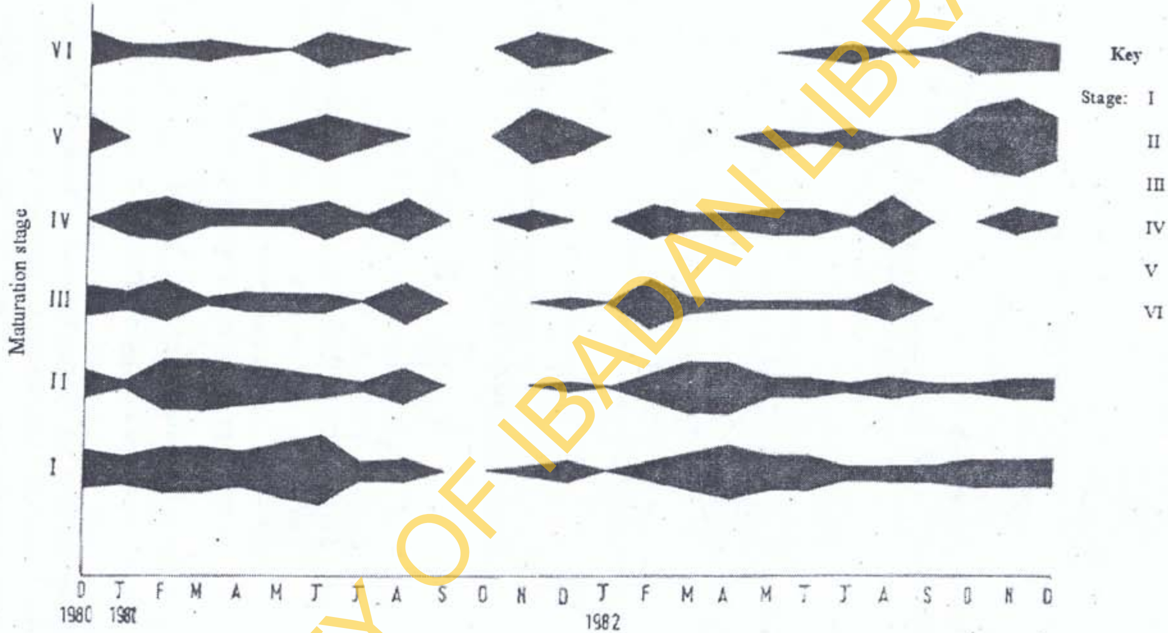


Fig. 2: Seasonal maturation cycle in male *E.lacerta* shown by percentages in the monthly samples of fish at each maturation stage.

Source: Ugwumba and Kusemiju (1992)

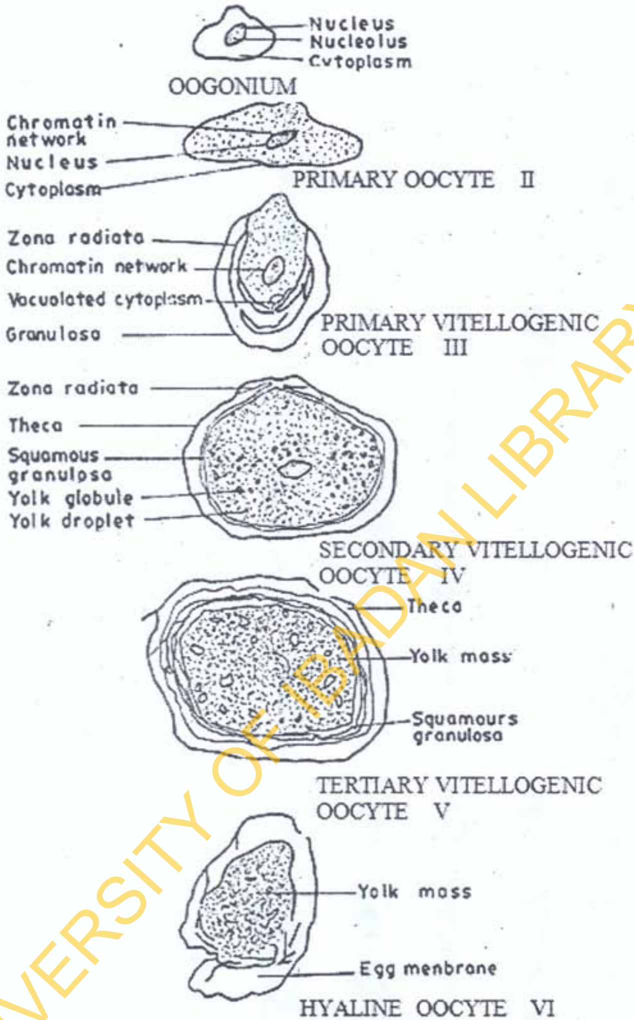


Fig. 3: Egg development stages in *E. larceta*.

Source: Ugwumba and Kusemiju (1992)

My second Ph.D student, a Camerounean, Professor Pius Oben now at the Yaoundé University, Cameroon repositioned the use of hard parts in the ageing of tropical fish from Lekki Lagoon, Nigeria. Our findings, an offshoot from our erudite and retired Professor S.O. Fagade (THE GRAND MASTER) was reported in several scientific sessions across the globe. Three key manuscripts—Oben, Ugwumba and Fagade (1998, 1999), Oben and Ugwumba (1999) reported the use of otoliths and opercular bones to age fish, through observed lunar rings (annual rings) in the mormyrids: *Hyperopisus bebe*, (Lacepede: Mormyridae), *Mormyrus rume* (Cuvier and Valenciennes: Mormyridae) and *Heterotis niloticus* (Cuvier: Osteoglosidae) in Lekki Lagoon and inland tropical fresh water ecosystem lakes in IITA Ibadan Nigeria.

Further fresh water fish biology contributions include Ugwumba O.A. and Ugwumba A.A.A. (1993) which reported for the first time the biology of the erstwhile brackish water black jaw tilapia *Sarotherodon melanotheron* (Ruppel) in the fresh water lake – Awba Reservoir, University of Ibadan. Along same line, the report recorded reproduction of the tilapia species in Awba Reservoir in affirmation of a successful adaptation and breeding in a completely fresh water ecosystem.

Contributions to Limnology

Professor L.C. Beadle, Honorary Senior Research Fellow in University of Newcastle, Tyne and Professor of Zoology, Makerere University, Uganda in 1949 – 1964 gave my most favoured description of Limnology: "The study of inland waters—lakes, rivers and swamps concerned with not only discovering what these water bodies are composed of, but more especially the understanding of the complex inter-relationships between the physical, chemical and biological events which maintained them and linked them with the outside world which moulded them in the past". The subject limnology has its main practical applications in fisheries, water pollution and public health.

My contributions on limnological studies covered the South west (Ibadan and Iwo), South east (mid Cross River ecosystem) and the South south Nigeria (Okpoka Creek, Port Harcourt), Niger Delta. In the south western Nigeria, Dr. Tosin Atobatale, then my Ph.D Student focused on the aquatic environment in the River Ogunpa, Ibadan, Oyo State and Aiba Reservoir, Iwo, Osun State. In Ogunpa River, pollution/stress signals were that most benthic invertebrates recorded were pollution tolerant species; high species richness of blue green algae with 92% abundance of all phytoplankton, mostly the colonial/filamentous forms confirm influence of organic pollution (Atobatale, Morenikeji and Ugwumba 2005 & 2007).

However, in Aiba Reservoir – a tropical sub-urban reservoir in Iwo, studies revealed reservoir water of suitable potential aquaculture features in pH, temperature and dissolved oxygen all within acceptable limits for fish growth. Condition index of two congeneric catfishes *Chrysichthys nigrodigitatus and C. auratus* (Suliformes: Clarotidae) showed similarity in diets which varied with sex. However, feeding behaviour suggests strategies to reduce intra-and inter-specific competition (Atobatale and Ugwumba 2008; Atobatale and Ugwumba 2010; Atobatale and Ugwumba 2011).

Contributions from Okpoka Creek, Niger Delta; my then PhD Student, Dr. Bubu Davies targeted the resultant input of anthropogenic effluents from Trans-Amadi Layout and the surrounding water-front communities on the creek. The studies investigated species composition, diversity, distribution of plankton, epiphyton and fin fish assemblages. Further studies recorded total coliform bacteria pollution and the Ribonucleic acid interference (RNAi) technology, a promising solution to shrimp viral diseases.

Physico-chemical parameters within acceptable values included – water turbidity, transparency and temperature all of which favoured algae growth in the creek. However, total dissolved solids, total organic carbon and total organic matter levels signified organic water pollution from anthropogenic inputs. Other chemical parameters not within the acceptable levels included Chloride, Calcium, Magnesium and water hardness. Nutrients especially phosphate and ammonia exceeded FEPA and USEPA acceptable levels for natural water bodies. Pollution indicator phytoplankton/epiphyton species – *Navicula, Nitzschia, Synedra, Cladophora,* *Euglena, Anabaena* and *Ceratium* were abundant in the creek. Fin fishes (eleven species) were dominated by *Sardinella maderensis* and their abundance correlated positively with abundance of phytoplankton and epiphyton, their major food (Davies, Abolude and Ugwumba 2008a&b; Davies and Ugwumba 2013a&b).

The studies positively asserted that Okpoka Creek was under stress due to organic pollutants from anthropogenic sources from water front dwellers, and industries releasing raw sewage, dredged materials, animal dung from abattoir and cleaning agents from industries. Concerted environmental management strategies to conserve the abiotic and biotic integrity of the creek must be adopted for the future (Davies, Ugwumba and Ugwumba 2008a&b; Davies and Ugwumba 2013a, b&c).

Dr. Oke Okogwu during his PhD studies under my supervision evaluated the water quality and ecology of the mid Cross River flood plain ecosystem comprising of Cross River, Asu River, Ebonyi River, Eloma Lake and Iyeke Lake. A rich faunal diversity in the mid Cross River Flood plain was symbolised by one hundred and one (101) phytoplankton species, seventy seven (77) zooplankton species and sixty nine (69) fish species (Okogwu, Nwani and Ugwumba 2009; Okogwu and Ugwumba 2009, 2010).

Of important reference was the zooplankton, *Daphnia oblisa,* a new African record and ten species of rotifers, *Keratella volga, K. trciresis, K. cocklearius var lispida, K. cochlearis var robusta, K. liemali, Brachionus dimidiates, B. zahniseri, Dicranophorus haverianus combari, Lecane candida* and *L hyphera* were recorded in Nigeria for the first time. Amongst the finfishes – three marine intrusive species were recorded in the mid Cross River (*Decapterus rhinchus, Trachinotus tersia and Caranx hippos*) which confirm the migratory behaviour of these fish species. Hence mid Cross River ecosystem appears unique but also complementary to the lower and upper Cross River as it contains a number of endemic species and also serves as breeding site for migratory and estuarine fish species of the lower Cross River (Okogwu and Ugwumba 2012, 2013). A very rich fish trade abound in the region with over 40% of the fish families being monospecific and endemic (Okogwu and Ugwumba 2010, 2013).

In a just concluded PhD studies in Ibuya River, Old Oyo National Park Sepeteri, another PhD Student of mine reported abundant pollution tolerant biota: blue green algae (*Microcystis*, *Merismopedia* and *Oscilatoria*), the copepod (*Mescyclops*) and the gastropods (*Melanoides* and *Indoplanobis*). When combined with the high metal and nutrient concentrations that were above acceptable limits, the river was classified eutrophic and under pollution stress. Akponine and Ugwumba (2015) thus concluded that the water quality is deteriorating and may become unsuitable for some aquatic organisms and unsafe for humans. This shows that the so called reserved areas are not safe, hence the need for urgent management measures to protect the resources.

Aquaculture

The deliberate culture (growing/rearing) in natural water or artificial enclosure containing water of economically important fin fishes, shell fishes, aquatic plants or other organisms for food, recreational, ornamental and scientific/ educational purposes.

History

An exact date on the origin of fish culture is a mere guesswork. The general belief is that aquaculture seems to have originated in China, and numerous Chinese proverbs made reference to culture of fish.

Prominent amongst them are:

(i) "Give a man fish you have given him food for the day, teach him to grow fish you have given him food for the rest of his life".
(ii) Where there is water there must be fish.

