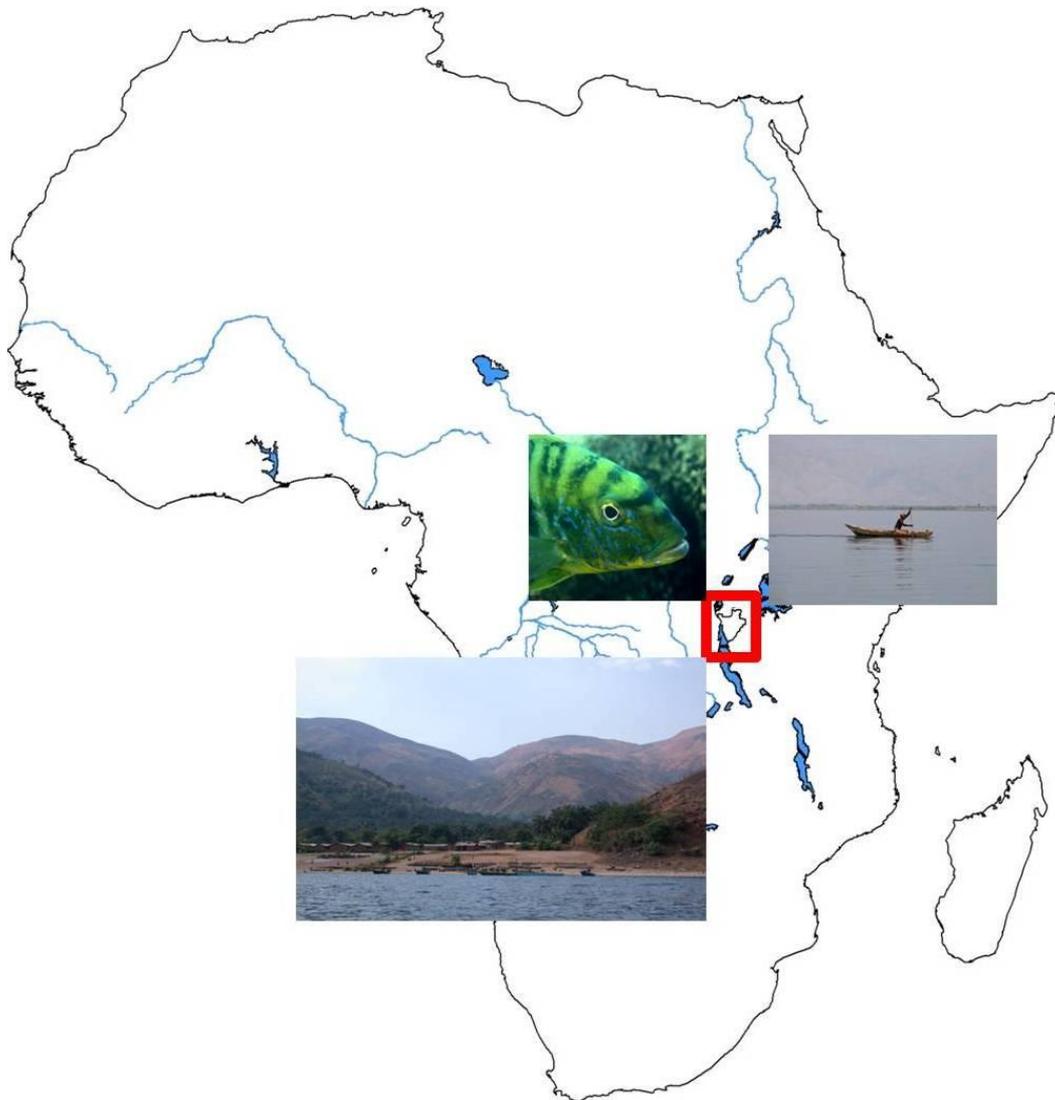




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Book of Abstracts



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Theme 1



Fish systematic, biodiversity research and data management

Oral presentations

African ichthyology: lessons learned, challenges accepted

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While there is still an enormous amount of work to be done simply to get a decent inventory of the African fresh and brackish water fish diversity, new projects, new sampling strategies and new methodologies are slowly improving our level of understanding. However, contemporary studies not only solve long-standing problems but also uncover new challenges. Since several years, the ichthyology unit of the Royal Museum for Central Africa, Tervuren, in collaboration with local partners, is undertaking a number of initiatives to boost the studies on the poorly known Central African ichthyofauna, and especially the Congo basin. These are combined with intensive collecting efforts in various regions such as the Lower Congo, the Inkisi, the Léfini, the region around Kisangani, the Ituri, Lake Tanganyika, the Malagarazi, the Luapula and the Lualaba. Hence, a much more fine-grained geographic coverage is now available for many fish taxa. A large collaborative framework with Belgian partners and the University of Kisangani resulted in two major multidisciplinary expeditions in the Central Congo basin in 2009 and 2010, and the creation of a new biodiversity centre at Kisangani in order to assure the sustainability of the collecting and research initiatives. The combination of major sampling efforts and detailed morphometric studies (classical and geomorphometric) eventually combined with genetics, lead to some remarkable results. While some groups remain remarkably stable after revision, others are completely overhauled. The family Hepsetidae is a case in point. For many decades regarded as a monogeneric and monospecific family, a thorough review revealed that there are actually six clearly distinct species of African pike.