Brown (1877) reported that in Honan Province China, Wen Fang the founder of the Chou Dynasty had built several ponds and filled them with fish which recorded the first reference of fish behaviour and growth. In 460 BC, Fan Li wrote his fish outline classic from experiments based on carp culture for pleasure, which later turned into rearing for food. Culture of fish expanded in China, India, Indonesia, Vietnam and Cambodia.

Huet (1970) reported fish culture in occidental Europe which developed along with the monatries and was limited to production of food. By the 19th century, modifications, modernisation of rearing methods, introduction and general use of fertilisers and the growing use of artificial feed took off.

Considerable development was involved in North America and by the end of the second World War, fish farming practices were forced to spread to other countries in Latin America and Africa by three major factors:

(a) Facilities offered by modern forms of transportation of fish
(b) The constant expansion of artificial reproduction of farmed fish and
(c) The development and the use of formulated feeds

In Nigeria, certain records show that fish farming commenced in 1951 or sometime earlier with government demonstration fish farm in Panyam, Plateau State. This has been challenged with the fish ponds by the colonial masters in Ikoyi and Calabar.

Fish Production through Aquaculture

FAO (1983) documented the contributions of aquaculture by several countries towards fish production. In the 70s and 80s, in the United States of America values of up to 11% of the overall fish production came from aquaculture, China, 50% and Israel, 25%. By 2013, China also had the highest finfish production of 60% through aquaculture (FAO 2016a). Federal Department of Fisheries (FDF) (2008) reported Nigeria aquaculture production of 85,087 tonnes in 2007. However, FAO (2016b) put our aquaculture production at 200,000 tonnes in 2010.

Vice-Chancellor, Sir, in the early nineties we had hinted about the new and profitable frontiers in aquaculture. Fagade, Adebisi and Ugwumba (1993) on conservation of aquatic resources through aquaculture advocated the culture of marine and fresh water prawns, *Machrobrachium* spp. for export, culture of our local crocs – *Crocodilus niloticus* (Nile Crocodile) and the long nose species *Crocodilus cataphractus* for sales to the zoological gardens and other markets under appropriate licence from National Resources Conservation Council. This also will serve as supportive action towards conservation efforts.

The Vice-Chancellor, Sir, the problem that has remained the bane of tropical aquaculture has been that of inadequate fish seed and fish food. Solutions to fish seed production are found in adapting technologies for indoor production of fish seed. The success from şuch technologies is strongly hinged on a thorough understanding of teleost reproductive endocrinology as well as the underlying theories of/and the techniques of induced spawning in fish.

Teleost Reproductive Endocrinology

The nervous and endocrine systems of teleost fishes as in other vertebrates act in concert to coordinate reproductive events. The reception of environmental stimuli as day length (photoperiod), temperature and the amount of rain fall is mediated by the nervous system and it involves the passage of information from sensory receptors to the brain. The neural information on reaching the hypothalamus determines the activities of the pituitary gland by way of chemical messengers termed gonadotropin releasing hormones. These in turn stimulate the pituitary to release into the general circulation a hormone whose target organ is the gonad. The hormone is termed *GONADOTROPIN*. Its effect is to stimulate the production of the sex steroids in the gonads. These are responsible for the maturation of the gametes. The transmission from neural information to hormonal control takes place at the inter phase between the hypothalamus and the pituitary and this is where the detail consideration of the endocrinology of fish reproduction begins. It is evident that the pituitary gland regulates certain aspects of reproduction in all vertebrates. It is equally true that this control is sometimes less precise and embraces fewer elements of reproduction among fishes and furthermore, that there may be marked variations among different groups of fishes, hence the need for several approaches and "OPTIONS" towards induction.

Techniques in Induced Spawning

There are two approaches to induction of spawning in fish- Hormonal and Environmental Approach (fig. 4). After treatment, the fish in each approach may be stripped for artificial fertilization or left for natural spawning and fertilization. The fertilized eggs are then incubated and the hatched larvae raised to fry or fingerling stage in the hatchery which may be indoor or outdoor.

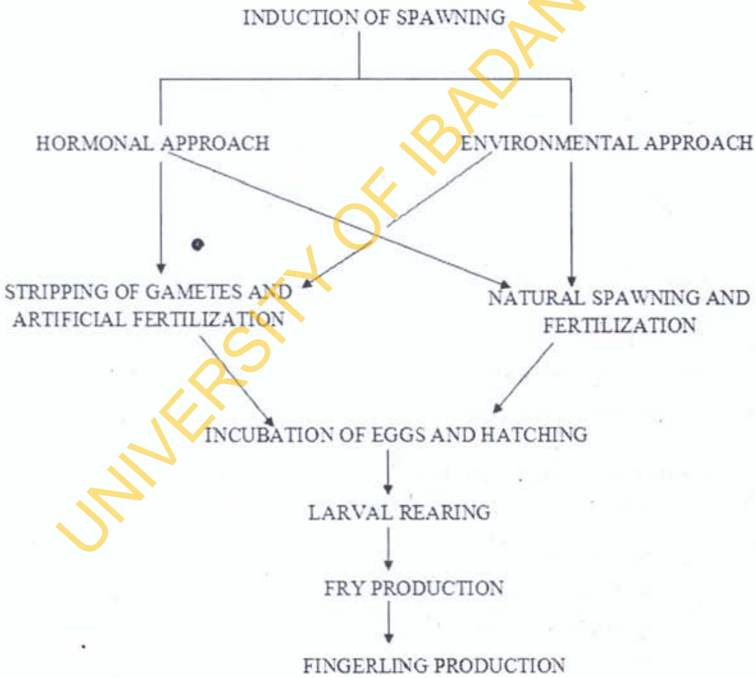
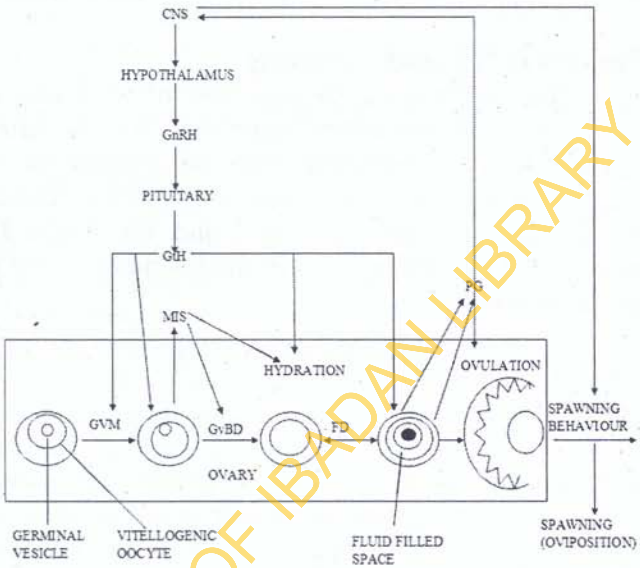


Fig. 4: Hormonal and environmental approaches to induction of spawning in fish (Modified after Hoar and Randall 1969).

Induced Spawning by Hormonal Approach

This approach is based on an understanding of the neuroendocrine control of oocyte maturation, ovulation and spawning behaviour in females and of spermiation and seminal hydration in males (fig. 5).



CNS = Central Nervous System; GnRH = Gonadotropin Releasing hormone; GtH = Gonadotropin hormone; MIS = Maturation Inducing steroid; PG = Prostaglandin; FD = Folicular detachment; GVM = Germinal vesicle migration

Fig. 5: Tentative schematic diagram on endocrine control of final oocyte maturation, hydration and ovulation in fish

Source: Hoar and Randall (1969)

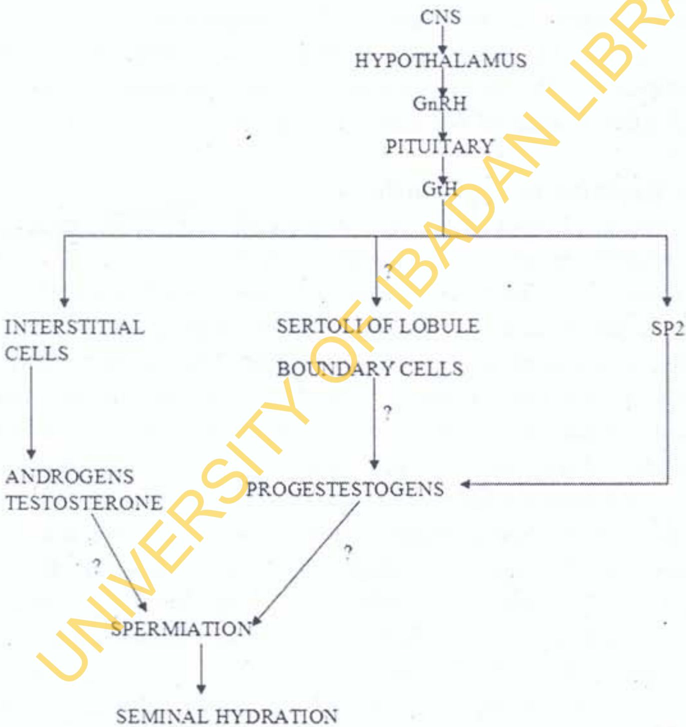
Generally, in females, hormonal treatment of fish is known to achieve the following:

(a) Stimulate the release of gonadotropin releasing hormone (GnRH) which causes the pituitary to secrete gonadotropin i.e gonadotropic hormone (GtH) into the blood stream

(b) When a certain level of GtH is reached, the germinal vesicle migrates to the periphery and the theca and granulose cells of the follicles are stimulated to secrete maturation-inducing steroid (MIS)

(c) The MIS induces germinal vesicle breakdown (GVBD) i.e resumption of meosis or final oocyte maturation as well as other associated events e.g hydration of eggs, grouping/coalescence of yolk granules and/or lipid droplets in some species.

In the males, the steroid mediation of GtH action on the testis to bring about spermiation and seminal hydration is not clear (fig. 6).



CNS = Central Nervous System; GnRH = Gonadotropin Releasing hormone; GtH = Gonadotropin hormone; SP2 = Another route for spermiation

Fig. 6: Tentative schematic diagram on neuroendocrine control of spermiation and seminal hydration in fish

Source: Hoar and Randall (1969)

The two approaches may and are often combined to obtain the best effects/results of induction.

Hypophysation

The use of pituitary extract to induce fish spawning is known as HYPOPHYSATION. Induced breeding achieved through hypophysation amounts to a "short cut" of the natural process. Gonadotropic hormone extracted from the pituitary of a fish (donor) is injected into the breeder fish to bring about final ovulation. Hypophysation is effective only when the eggs in the ovary have reached the resting or dormant phase i.e. after the completion of vitellogenesis (Stage IV). At this stage, the eggs are materially ready for further development to be triggered by the gonadotropins (see Maturation Stages of *E.lacerta* in fig. 3).

Contributions to Aquaculture

The paper Ugwumba and Ugwumba (2003) examined aquaculture options and the future of fish supply in Nigeria. There has been decline in returns from capture fisheries, thus using aquaculture to bridge the widening gap between domestic demand and supply of fish. The review recorded species which have shown through studies ability to tolerate culture conditions in terms of feeding habits, seed production and acceptability of artificial feeds. Tables 6 and 7 and figure 7 show prominent cultivable species in Nigeria with several unexploited potential candidate species. Presently under ten percent of the species listed are being cultured. Reasons include inadequacy of seeds, expensive artificial feed and lack of adequate knowledge of culture techniques. Ugwumba and Ugwumba (2003) also reviewed several documented reports on artificial propagation including Ugwumba et al. (1998) where we used Ovaprim in the Limpe Option to spawn fish.

Table 6: Summary of important Cultivable Tropical Fishes
(Modified after Maclaren 1949; Silvalingan 1973, Ezenwa 1979; Fagade, Adebisi and Ugwumba 1986)

No	Species	Market Value	Availability of Seed/Fry	Feeding Habits	Salinity Tolerance	Remarks/Potential Yield (kgha^{-1}yr^{-1})
1	*Parchanna obscura* (Snake head)	Average	Seasonal/ inadequate	Predatory	Freshwater	Good culture potential and is still experimentally tried to ascertain species combination for good production. Young are good for aquaria. Voracious predator, care must be taken in the stocking density
2	*Heterobranchus bidorsalis* (mud catfish)	Good	Seasonal	Omnivorous	Freshwater	Cultured extensively and attain large size in good time. Responds to fertilizer and supplementary feeding. Yield 4500 kgha^{-1}yr^{-1}
3	*Heterotis niloticus* (African bony tongue)	Good	Seasonal	Benthophagous/ Omnivorous	Freshwater	Effectively cultured to attain large size in time. Procurement of seed is experimentally being tried in induced breeding experiments; however fry and fingerlings are available in inland waters since they move in shoals. The apparent seasonality of the stock justifies the need for indoor production of seeds. Yield 5580 kgha^{-1}yr^{-}
4	*Lates niloticus* (Nile perch)	Very good	Scarce	Predatory	Freshwater	Fast growth-rate and good predator species to control tilapia numbers. Yield 5125 kg ha^{-1}yr^{-1}
5	*Gymnarchus niloticus* Giant trunk fish)	Good	Inadequate	Predatory	Freshwater	Fast growth rate and a good predator species for tilapia culture. Yield 5450 kgha^{-1}yr^{-1}
6	*Melapterurus electricus* (Electric catfish)	Good	Seasonal	Predatory	Freshwater	Possible choice to prey on excess tilapia

Table 6 contd.

7	*Chrysichthys nigrodigitatus* (silver catfish)	Very good	All year round but inadequate	Predatory	Freshwater/ Brackish water	Very hard and highly valued culture fish. High production results have been obtained and supplementary feed is very necessary. Initial set-back of inability to spawn in captivity has artificial breeding. Combines and grows well with tilapias in freshwater ponds, tilapias or mullets in brackish water ponds. Yield 4542 $kgha^{-1}yr^{-1}$
8	*Clarias gariepinus* (mud catfish)	Very good	Seasonal	Omnivorous	Freshwater	High culture potential and readily amendable to pond condition. Commonly cultured in Nigeria. High stocking density and grows to table size in good time. Grows well with Tilapia, *Heterotis* or Carp. Yield 400 $kgha^{-1}yr^{-1}$
9	*Cyprinus carpio* (common carp)	Good	All year round but inadequate	Omnivorous	Freshwater/ Brackish water	Universal acceptability for culture. Blends from fresh water to brackish environments. The initial taste problems with indigenous consumers seems to have been overcome. Expected to compete favourably with local species. Responds to fertilizer and supplementary feeding. Yield 2240 $kgha^{-1}yr^{-1}$
10	Tilapias *Oreochromis niloticus* *Sarotherodon melanotheron* *S. galilaeus* *Coptodon zillii* (=*Tilapia zillii*)	Good	All year round but inadequate	Phytophagous Detritivorous	Freshwater/ Brackish water	Hardy with wide acceptance for culture. About the most cultured species in tropical inland ponds. Hybridization and genetic manipulation for hardiness, taste, resistance to disease have improved culture of the species in ponds. Yield 4800 $kgha^{-1}yr^{-1}$

Table 6 contd.

11	*Elops larceta* (Ten pounder)	Low	Inadequate	Predatory	Freshwater/ Brackish water/marine	Fast growth, needs marine environment to spawn. Very sensitive to oxygen deficiency. Yield 4250 $kgha^{-1}yr^{-1}$
12	Mullets *Liza falcipinis* *L. grandisquamis* *Mugil cephalus* *M. bananesis* *M. curema*	Good	All year round adequate	Detritivorous Phytophagous	Brackish water	Universal culture potential. Good results in brackish waters. Can be acclimatized for fresh water culture. Polyculture with catfish.
13	*Tarpon (=Megalops) atlanticus* (Atlantic Tarpon)	Good	Seasonal	Predatory	Brackish water/marine	Culture potential is high in brackish waters. Good predator on excess tilapia. Yield 4542 $kgha^{-1}yr^{-1}$
14	*Pomadasys jubeline* (Grunter)	Good	Seasonal	Predatory	Brackish water/marine	Good predator species in brackish water ponds. Yield 1412 $kgha^{-1}yr^{-1}$
15	*Lutjanus sp.* (Snapper)	Good	Adequate	Predatory	Brackish water/marine	Good predator species in brackish water ponds. Yield 1 931$kgha^{-1}yr^{-1}$

Source: Ugwumba and Ugwumba (2003).

Table 7: Commonly Cultured Fishes of West Africa (FW fresh water, BW brackish water)

Species	English	Habitat
Cichlids		
Oreochromis niloticus	Nile tilapia	FW
Oreochromis aureus	Blue tilapia	FW
Sarotherodon galilaeus	Galilae tilapa (St. Peterfish)	FW
Coptodon (=Tilapia) zillii	Zilli's tilapia	FW
Coptodon (=Tilapia) guineensis	Guinea tilapia	BW/FW
Sarotherodon melanotheron	Blackjaw tilapia	BW/FW
Tilapia mariae	Swamp tilapia	FW
Hemichromis fasciatus	Jewel fish	FW
Catfishes		
Clarias gariepnus	Mud catfish (walking catfish)	FW
Clarias anguilaris	Giant mud catfish (walking catfish)	FW
Heterobranchus longifils	Giant catfish (walking catfish)	FW
Heterobranchus bidorsalis	Giant mud catfish (walking catfish)	FW
Chrysichthys nigrodigiatus	Silver catfish	FW/BW
Bagrus bayad	Silver catfish	FW/BW
Bagrus docmac	Silver catfish	FW/BW
Auchenoglanis biscutatus	Yellow catfish	FW/BW
Synodontis membranaceus	Upside down catfish	FW/BW
Arius gigas	Sea catfish	FW/BW
Moon fishes/Grass Eaters		
Citharinus latus	Moonfish	FW
Citharinus citarius	Moonfish	FW
Citharinus ansorgei	Moonfish	FW
Citharinus distichodoides	Moonfish	FW
Distichodus rostratus	African grass eater	FW
Carps		
Labeo coubie	African carp	FW
Labeo senegalensis	African carp	FW
Cyprinus carpio	Common carp	FW
Knife Fishes		
Notopterus afer	Knife fish	FW
Trunk Fishes		
Mormyrus rume	Trunk fish	FW
Mormyrops deliciosus	Trunk fish	FW
Hyperopisus bebe	Trunk fish	FW
Gynarchus niloticus	Trunk fish	FW

Table 7 contd.

Silver sides		
Brycinus (=Alestes) macrolepidotus	Silversides	FW
Brycinus (=Alestes) nurse	Silversides	FW
Brycinus baremoze (=Alestes baremose)	Silversides	FW
Stone tongue		
Heterotis niloticus	African Bony tongue/Slap water	FW
Perch		
Lates niloticus	Nile perch	FW
Snake head		
Parachanna obscura	Snake head	FW
P. africana	Snake head	FW
Mullets		
Mugil cephalus	Grey mullet	BW
Liza falcipinnis	Sickle fin mullet	BW
Liza grandisquamis	Large scaled mullet	BW
Ladyfish		
Elops lacerta	Ten pounder/West Africa lady fish	BW
Tarpon		
Tarpon (=Megalops) atlanticus	Tarpon	BW
Snapper		
Lutjanus goreensis	Gorrean Snapper	BW
Grunter		
Pomadasys jubelini	Grunter	BW
Carangids		
Trachinotus teraia	Pompano	BW

Source: Ugwumba and Ugwumba (2003)

Table 7 contd.

Silver sides		
Brycinus (=Alestes) macrolepidotus	Silversides	FW
Brycinus (=Alestes) nurse	Silversides	FW
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P. africana	Snake head	FW
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Ladyfish		
Elops lacerta	Ten pounder/West Africa lady fish	BW
Tarpon		
Tarpon (=Megalops) atlanticus	Tarpon	BW
Snapper		
Lutjanus goreensis	Gorrean Snapper	BW
Grunter		
Pomadasys jubelini	Grunter	BW
Carangids		
Trachinotus teraia	Pompano	BW

Source: Ugwumba and Ugwumba (2003)

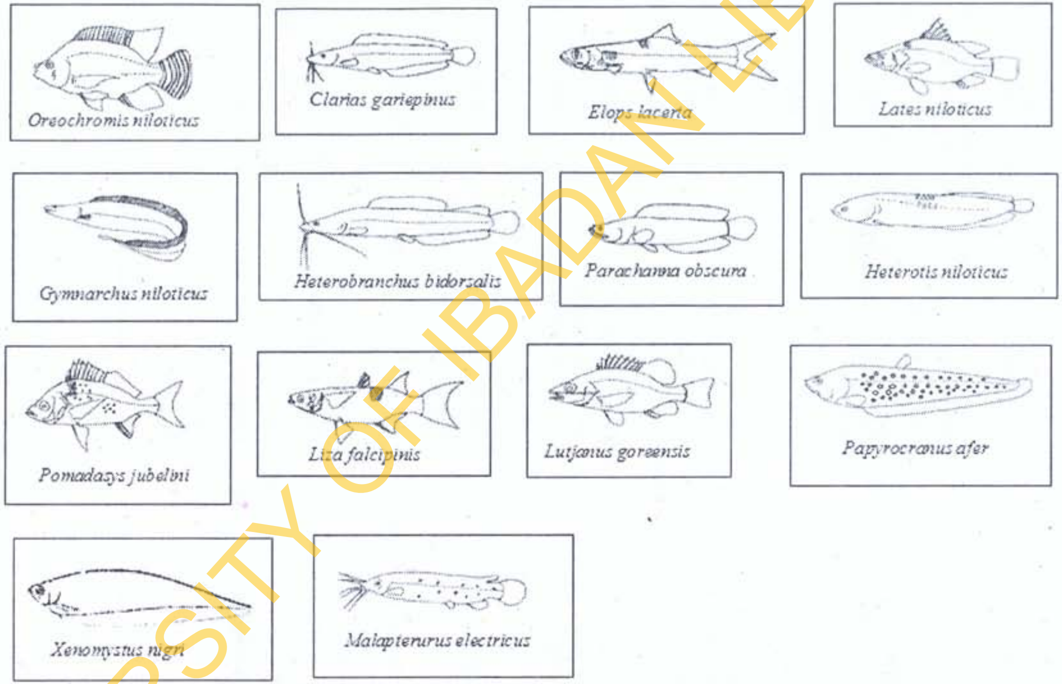

Fig. 7: Some potential candidate cultivable species.

Source: Ugwumba and Ugwumba (2003)

Limpe Option

The synthetic mammalian luteinizing hormone-releasing hormone (LHRH) and its superlative analogue and a combination of dopamine and LHRH analogues have been found promising in the continuous search for better and effective artificial breeding techniques. This is unavoidable since it is imperative that the replacement of pituitary material may assist in coping with the lack of uniformity in gonadotropin potency of pituitary homogenates and extracts. Mammalian steroids and gonadotropin are readily available and can be calculated exactly for potency and dosage and avoid the need to sacrifice mature fish for pituitary materials. The Limpe technique of inducing ovulation and spawning in fish with a combination of GnRH analogue (LHRH or GnRH-A) and dopamine antagonist (Pimozide or domperidome) has resulted in high rate of complete ovulation in short predictable time with resultant viable eggs. This combination known as Ovaprim is the most viable option to avoid production of low number of fertile eggs from pituitary extract.

Ugwumba, Ugwumba, Sowunmi, Bubu and Ofuani (1998) studied Ovaprim efficiency in artificial spawning of *Clarias gariepinus* with survival and early growth of hatchlings. The report showed that a single knock-out dose of Ovaprim (0.4 – 0.45ml for fish weighing 280 – 1,800g) administered intramuscularly during peak breeding period (June/July) of the species was very effective in inducing ovulation and spawning. Maximum latency period was 16 hours, incubation period ranged between 24 – 36 hrs under temperature and pH of 25°C – 27.2°C and 7 – 8 respectively (tables 8 – 10, fig. 8).

Table 8: Percentage Larval Production and Survival in Ovaprim Induced *C. gariepinus*

Spawning	Tank No.	No. of Stripped Eggs	No. of Fertilized Eggs	No. of Hatched Eggs	Percentage Larval Production	No. of Deformed Larvae	No. of Normal Larvae	Percentage Larval Survival	Percentage Larval Mortality
	1	17290	13300	9310	70	2810	6500	69.8	30.2
1	2	-	-	-	-	-	-	-	-
	3	61180	53200	36620	68.8	11303	25317	69.1	32.5
	TOTAL	78470	66500	49630	69.1	14113	31817	69.3	30.7
	4	·61880	47600	34620	72.1	11332	22988	66.9	33.1
2	*5	-	-	-	-	-	-	-	-
	6	69160	53200	36240	68.1	11607	24633	67.9	32.0
	TOTAL	131040	10080	70560	70.0	22937	47621	67.5	32.5
	8	65520	50400	34280	68.0	13470	21810	63.6	36.5
3	9A	29120	22400	17040	46.1	6458	10582	62.1	37.1
	9B	32760	25200	18640	74.0	6235	12405	66.6	33.4
	11	47530	36400	26600	73.1	8392	18208	68.5	31.5
	TOTAL	174930	134400	96560	71.8	33555	63005	65.2	34.8

* Unripe eggs

Source: Ugwumba, Ugwumba, Sowunmi, Bubu and Ofuani (1998)

Table 9: Growth Performance of Induced *C. gariepinus* (First 14 days after Yolk sac Absorption)

Spawning	Initial Average Body Weight (mg)	Final Average Body Weight (mg)	Weight Gain/14 Days (mg)	Weight Gain/Day (mg)	Percentage Gain (%)	Specific Growth Rate (SGR) (%)	Food Intake	Food Conversion Ration
1	1.88	2.53	0.67	0.05	35.6	0.9	0.217	4.34
2	1.80	2.66	0.96	0.006	47.8	1.2	0.223	3.72
3	1.85	3.26	1.39	0.10	75.1	1.8	0.232	2.32

Source: Ugwumba, Ugwumba, Sowunmi, Bubu and Ofuani (1998)

Table 10: Dosage of Ovaprim Administered, Latency Period, Fecundity and Pseudogonadsomatic Index in *C. gariepinus*

Tank	Body weight (g)	Dosage Ovaprim ml/kg BW	Weight of eggs (g)	Percentage weight of egg to body weight %	Latency period	Fecundity	Pseudo. GSI %
FIRST SPAWNING							
FEMALE							
1	320	0.16	80	25.0	15h.28min	14000	33.33
2	680	0.34	-	-	16h	-	-
3	440	0.25	50	11.3	15h.53min	28000	12.82
MALE							
7	670	0.34	-	-	14h.10min	-	-
SECOND SPAWNING							
FEMALE							
4	480	0.25	80	16.3	16h.52min	56000	20.00
5	400	0.20	-	-	15h.50min	-	-
6	400	0.20	80	20.0	15h.53min	56000	25.00
MALE							
10		0.45	-	-	13h.54min	-	-
THIRD SPAWNING							
FEMALE							
8	280	0.14	80	28.5	15h.32min	56000	40.00
9A	280	0.14	40	14.2	15h.23min	28000	16.66
9B	320	0.16	20	6.2	15h.3min	28000	6.66
11	600	0.30	40	6.6	13h.45min	39960	7.14
MALE							
12	1400	0.35	-	-	14h.5min	-	-

Source: Ugwumba, Ugwumba, Sowunmi, Bubu and Ofuani (1998)

Conclusions from the findings:

- When timed to peak breeding period, a single knockout dose of Ovaprim was enough to induce ovulation
- Maximum latency period of 16hrs was Ovaprim dependent
- Very high number of fertilised and hatchable eggs as well as high larval production can be obtained with the use of Ovaprim
- High larval production indicates overall good egg quality and effectiveness of Ovaprim in inducing ovulation and spawning in African mud catfish (table 8)

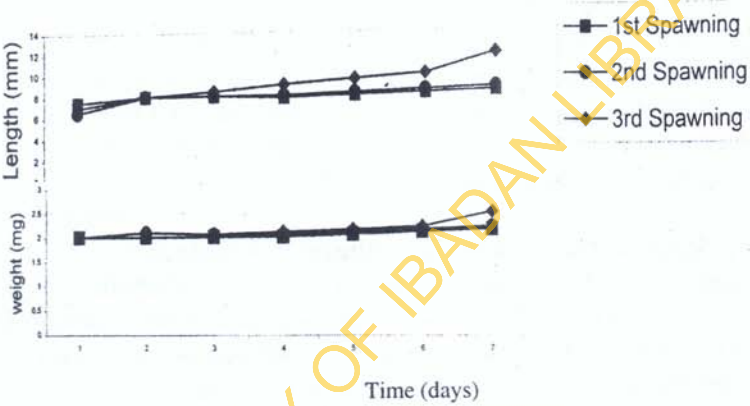

Fig. 8: Early growth of *C. gariepinus.*

Source: Ugwumba, Ugwumba, Sowunmi, Bubu and Ofuani (1998)

This is a further confirmation that manipulation of the hypothalamus-pituitary gonadal axis with the aid of synthetic hormones and non-hormonal agents can produce all year round eggs for fish seeds in farms. Advantages of Limpe option include effectiveness of labour, reduced stress of brood-stock as fish is handled once to give a single knockout injection. Thus, it is not difficult to apply. Furthermore, Ovaprim is stable with precise dosage and it is not immunogenic (Ajuzie and Fagade 1992). However, it should be noted that Ovaprim is imported to Nigeria and it is therefore expensive. Despite this, it is in high demand because of its effectiveness which makes its use very profitable.

In addition, this method showed that fish farmers could provide simple workable experimental sites where fish seeds can be produced in the farm to reduce stress due to transportation as well as avoid being supplied with "trash fish" by dishonest fry vendors. Hypophysation along this line despite its apparent sophistication remain a method of choice for the rural fish farmer since it may be carried out in the absence of such amenities as centrifuge, electrical balance and refrigeration.

Vice-Chancellor, Sir, our other studies examined best options for food/feed of fishes in captivity to a level that it won a National Award of the NUC for Best Doctoral Thesis in Biological Sciences within the Nigerian University System in 2007 (from the sáme Fisheries Unit in the Department of Zoology). This story will be told appropriately and by the right person in due time.

Environmental Research (Aquatic Toxicology)

Joint research on aquatic toxicology has been ongoing in Ecology and Environmental Biology Research Unit of our Department. This unit has been a melting point where staff from the research units join others to conduct research thus bringing in all aspect of Zoology to bear on Ecology. After all Sir, we are all ecologists seeing the animals and their world from different perspectives. These are my few humble contributions to aquatic toxicity and health in our Ecology and Environmental Biology Research Unit:

Okorie, Ugwumba and Okon (1992); Okorie, Ugwumba and Obafemi (1993) conducted static bioassays on the effects of *Piper guineense* on fingerlings of *Oreochromis niloticus* (Linn) and *Sarotherodon galilaeus* (Linn) using three preparations – oven dried powder, hot-water extract and ethanolic extract of *P. guineense*. The study showed that the ethanolic extract had piscicidal potential and advocated the possible use of *P. guineense* to selectively eliminate unwanted trash species of fish in aquaculture.

Esenowo and Ugwumba (2010) reported the growth response of catfish (*Clarias gariepinus*) exposed to water soluble fractions of detergent and diesel oil (pollutants of our aquatic environment). The study established that growth of *C. gariepinus* was adversely affected by water soluble fractions of diesel oil and detergent. Both induced various adverse behavioural responses depending on toxicant concentration and duration of exposure. Generally, detergents negatively affected the growth and survival of catfish fingerlings more than crude oil.

Nkpondion, Ugwumba and Esenowo (2016) reported toxic effects of detergent on enzymatic and protein activities of African mud catfish (*Clarias gariepinus*). The study showed that juvenile mud catfish exposed to even sub lethal concentrations of detergent induced toxic effects in the form of enzymatic degradation and organ damage which can make the organism vulnerable to diseases and eventually lead to death. Hence, we noted that environmental monitoring on regular basis will detect abnormal changes in organism's physiology for appropriate action to be taken before outbreak of epidemic.

Olarimoye, Bakare and Ugwumba (2015) on pharmaceuticals as environmental contaminants of concern in Nigeria. Against the background that very little information exist about the presence of Pharmaceutically Active Compounds (PHACs) in faunal and floral matrices, very little information from the African regional group and virtually none from Nigeria, our ongoing research currently employed recent advances in analytical protocols to detect and quantify several PHACs. A targeted snapshot reconnaissance investigation on surface water and benthic samples from six locations in Lagos Nigeria covered a range of different pharmaceuticals including antibiotics, estrogens, non-steroidal anti-inflammatory drugs (NSAIDs) and lipid lowering drugs. Screening showed that, the thirty seven detected had concentration of up to 8.84μg/L and four were found at levels exceeding allowable concentrations. The PHAC's presence established by this investigation especially in the very available and misused pharmaceutical families: antibiotics and the NSAIDs raise concern about the probable effects of unregulated use, their disposal and sewage impaction on water bodies, aquatic flora and fauna. The study suggests the need for Nigeria not just to acknowledge such issues as environmental concern but a priority for quick action as in the developed world.

In further studies along same line with the German Environmental Protection Agency (Umweltbundesamt) partners, we reported in Olarimoye, Bakare, Ugwumba and Hein (2016) that in industrial, domestic and hospital sewage sludge from Lagos Nigeria, nine different pharmaceutical substances were detected with the NSAID, dichlofenac present in all samples at concentrations of up to 11000 μg/kg dry weight, exceeding the highest measured concentration of 560 μg/kg reported in sludge samples worldwide. The study suggests comprehensive water monitoring campaigns especially in high density area with dilution of treated and untreated waste water in receiving streams. A need to include investigations of ground water, tap water/drinking water, manure, soil and sediments as additional matrices of concern will generate holistic pictures of the spatial environmental presence and concentration of PHACs.

Adeogun, Onibonje, Ibor, Omiwole, Chukwuka, Ugwumba O.A., Ugwumba A.A.A. and Arukwe (2016) reported endocrine-disruptor molecular responses, occurrence of intersex and gonado-histhopathological changes in tilapia species from Awba Reservoir in University of Ibadan, Nigeria from studies with our counterpart laboratory partner in Norway. The studies revealed how anthropogenic introduction of endocrine disruption chemicals into the environment correlated with sediment contamination burden in Awba Reservoir. Observed endocrine disruptive responses associated with contaminant concentration included intersex and elevated expression of vitellogenin and zona radiata protein, all negative sensitive early warning signals of disruption in reproductive processes. These suggest that the contaminants elicited severe endocrine disruptive effects in Awba Reservoir biota, an important source of water supply and fish for the University of Ibadan community (see figs. 9, 10 & 11).

Mr. Vice-Chancellor, Sir, the health consequences is probably the biggest issue of concern regarding the contamination burden in Awba Reservoir. The study contributes immensely towards the establishment of biomarker responses or monitoring protocols for feral fish species and human health in Nigerian rivers and streams providing useful information for sustainable management of environmental and potential human health issues.

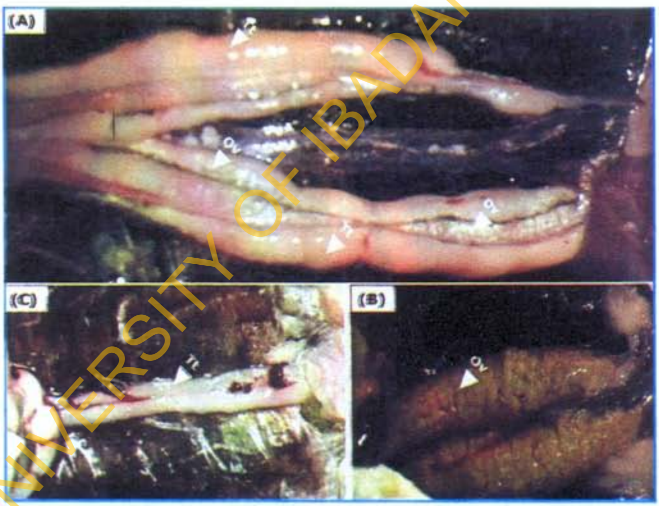

Fig. 9: Gross morphological examination of fish gonads at Awba Reservoir showing – (A) intersex *Sarotherodon melanotheron* with ovaries (ov) and testis (Tt); (B) Normal male *Sarotherodon melanotheron* with a normal testis (Tt); and (C) Normal female *Sarotherodon melanotheron* with ovaries (ov).

Source: Adeogun et al. (2016)

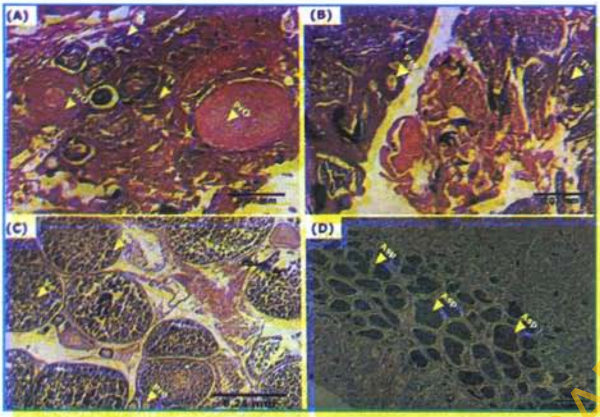

Fig. 10: Histological sections of tilapia gonad showing – (A) female intersex *Sarotherodon melanotheron* with testicular tissues (Tt) developing alongside previtellogenic oocytes (Pro); (B) Male intersex *Tilapia* guineensis with primary oocytes developing alongside testicular tissues (Tt); (C) Normal female *Sarotherodon melanotheron* with vitellogenic oocytes (vo) and previtellogenic oocytes (Pro); and (D) Normal male *Tilapia guineensis* with active spermatocyes (Asp).

Source: Adeogun et al. (2016)

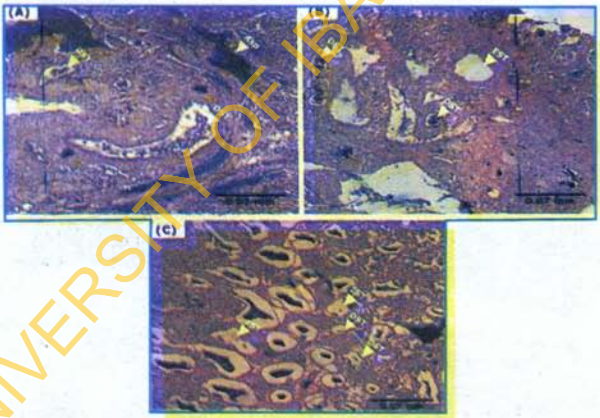

Fig. 11: Alteration in gonadal development of *Tilapia* species sampled at Awba Reservoir showing – (A) Male *Tilapia guineensis* with active spermatocytes (Asp) and degeneration in the seminiferous tubules (DST); (B) Male *Sarotherodon melanotheron* with empty seminiferous tubules (EST) and degeneration in the seminiferous tubules (DST); and (C) Male *Sarotherodon melanotheron* with empty seminiferous tubules (EST) and degeneration of the seminiferous tubules (DST).

Source: Adeogun et al. (2016)

Contribution through Books/Chapters in Books/Reports/ Manuals

Mr. Vice-Chancellor, Sir, over the years I have been involved in teaching and research as well as book writing, manuals and reports for the industry, research, non tertiary and tertiary institutions. Motivation to write a secondary school textbook came from experience from the years I served as examiner for the Senior Secondary School and West African Examination Boards. The marks obtained in Biology were comparatively low in the eighties. To me and my colleagues in the Department, one of the problems was how students answer biology questions. Also, students scored low in questions on conservation and biodiversity as well as wildlife and ecology at the O' level Examinations.

In Odaibo and Ugwumba (2003): *Mastering Series in Biology* – Macmillan Press Plc, we included model questions and answers in all chapters of the book with a good coverage of the biology syllabus at O'level Secondary School Certificate Examinations. The book received commendation even from our undergraduate students that found it still relevant and appropriate at the university level for general biology courses. In a follow-up book which I was invited to join secondary school biology teachers to write, we adopted the same pattern in Adebayo-Begun, Ugwumba, Sallam and Sarumi (2005): *Integrated Science for JSCE: Examination Focus Series in Biology*. University Press Plc.

Along our research area, I joined to co-author a fisheries research text book: Ugwumba and Ugwumba (2007) *Food and Feeding Ecology of Fishes in Nigeria*. Research results presentations of our findings along with other colleagues in the chosen field for undergraduate and postgraduate students of Fisheries Science in Nigerian Universities and also for fisheries researchers were fully documented.

As Director of the Zoological Garden (1990-1995), when we embarked on the Secondary School/Children Zoo project, I joined in writing the following:

- Okwilagwe and Ugwumba (1992) *Andy and Sally Zoo Series. University Zoo in Pictures.*
- Ugwumba (1995a) The Zoological Garden, University of Ibadan. Reminiscences and future survival.
- Ugwumba (1995b) Apes in the Zoological Garden, University of Ibadan.

For the international audience, I joined in writing the following:

- Fagade, Ugwumba and Ezenwa (1992) Introduction to Aquaculture: Aquaculture Development in Africa. *Training and Reference Manual for Aquaculture Extension in the Commonwealth.*
- Fagade and Ugwumba (1992) Species selection and identification. *Training and Reference manual for Aquaculture Extensionist in the Commonwealth.*

For the Nigerian Association of Aquatic Sciences, I joined to edit:

- Ezeri, Otubusin, Ugwumba and Ugwumba (1998) *Sustainable Utilization of Aquatic/Wetland Resources.*

For the Book builders Education-Africa we wrote a chapter:

- Ugwumba and Ugwumba (2012) Poverty Alleviation through Aquaculture. In *Poverty Alleviation from Biodiversity Management.*

For the industry/NGOs/stakeholders, the following are my humble contributions:

- Ugwumba (1993a) Environmental pollution in the oil industry and its effects on Human and Aquatic lives. Safety, Health and Environmental Campaign – PPM (NNPC), Ibadan.

- Ugwumba (1993b) Aquatic pollution and control measures with emphasis on freshwater fishponds. Oyo State MRTM/ADP.
- Ugwumba (1997) Hydrobiology of Agbada I & II Field development projects. In N.N.P.C. Eastern Division E.I.A. Studies.
- Ugwumba (1998) Hydrobiology and fisheries of the site for Gas-to-Liquid Project in Excravos. In Chevron Nigeria Limited E.I.A. Studies.
- Ugwumba (1999a) Animal faunal studies for site OML 53 Exploratory Drilling Programme. In Chevron Nigeria Limited EIA Studies.
- Ugwumba (1999b) Biodiversity (Animal fauna/ wildlife) in Owerrinta, Natural Gas Pipeline Project. In Shell Nigeria Gas, EIA Studies.
- Ugwumba (1999c) Hydrobiology and fisheries of Imo River in Owerrinta Natural Gas Pipeline Project. In Shell Nigeria Gas, EIA Studies.
- Ugwumba (2001) Environmental Baseline Studies, Agbami Field Development. In Chevron Nigeria Limited. EIA Studies.
- Ugwumba (2009a) Marine Resources of the Nigeria Coast: Need for conservation. Invited Lead Paper: National Stakeholders Workshop on Marine Environment Monitoring. Initiative of Nigeria Atomic Energy Commission (NAEC) and International Atomic Energy Agency (IAEA) – Use of Nuclear Technology in the Assessment of Contamination in the Marine Environment.
- Ugwumba (2009b) Current status of Environmental Pollution in Nigeria: Water Pollution. Genetic and Molecular Biology Approaches to Disease control and Environmental Pollution Management in Nigeria.
- Scientific and Environmental ROV Partnership using Existing Industrial Technology, Total Nigeria/ University of Southampton – Country Expert, Oil Field of Bonny & Biodiversity Studies, DEEP SEA – USAN BIODIVERSITY SURVEY REPORT (2010).

In all these, I was called a hydrobiologist, Fisheries Scientist, Animal Scientist (Animal fauna/wildlife Ecologist), Biodiversity Consultant, Pollution Expert/Consultant, Conservationist, Marine Biologist and Limnologist. However to me, I am simply a Zoologist seeking/studying/conducting research in new areas to impact on my students and the Society.

Biodiversity and Pollution in Nigeria Coastal Zone

The Vice-Chancellor, my second research activities in the marine environment was that of an environmental evangelist. In doing so, I will described an environment as comprised of every animate and inanimate influence which bears on man, his life, health and livelihood. During earlier research activities, I used fish in the study of fisheries of lagoons and coastal waters of Nigeria. Hence, quite many of them were sacrificed for the just cause—to improve, maintain, sustain, conserve and perpetuate the resource.

Earlier studies in this zone were quite many but I frequently refer to the book of Late Prof. Emmanuel Obot of the Nigerian Conservation Foundation (may his soul rest in peace) titled: "Oil Rivers of the ARMPIT OF AFRICA" where he described the tapped and untapped resources that abound in our coastal waters and described the Niger Delta zone like other biodiversity experts as a "Biological hotspot" with locally and globally endangered species. The Delta is also a repository of fish biodiversity with a minimum of 314 species from 158 genera and 64 families. Professor Martin Ogbe submitted in "Wetland, water and poverty eradication in a water-short world" the problems in our wetlands along the coast and wetland services we take for granted. In my own submissions – Ugwumba 2009 and 2011 on "The current status of Environmental Pollution in Nigeria" and "Marine Resources of Nigeria – some yet unknown: need for conservation", I listed the problems of the coastal zones and the way forward in pollution studies and abatement.

Wetland services we take for granted:

- Water storage and purification
- Flood water control
- Ground water replenishment
- Nurseries for fresh water and marine fishes
- Shoreline stabilization and protection against storm
- Nutrient and sediment retention
- Carbon storage
- Support for biological diversity
- Climate change mitigation
- Place for recreation and tourism
- Transport

However, major wetland values/products easily identified include finfishes, shellfishes, fruits, fodder, fuel wood, medicinal plants, timber and other building materials such as reeds and palms.

In Ugwumba (2009), I listed the problems of coastal zones of Nigeria to include:

- Over population
- Environmental pollution
- Gas Flaring
- Oil spills
- Sewage
- Solid wastes
- Climate change: sea level rise
- Fish stock depletion and habitat degradation
- Construction activities e.g. land reclamation
- Coastal erosion and flooding

(See Plates 1 to 12).

Plate 1: Swamp in the Niger Delta (before pollution)

Plate 2: A Typical rain forest in Niger (before pollution)

Plate 3: Oil exploration

Plate 4: Impact of oil exploration

Plate 5: Accident with oil tanker

Plate 6: Gas flaring

Plate 7 : Oil spill fire

Plate 8: An outburst of an oil pipe

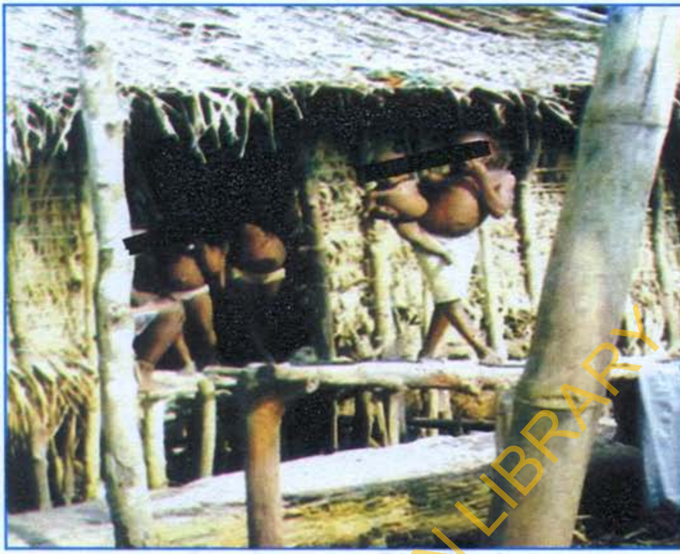

Plate 9: The face of poverty

Plate 10: A common source of supply of drinking water

Plate 11: Malnourished babies as a result of poor harvest and low yield

Plate 12: Associate congenital malformation as a result of gas flaring

Living Resources of the Nigerian coastal zone include:

- Marine and Brackish water finfishes (table 11)
- Commercially important shell fishes (table 12)
- Marine mammals (table 13)

Table 11: Important Marine and Brackish Water Fishes of Nigeria

Family	Common Name	Scientific Name
Cartilaginous Fishes		
Alopidae	Big eye thresher	*Alopias supercilliosus* (Lorme 1939)
	Thresher shark	*A. vulpinus* (Bonnaterre 1788)
Carcharinidae	Bull shark	*Carcharinus leucas* (Valenciennes and Henle 1839)
	Black tip shark	*C. limatus* (Valenciennes in Muller and Henle 1839)
	Milk shark	*Rhizoprionodon acutus* (Ruppell, 1837) (= *Scoliodon terranovae*) (Richardson 1836)
Hexanchidae	Six gill shark	*Hexanchus griseus*
Lamnidae	Great white shark	*Carcharodon carcharias* (Linnaeus 1758)
Odontaspididae	Sand tiger shark	*Eugomphodus taurus*
Peudocarchariidae	Crocodile sharks	*Pseudocarcharias kamoharai*
Sphyrinidae	Smooth hammer head	*Sphyrna zygnaena* (Linnaeus 1758)
	White fin hammer head	*Shyrna couardi* (Cadenat 1950)
	Scalloped hammer head	*S. lewini* (Griffith and Smith 1834) (= *S. diplana* Springer 1941)
Triakidae	Tope shark	*Galeorhinus galeus* (Linnaeus 1758)
	Tope shark	*Mustelus mustelus* (Linnaeus 1758)
Pristidae	Large tooth Sawfish	*Pristis microdon* (Lathman 1794) (= *pristis perottei* Muller and Henle 1841)
	Small tooth	*P. pectinata* (Latham 1794)
	Common sawfish	*P. prestis* (Linnaeus 1758)
Dasyatidae	Rough tail sting ray	*Dasyatis cenroura* (Mitchill 1851)
	Daisy sting ray	*D. margarita* (Gunther 1870)
	Common sting ray	*D. pastinaca* (Linnaeus 1758) (= *Trygon pastinaca)* (Linnaeus 1758)
	Round sting ray	*Taeniura grabata* (E. Greoffory Saint Hilaire 1817)

Table 11 contd.

Mobulidae	Giant Atlantic Mantu	*Manta birostris* (Donnderff 1758)
		Mobula rochebrunei (Vaillant 1879)
Myliobatidae	Common eagle ray	*Myliobatis Aquila* (Linnaeus 1758) (= *M. cervus* Smith 1934)
	Bull ray	*Pteromylaeus bovines* (E. Greoffory St. Hilaire 1817)
Bony Fishes		
Acanthuridae	Monrovia doctorfish	*Acathurus monroviae* (Steindachner 1876)
Albulidae	Bonefish	*Albula vulpes* (Linnaeus 1758)
	Long fin bonefish	*Pterothrissus belloci* (Cadenat 1937)
Ariidae	Rough head sea catfish	*Arius latiscutatus* (Gunther 1864) (= *A. gambiensis* Cadenat 1950)
	Giant sea catfish	*A. gigas* (Boulenger 1911)
	Smooth mouth sea catfish	*A. heudeloti* (Valenciennes 1840)
Ariommatidae	Silver-rag drift fish	*Ariomma bondi* (Fowler 1930) (=*Paracubiceps multisquamis* Marchal 1961)
	Brown drift fish	*A. melanum* (Ginsburg 1954) (=*Paracubiceps multisquamis* Marchal 1961)
Balistidae	Grey trigger fish	*Balistes capriscus* (Gmelin 1788)
	Blue spotted trigger fish	*B. punctatus* (Gmelin 1788)
Batrachoididae	Hairy toadfish	*Batrachoides liberiensis* (Steindachner 1867)
Bothidae	Cape scaldfish	*Arnog lossuscapensis* (Boulenger 1898)
	Imperial scaldfish	*A. imperialis* (Rafinesque 1810)
	Wide-eyed flounder	*Bothus podas africanus* (Nielsen 1961)
	Channel flounder	*Sycium micrurum* (Ranzani 1840) (= *S. guineensis* Bleeker 1853)

Table 11 contd.

Carangidae	Alexadria pompano	*Alectis alexandrines* (Geoffroy St. Hilaire 1817) (= *Syris alexandrines*) (=*Hynnis goreenisis* Cuvier 1833)
	Blue runner	*Caranx crysos* (Mitchill 1815)
	Crevalle jack	*C. hippos* (Linnaeus 1766)
		C. senegallus Cuvier 1833 (= *C. africanus*, Steindachner 1833)
	Atlantic bumber	*Chloroscombrus chrysurus* (Linnaeus 1776)
	Round scad	*Decapterus punctatus* (Cuvier 1829)
	Rainbow runner	*Elegatis bipinnulata* (Quoy and Gaimard 1825)
	Two-colour jack	*Hemicaranx bicolor* (Gunther 1860)
	African moonfish	*Selene dorsalis* (Gill, 1863) (= *Vomer gibbiceps* Gilchrist and Thompson 1914)
	Greater amberjack	*Seriola dumerili* (Risso 1810)
	Longfin pompano	*Trachinotus goreensis* (Cuvier 1832)
Citharidae	Spotted flounder	*Citharius einguatula* (Linnaeus 1758)
Clupeidae	Bonga shad	*Ethmalosa fimbriata* (Bowdich 1825) (= *E. dorsalis* (Valenciennes 1847)
	West African ilisha	*Ilisha africana* (Bloch 1795)
	Round sardinella	*Sardinella aurita* (Valenciennes 1847)
	Madeiran sardinella	*S. maderensis* (Lowe 1839)
Coryphaenidae	Pompano dolphinfish	*Coryphaena equiselis* (Linnaeus 1758)
Cynoglosidae	Nigerian tonguesole	*Cynoglossus browni* (Chabanaud 1949)
	Ghanaian tonguesole	*C. cadenati* (Chabanaud 1947)
	Canary tonguesole	*C. canariendis* (Steindachner 1882)
	Guinean tonguesole	*C. monody* (Chabanaud 1947)

Table 11 contd.

	Senegalese tonguesole	*C. senegalensis* (Kamp 1858)
	Elongate tonguesole	*Symphurus ligulatus* (Cocco 1844)
Dactylopteridae	Flying gurnard	*Dactylopterus volitans* (Linnaeus 1758)
Drepanidae	African sicklefish	*Drepane Africana* (Osorio 1892)
	West African ladyfish	*Elops lacerta* (Valenciennes 1846)
	European anchovy	*Engraulis enrasicolus* (Linnaeus 1758)
	African spade fish	*Chaetodipterus goreensis* (Cuvier 1831)
	West African spage fish	*C. lippie* (Steindachner 1895)
	Blue spotted cornetfish	*Fistularia tabacaria* (Linnaeus 1758)
	Flagfin mojarra	*Eucinostomus melanopterus* (Bleeker 1863)
	Guinean stripped Mojarra	*Gerres nigri* (Gunther 1859)
	Greater soapfish	*Rypticus saponaceus* (Bloch and Schneider 1801)
Haemulidae (=Pomadasyidae)	Bigeye grunt	*Brchydeuterus auritus* (Valenciennes 1831)
	Sompat grunt	*Pomadasys jubelini* (Cuvier 1830)
	Pigsnout grunt	*P. rogerii* (Cuvier 1830) (= *P.suillus*) (Valenciennes 1833)
Hemiraphidae	Ballyhoo halfbeak	*Hemramphus brasiliensis* (Linnaeus 1758)
Lutjanidae	African red snapper	*Lutjanus agennes* (Bleeker 1863)
	African brown snapper	*L. dentatus* (Dumeril 1860)
	Gorean snapper	*L. goreensis* (Valenciennes 1830)
Megalopidae	Atlantic tarpon	*Tarpon atlanticus* (Valenciennes 1846) (=*megalops atlanticus* Valenciennes 1846)

Table 11 contd.

Mugilidae	Sicklefin mullet	*Liza facipinnis* (Valenciennes 1836)
	Largescaled mullet	*L. grandisquamis* (Valenciennes 1836)
	Flat head grey mullet	*Mugil cephalus* (Linnaeus 1758)
Mullidae	West African goatfish	*Pseudopeneus prayensis* (Cuvier 1829)
Ophidiidae	Bearded brotula	*Brotula barbata* (Bloch in Bloch and Chneider 1801)
Platycephalidae	Guinea flathead	*Grammoplites gruveli* (Pellegrin 1905) (=*Platycephalus gruveli* Pellegrin 1905)
Polynemidae	Lesser African threadfin	*Galoides decadactylus* (Bloch 1758)
	Royal threadfin	*Pentanemus quiquarius* (Linnaeus 1758)
	Giant African threadfin	*Polydactylus quadrifilis* (Cuvier 1829)
Priacanthidae	Atlantic big eye	*Priacanthus arenatus* (Cuvier 1829)
Psetttodidae	Spottail spiny turbot	*Psettodes belcheri* (Bennett 1831)
Rachycentridae	Cobia	*Rachycentron cannadum* (Linnaeus 1766)
Sciaenidae	Blackmouth croaker	*Pentheroscion mbizi* (Poll 1950)
	Law croaker	*Pseudotolithus brachygnathus* (Bleeker 1863)
	Bobo croaker	*P. elongatus* Boodich 1825 (= *Corvina nigrita* Cuvier 1830)
	Guinea croaker	*P. epipercus* (Bleeker 1863)
	Cassava croaker	*P. senegalensis* (Valenciennes 1833)
	Longneck croaker	*P. typus* (Bleeker 1863)
Scombridae	Frigate tuna	*Auxis thazard* (Lacepede 1800)
	Little tunny	*Euthynmus alletteratus* (Rafinesque 1810)
	Skipjack tuna	*Katsuwonus pelamis* (Linnaeus 1758)
	Atlantic bonito	*Sarda sarda* (Bloch 1973)
	Abacocre	*Thunnus alalunga* (Bonnaterre 1788)
	Yellowfin tuna	*Thunnus albacores* (Bonnaterre 1788)
	Bigeye tuna	*Thunnus obesus* (Lowe 1839)

Table 11 contd.

Serranidae	White grouper	*Epinephelus aenues* (Geoffroy St. Hilaire 1809)
	Dungat grouper	*E. goreensis* (Valenciennes 1830)
	Dusky grouper	*E. guaza* (Linnaeus 1758) (= *E. gigas* Brunnich 1968)
	Esonue grouper	*E. itajara* (Lichtenstein 1822) (= *Promicrops ditobo* Roux and Collignon 1954)
	Ghanian comber	*Serranus acctaenis* (Norman, 1931) (= *Neanthias accreansisi* Norman 1931) (= *Novanthius accreansis* Norman 1931)
Soleidae	Four-eyed sole	*Microchirus ocellatus* (Linnaeus 1758)
Sparidae	Bogue	*Boops boops* (Linnaeus 1758)
	Angola dentex	*Dentex angolensis* (Poll and Maul 1953)
	Canary dentex	*D. canariensis* (Steindachner 1881)
	Congo dentex	*D. congoensis* (Poll 1954)
	Large-eye dentex	*D. macropthalmus* (Bloch 1791)
	Senegal seabream	*Diplodus bellottii* (Steindachner 1822) (= *D. senegalensis*, Cadanat 1964)
	Red Pandora	*Pagellus bellottii* (Steindachner 1822) (= *P. coupei*, Dieuzeide 1960)
	Red banded seabream	*Pagrus auriga* (Valenciennes 1843)
Sphyaenidae	Great barracuda	*Sphyraena barracuda* (Walbaum 1972) (= *S. picuda* Bloch and Schneider 1801)
	Guachanche barracuda	*S. gauchancho* (Cuvier 1829) (= *S. dubia* Bleeker 1863) (= *S. guaguache* Poey 1860)
Stromateidae	Butterfish	*Stromateus fiatola* (Linnaeus 1758) *S. faciatus* (Risso 1826) (= *S. microchirus* Cuvier and Valenciennes 1833) (= *S. capensis* Peppe 1866)
Synodontidae	Brazilian lizardfish	*Saurida basiliensis* (Norman 1935) (= *S. parri* Norman 1935)
Trichiuridae	Largehead hair tail	*Trichiurus lepturus* (Linnaeus 1758) (= *T. haumela* Forskal 1775)
Xiphiidae	Swordfish	*Xiphias gladius* (Linnaeus 1758)
Zeidae	John dory	*Zeus faber* (Linnaeus 1758)

Table 12: Commercially Important Shellfish Resources of Nigeria

Class/Family	Common Name	Scientific Name
Crustacea		
Geryonidae	West African geryon	*Geryon mariae* Manning and Holthius (=*Geryon quinquedens* Monod 1956)
Palaemonidae	Congo River prawn	*Macrobrachium dux* (Lenz 1910)
	Niger River prawn	*M. felicinum* (Holthuis 1949)
	Brackish water prawn	*M.macrobranchion* (Herklots 1851)
	African river prawn	*M. vollenhovehnii* (Herklots 1857)
	Estuarine prawn	*Nematopalaemon hastatus* (Aurivillus 1898) (=*Palaemon hastatus* Aurivillus 1898)
	Creek prawn	*Palaemonetes africanus* (Balss 1916)
Penaeidae	Guinea shrimp	*Parapenaeopsis atlantica* (Balss 1914)
	Deep water rose shrimp	*Parapenaeus longirosris* (Lacas 1848)
	Caramote prawn	*Penaeus kerathurus* (Forsskal 1775)
	Pink shrimp	*Penaeus (Farfantepenaeus) notialis* (Perez-Fantante 1967)
Mollusca		
Bivalves		
Arcidae	Senegal ark	*Anadara senegalensis* (Gmelin 1791)
	Costate cockle	*Cardium costatum*, (Linnaeus 1758)
	Gaping cockle	*C. ringens* (Bruguire 1789)

Table 13: Marine Mammals Commonly known to exist within Deep Offshore of the Nigerian Waters

Common Name	Scientific Name
Rough toothed dolphin	*Steno bredanensis*
Atlantic hump-backed dolphin	*Souse tuezil*
Risso's dolphin	*Grampus graseus*
Bottle-nose dolphin	*Tursiops truncates*
Atlantic spotted dolphin	*Stenella frontalis*
Pantropical spotted dolphin	*Stenella attanuata*
Spiner dolphin	*Stenella longirostris*
Clymene dolphin	*Stenella clymene*
Striped dolphin	*Stenella coeruleoalba*
Common dolphin	*Delphinus delphis*
Fraser dolphin	*Lagenodelphis hosei*
Melon-headed dolphin	*Peponocephala electra*
Pygmy killer whale	*Feresa attenuate*
False killer whale	*Psudorca crassidens*
Killer whale	*Orcinus orca*
Short-finned pilot whale	*Globicephala macrorhynchus*
Blainville's beaked whale	*Mesoplodon densirotis*
Cuvier's beaked whale	*Ziphius cavirostris*
Sperm whale	*Physeter macrocephalus*
Pigmy sperm whale	*Kongia breviscep*
Dwarf sperm whale	*Kogia simus*
Minke whale	*Balaemoptera acutorostrata*
Sei whale	*Belaneoptera borealis*
Byde whale	*Boalaeoptera edeni*
Blue whale	*Balaneoptera musculus*
Fin whale	*Baleneoptera physalus*
Humpback whale	*Megaptera noveagliae*

With these huge amounts of resources in our coastal waters, the need/rationale for conservation becomes an urgent issue for research and government interventions through sustainable management/preservation.

Rationale for Conservation of Coastal Zones

Conservation is defined as the highest sustainable quality for mankind by the rational utilisation of the environment and the total resources therein. A resource is defined as a commodity ready for use or available as needed since it may be renewable or non-renewable. Most clearly recognisable resources consist of living organisms characterised by being able to reproduce and regenerate their populations as long as environmental conditions remain favourable.

Conservation embraces the concept of the rational use of the environment which includes the preservation of certain areas and/or resources in an undisturbed condition because they are either of economic and scientific interest or have aesthetic/recreational appeal. Rational use implies the direct use of resource for their commodity or recreational value. The catching of fish is considered a legitimate part of rational use when carried out in a way that the resources is perpetuated and not endangered.

The conservation of species enables every species to fully develop its global values of biodiversity, specifically ecological, scientific and educational. Aquatic resources are assumed in-exhaustive hence the general belief – "just go and collect". The precision of fishing technology (echo sounder/ sonar, other fish detectors etc.) had increased the rate of exploitation faster than regeneration resulting to over fishing, particularly in our inshore waters characterised by relatively low catch without time to rejuvenate. Ruthless exploitation, habitat loss and desecration of all habitats by oil industries hasten drastic reduction and extinction of species. For Nigeria blessed with a long coastline (856km excluding indentations) rich with resources, there must be a harnessed programme of conservation and prevention/abatement of pollution.

Further reasons in support of protection and conservation include the fact that there are resources still unexploited and resources yet unknown with values yet untapped. In my submission on the World Ocean Day (2011) lecture, I attempted to show resources still in different museums awaiting full identification from our studies from Usan as well as earlier studies from our partners of the SERPENT Group (Scientific and Environmental ROV Partnership using Existing Industrial Technology). Challenges that faced the studies, which slowed down capture/and identification processes included:

- Remote environment
- Limited existing knowledge
- Evolving impact assessment methods need new information

Pollution Monitoring and Pollution Control/Abatement/ Prevention – Way Forward

The following are the emerging trends on the above:

A. ***Environment Impact Assessment (EIA)***

By law, all new facilities and already existing ones are supposed to conduct an EIA to be certified/clarified by the appropriate ministry to operate/transact business.

B. ***Environment Sensitivity Index (ESI)***

- Use of spatial coordinates to project systems through geo-informatics.
- Use of remotely based geospatial data using appropriate hardware and software to depict spatial variability, an initiative of RECTAS (Regional Centre for Training in Aerobase Surveys) OAU, Ile Ife.

C. ***Satellite Imagery***

Norwegian initiative/technology. Use of satellite imagery based on density/colour of seawater, estuaries, and coastline communities to assess contamination levels of water bodies: VERY EXPENSIVE

D. ***International Atomic Energy Agency (IAEA): A Proposed Partnership with other Countries (PROJECT RAF/7/000)***

- Resident in Ministry of Environment, Abuja.
- Operational Base/National Coordination, Department of Animal and Environmental Biology – University of Port Harcourt

Mandate/Objective of IAEA Proposed Project

Integration of functional network of laboratories using **nuclear analytical techniques** in pollution monitoring/ detection/assessment of contamination

- Baseline studies of "HOTSPOTS" for the identification of life forms.
- Show: Land/resource degradation/renewable resource depletion/environmental pollution

Question: Nuclear material emission/incidence/accidents/ nuclear contamination – Are these safe?

ANSWER: ????

E. ***Project "Serpent"***

"Scientific and Environmental ROV Partnership using Existing Industrial Technology" (SERPENT).

- Opportunistic use of Remotely Operated Vehicles (ROV) to gather environmental data through:
    - Video/still cameras
    - Live pictures
    - Physico-chemical parameters equipments
    - Corers
    - Grabs
    - Plankton monitoring
    - Benthos monitoring
    - Fish monitoring

Highlight of ROV
Multiple benefits from:

- Already existing technology
- Less cost for the researcher (220 ROVs is in existence. ROVs are already in use. About 200+ ROVs in the developed world – About 20 in Research Institutions, 200 in oil production/Exploratory facilities)
- Quick identification in the field
- Observe through seabed videos the organizational/ ecosystem/habitat interactions of organisms

"Serpent" Team
HOMEBASE: National Oceanographic Centre, Southampton, UK REPRESENTATIVE
Dr. Daniel Jones (Coordinator)
TOTAL NIGERIA – Charles Mbabure

Country Scientists

- Dr. Adesina Adegbae (Geophysicist, Nigeria Institute for Oceanography and Marine Research NIOMR)
- Prof. Alex Ugwumba (Professor of Zoology University of Ibadan, Marine Biology, Pollution and Environmental Consultant)

(The pictorial presentation of the Usan research team field trip in bourbon research vessel deep sea bed research is shown in plates 13 – 22).

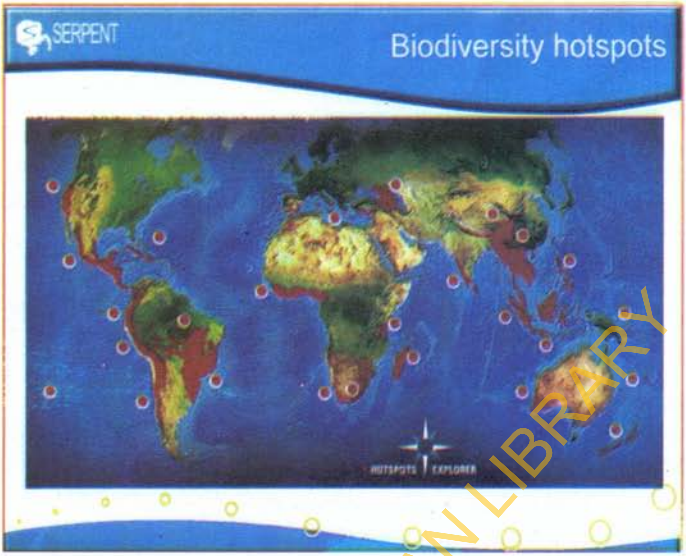

Plate 13: Biodiversity hotspots of the world

Plate 14: Basket throw of research team from rig to research vessel

Plate 15: Landing on to research vessel

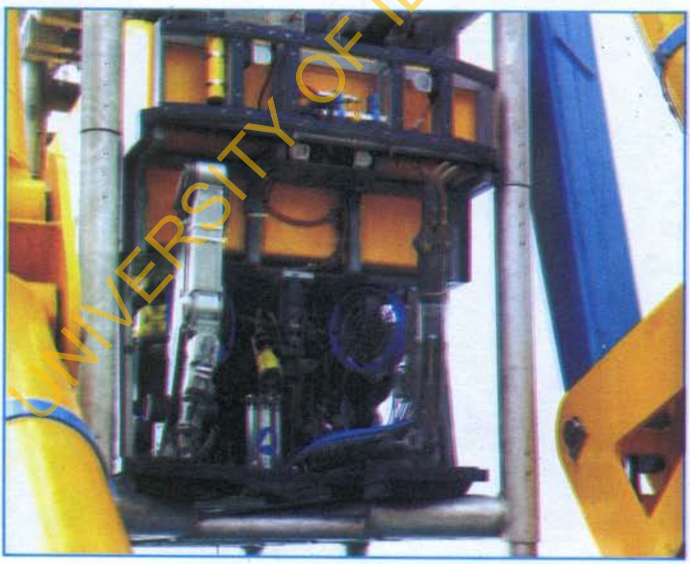

Plate 16: ROV (Remotely Operated Vehicle)

Plate 17: Plankton Net (PN) on ROV

Plate 18: ROV dive

Plate 19: ROV operations room

Plate 20: Fabricating/assembling equipment in mini lab

Plate 21: Research team

Plate 22: Captain/Chief Boatman – great hosts

Fishes – Some Yet Unknown

Against the background that our planet is largely composed of water with depths reaching 4000m in some areas, little is known of the creatures at these depths as well as the nature of ecosystem supporting the fauna. As we turn to the deep seas for wide range solution to mankind now and in the future, wise use of these resources in the deep seas demands knowledge of the resources and the fragile environment they reside in.

Fishes that abide in these deep abyss have displayed a wide variety of adaptations, modifications, behavioural responses to survive and live in the often dark ecosystems. Adaptations range from torpedo shapes, bioluminescence, balloon-shape formations, attachment surfaces to escape from predators as well as natural water movement. The presence of some of the species point to the presence/accumulation of natural resources in the deep sea bed. The fishes of our Usan study with our partners—National Oceanographic Centre, Southampton—are shown in plates 23 – 32.

Plate 23: Piglet squid (bloated in an excited state)

Plate 24: Unidentified pteropod gastropod

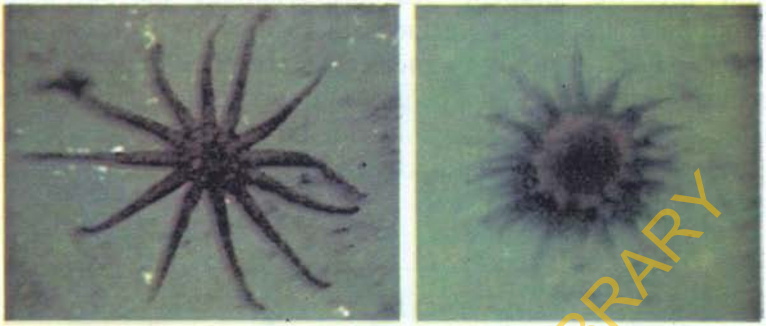

Plate 25: Unidentified sea anemone

Plate 26: Unidentified sea lily (a crinoid)

Plate 27: Unidentified comb jellyfish

Plate 28: Unidentified king crab

Plate 29: *Antimora rostrata*

Plate 30: Unidentified monk fish

Plate 31: Unidentified grey reef shark

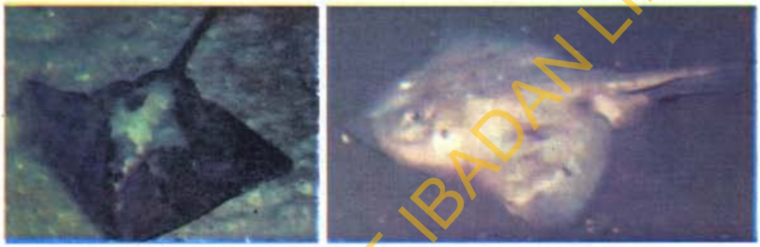

Plate 32: Unidentified ray/skate

Concluding Remarks and Recommendations

Vice-Chancellor Sir, over the years in pursuit of my academic career, I observed and sometimes joined in the formulation of policies, some of which are just "copycats" of several others before. It has always been a norm to just say something for the sake of it. However, it has become clear to some of us that this has been the reason why we keep complaining over and over again. We have not resolved the pertinent issue before we advance to the next robust and more complex issues.

Mr. Vice-Chancellor, Sir, over the years with my professional colleagues echoed promises to Nigerians – "Fish for all" in every decade. Very recently it has been moved to fish for all 2020. If for over three decades we have not been able to achieve this – is it in the next 3 – 4 years that fish will "flow" into every home in required/desired quantities and affordable prices? I hereby submit that until we quickly revisit with all sincerity why fish has not been available in the desired quantity and cost, we must stop these slogans.

I do reaffirm in line with other "HONEST FISHERMEN" in our calling:

- A vigorous promotion of fisheries as a viable commercial venture to be modified by the fisheries sector through research partnership and networking locally and internationally.
- Training at different levels on various aspects of fish culture, preservation and marketing.
- Ensuring that stake holders are registered members of Fisheries Society of Nigeria to coordinate best practises and dissemination of findings and polices.
- Provision of:

    - Fisheries statistical data base that is verifiable
    - Effective fisheries legislation and surveillance
    - Resolve conflicts between artisanal and industrial fisheries
    - Reappraise and eliminate factors limiting abundance of fish viz – fishing intensity, use of chemical poisons and ichthyotoxic plants, use of explosives, mesh size control etc.

Furthermore:

- Giving way to aquaculture and restocking cum rejuvenation of depleted water bodies
- Production of fish seeds and feeds
- Comprehensive Stock assessment
- Provision of fishing inputs and
- Extension Research Linkage

All these must be done with full consideration that the **HEALTH OF THE AQUATIC ENVIRONMENT** is the strategic base for the success of **"FISH FOR ALL AND FOR NOW".**

Our inland waters have become sources of livelihood for many; hence they should not be turned into sinks for impurities. It is time for the appropriate agencies to get on with their duties of monitoring, regulating and controlling what gets into the water bodies from several anthropogenic sources. Industries of all categories must fall in line and be made to abide with laid down regulations of disposal for a healthy aquatic environment.

The Nigeria Universities Commission's (NUC) present benchmark for academic programmes need to fall in line with present realities. Again, the University of Ibadan has approved new academic curricula submitted by different Departments. I will speak and defend what we did in the Biological Sciences and the Faculty of Science, Sir. We have taken Botany, Microbiology and Zoology as an applied science to the next decade. This is a wakeup call for NUC to adopt from University of Ibadan that is the **FIRST** and **STILL THE BEST.** Finally Mr. Vice-Chancellor, Sir, the University of Ibadan must reappraise the water bodies within the campus to ensure the quality of what is entering from the Ibadan metropolis and as well as within the campus. These must be monitored and checked before use by consumers on campus.

Acknowledgements
To God be the Glory for fulfilled dreams. I owe it all to my father who passed through the University of Ibadan on his way from Furrabay College Sierra Leone where he bagged an Inter B.A. Honours – European History. He vowed to have a son pass through the University of "IBADAN". Here I am, son of Mr. Nelson Oti Ugwumba (TEACHER OTI), Head Master/Principal in 11 primary schools and six secondary schools in Cross River, Akwa Ibom, Imo and Abia States Nigeria. MAY HIS SOUL REST IN PERFECT PEACE AFTER 91 years sojourn on earth.

I salute all my teachers, for that profession was a house hold name throughout my early teenage years. My sincere gratitude goes to the first generation of the Ibadan School of Zoology from the transitional mother of all, Dr. (Mrs.) M.B. Hill to Late Professors F.M.A. Ukoli and S.A. Toye; Professors M. Nwagwu, W.W.D. Modder and S.O. Fagade. From the Akoka Lagos School of Zoology, I salute Professor C.I.O. Olaniyan (product of Ibadan), Professors K. Kusemiju and W. Odiete. I appreciate them and their students who taught me and my other colleagues. I thank all my colleagues in the Department of Zoology, University of Ibadan who continued to follow the academic foundation and relationship handed down by our predecessors which have been devoid of geographical affiliations. I thank all my students at all levels for the cooperation and positive response to my often times demand for the best.

I am grateful to the Faculty of Science family, the elders (Professors – Ogunmola, Okorie D., Faniran, Okongwu, Adeleke, Odiaka, Adesomoju, Oso and Hussein to mention a few) and my colleagues and friends Professors – Odaibo, Onianwa, Olayinka (The current Vice-Chancellor), Sanni, Folurunsho, Oyelaran, Aleru, Onulide, Fagade, Adebowale just to mention a few. My supervisors – Late Professor S.A. Toye (B.Sc.) and Professor K. Kusemiju (Ph.D), I pray that your families will receive same unparalleled guidance like I got from you.

To my professional colleagues in the Fishery Society of Nigeria (FISON), I salute you all and also those in the Zoological Society of Nigeria (ZSN) that I am currently the President, I repeat my promise to serve you with MY ALL. To my in-laws of the Ekerenam Etim Amba Ekpo Family of Eyo Abasi, Oro Nation. Little will you know you were dealing with Princes and Princesses until you are told. May the great Lord continue to reward you for the joint family you forged with the Okon na akoro, Nde Owuu Clan of Ibom Village, Aro Nation through marriage. From the same family came one of the finest policemen this country groomed, Late

DCP Osung Ekpo "My Friend for Life" and "Crime buster per excellence".

I bow to the teachers of the Aro Nation from the Patriach Teacher, Late Alvan Ikokwu to Late Nwosu Okoro, Kanu Oti, Nwafor Udoh and others including Obinai Achinivu, Bassey Ijeomta, Godwin Umeham, Henry Nkemakolan. The bond between these teachers was so great that in Ibom Village Arochukwu, three "Colonial" buildings (adapted while in Hope Waddal Calabar) still exist, owned by Teachers Kanu Oti, Nwafor Udoh and Nelson Ugwumba.

I salute the President, Executive Committee and members of the Senior Staff Club, University of Ibadan, especially the present Exco who through hard work returned the club's glory to the 2003 – 2005 era when I was President and First Chairman Table I. Their ability to supervise and manage the huge investment by the University in the Staff Club is commendable. The club's history will always place you amongst the eggs heads or like the popular saying "the best brains that are best preserved in alcohol".

I am very grateful to the National Universities Commission (NUC) for exposing me to academic standards and ethical issues through trainings/workshops and accreditation exercises. These strengthened my vision on academic issues especially on the instruments of academic standardisation.

I thank the Vice-Chancellor, Igbinedion University Prof. (Rev.) E.E. Osaghae JP, The Registrar, Mr. Eddy Okoro and The Librarian, Mr. Yakubu Izevbekhai for providing me with a serene atmosphere to think and write this lecture.

I thank the University of Ibadan for apart from my basic academic assignments, allowed me to serve in several areas at various times:

- Member of different boards/committees/panels over the years till date
- Sub Dean Biological Science, 1990 – 1992

- Ag Director, Zoological Garden, 1990 – 1995
- Warden, Nnamdi Azikiwe Hall, 1996 – 1999
- Hall Master, Independent Hall, 2012 – 2015
- Head of Department of Zoology, 2003 – 2005
- Chairman, Senate Committee, General Studies Programme, 2014 – 2016
- Presently, Chairman, University Accreditation Committee and University Ranking as well as many others that are of coded description by the present Vice-Chancellor ("JJTs")

I thank my best and special friends:

- My daughter, Town Planner Bella Uchechi Ugwumba who recently completed her M.Sc. Programme from University of Ibadan.
- My son, Dr. Alex Obinna Ugwumba, a private medical practioner.
- My sister-in-law that took care of my children, Dr. Geraldine Umoh Ekpo Fashina, a Senior Lecturer in Ignatius Ajuru University of Education, Port Harcourt.
- My wife, Professor Adiaha A.A. Ugwumba, Head Department of Zoology University of Ibadan. We have come a long way through God's Grace. Given another chance, I will marry you again and again.
  In you all, I live and have no REGRETS.

FISH FOR ALL AND NOW

TO GOD BE THE GLORY

THANK YOU ALL

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BIODATA OF
PROFESSOR OBIH ALEX UGWUMBA

Professor Ugwumba was born on Monday 10th March 1956, the sixth of the seven children of Mr. Nelson Oti Ugwumba (Teacher OTI) and Lucy Ngbokwo Ugwumba of Arochukwu, Abia State. His father started as a missionary teacher in the old Cross River State after training from Hope Wadell Institute Calabar and Furabey College, Sierra Leone. Alex was the last but one of the children that moved with the father during his last years as Divisional School Inspector. After his primary school years in Wilcox Primary School and secondary school in Ngwa High School both in Aba, he proceeded to Baptist Academy, Shepherd Hill, Ikorodu Road Lagos for his higher school certificate. He was then admitted into the University of Ibadan from 1976 to 1979 where he graduated with BSc. Honours in Zoology (2nd Class Upper Division).

On completion of the National Youth Service in 1979/80, he proceeded to the University of Lagos where he obtained through joint partnership with the Environmental Protection Agency Washington DC, a certificate in Waste Management: EPA Cert. (1983) and bagged a Ph.D Degree in Zoology in 1984. In April 1985, he joined the staff of the Department of Zoology, University of Ibadan as Lecturer II. During his career, he was appointed resource person Common-wealth Training Programme for Aquaculture Extentionist in Commonwealth Africa, 1998. Listed in poster of experts – Commonwealth Secretariat for developing countries programmes in aquaculture and fisheries development in same year. He was Executive committee member, Oyo State Fishermen Society of Nigeria. He is a Member, Editorial Board – Nigerian Association of Aquatic Sciences; Member Senate, University of Ibadan 1998 to date. He was Acting Director, Zoological Garden 1990 – 1995.

He rose to the rank of Professor of Zoology in 1999 and belongs to the following learned societies:

- Fellow Nigeria Institute of Biology (FNIBIOL);
- Fellow Fisheries Society of Nigeria (Ffs);
- Member Nigeria Association of Aquatic Sciences;
- Member Ecological Society of Nigeria;
- Member Network of Tropical Aquatic Scientists;
- Member Network of Tropical Fisheries Scientists; and
- Member Zoological Society of Nigeria.

He was:

- Editor in Chief: The Zoologist, 2001 – 2010.
- 1st National Vice President of Zoological Society of Nigeria, 2011 – 2015.

Presently, he is National President of Zoological Society of Nigeria 2015 to date.

He was 1st appointed Chairman Science Sub-Team NUC Accreditation to Nigerian Universities in 2004 and he is still serving to date. He served in several committees, Boards and Halls of our University at various times and he is External Examiner/Assessor in several Nigerian and West African universities.

Professor Ugwumba is happily married to his best friend and university class mate – Adiaha Alda Alex Ugwumba, Professor and Head, Department of Zoology, University of Ibadan. They are blessed with two lovely children Alex and Bella.

NATIONAL ANTHEM

Arise, O compatriots
Nigeria's call obey
To serve our fatherland
With love and strength and faith
The labour of our heroes' past
Shall never be in vain
To serve with heart and might
One nation bound in freedom
Peace and unity

O God of creation
Direct our noble cause
Guide thou our leaders right
Help our youths the truth to know
In love and honesty to grow
And living just and true
Great lofty heights attain
To build a nation where peace
And justice shall reign

UNIVERSITY OF IBADAN ANTHEM

Unibadan, Fountainhead
Of true learning, deep and sound
Soothing spring for all who thirst
Bounds of knowledge to advance
Pledge to serve our cherished goals!
Self-reliance, unity
That our nation may with pride
Help to build a world that is truly free

Unibadan, first and best
Raise true minds for a noble cause
Social justice, equal chance
Greatness won with honest toil
Guide our people this to know
Wisdom's best to service turned
Help enshrine the right to learn
For a mind that knows is a mind that's free