In depth studies on various groups revealed geographic variation that was often found to render species delineation difficult. Another challenge is represented by the discovery of complex evolutionary histories in some Cichlids, Cyprinids and Mastacembelids, indicating that hybridization may be more common than previously thought.

A morphological revision of the *Brycinus macrolepidotus* (Valenciennes, 1850) group (Characiformes: Alestidae) reveals unexpected species diversity

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The genus *Brycinus* includes, morphologically, three species groups, i.e. the *longipinnis*, *nurse* and *macrolepidotus* group (Paugy, 1986). However, only the monophyly of the latter, including eight valid species so far, has genetically been confirmed (see Hubert *et al.*, 2005). Although important studies have been undertaken, the status of some of the included species still remains unsettled. For instance, the Congo *B. carmesinus* is still known from the holotype only and the Lower Guinea *B. schoutedeni* and *B. batesii* have recently been considered junior synonyms of *B. macrolepidotus* by Paugy (2007). Five meristics and 27 morphometric characters have been studied on a total of 294 specimens of the *macrolepidotus* group originating from all over its distribution area. The results allow the meristic recognition of two species groups based on the number of anal branched rays (mode 11-13 vs. 12-14) and the number of outer premaxillary teeth (mode 8 vs. 10). The first group is referred to as the *macrolepidotus* group *sensu stricto* and includes *B. brevis*, *B. macrolepidotus*, *B. rhodopleura*, and a

first group of specimens identified as a new species for science, *B. sp. "congo"*, while the second species group, referred to as the *grandisquamis* group, includes *B. batesii*, *B. carmesinus*, *B. grandisquamis*, *B. poptae*, *B. schoutedeni* and a second group of yet unidentified Congo basin specimens. Further analysis of the *macrolepidotus* group so far revealed that the specimens from the Congo basin, previously attributed to widely distributed *B. macrolepidotus*, in fact belong to a Congo endemic undescribed species, *B. sp. "congo"*. Indeed, *B. sp. "congo"* can be distinguished from *B. macrolepidotus* by, next to others, the presence of: a single row of outer premaxillary teeth (vs. two) and a single scale between pelvic fin insertion and lateral line (vs. two). Further research on the *grandisquamis* group is still ongoing.

Genetic variability of some Tilapia species from three different reservoirs in Southwestern Nigeria

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The genetic variation within and between three species of Tilapia, to identify novel traits for the improvement of breeding techniques and production in aquaculture was carried out. One hundred and eighty five Tilapias were collected from three reservoirs; Owena, Asejire and Aiba in Southwestern Nigeria. Random Amplified Polymorphic DNA primers (RAPD) were used to estimate genetic variation of three Tilapia species in the reservoirs and their phylogenetic relationship. Good quality DNA was extracted from blood samples obtained through gill vein puncture by CTAB method. The quality of DNA was checked by Agarose Gel Electrophoresis. The isolated DNA was quantified using Nanodrop spectrophotometer at 260nm and 280nm. Quantified DNA was subjected for PCR amplification. Out of thirty five RAPD primers used for this study, twelve RAPD markers gave amplification and four primers (OPAD-09, OPC-09, OPI-03 and OPB-15) yielded a clear and consistent DNA banding pattern. A total of seventy seven detected alleles were generated by the twelve RAPD primers in all studied Tilapia species. Thirty two of the alleles generated were monomorphic while forty five were polymorphic. UPGMA cluster analysis of genetic data showed moderate to high level of genetic diversity and generated two main clusters CI and CII at 60% similarity level. Cluster I had twenty four samples of different Tilapia species of which seven were *Oreochromis niloticus*, eleven were *Sarotherodon galilieus* and six belongs to *Tilapia guineensis*. Cluster II had eleven samples of which six belongs to *Tilapia guineensis*, four were *Sarotherodon galilieus* and one sample was *Oreochromis niloticus*. Cluster I and II was further divided into sub-clusters. Data obtained from this study could be used as baseline for improving breeding techniques and germplasm management in aquaculture.

Molecular phylogeny of the Distichodontidae (Ostariophysi: Characiformes) and the timing of citharinoid diversification: Implications for characiform biogeography

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Prior to the present study, the only comprehensive phylogenetic treatment of the African characiform family Distichodontidae had been a morphology-based analysis published over three decades ago. To further investigate distichodontid interrelationships, we inferred a phylogeny of the family based on DNA sequence data and established the temporal context of distichodontid diversification using a Bayesian approach to divergence time estimation. Additionally, variation in divergence-time estimates resulting from different calibration strategies was explored via sensitivity analysis. Our results

corroborate the monophyly of the Citharinoidei, the Distichodontidae, and most distichodontid genera. The resultant phylogeny also provides support for the recognition of morphologically distinct suprageneric assemblages represented by well-supported clades. The inferred chronogram is robust to changes in calibration priors and indicates that the origins of citharinoids and distichodontids date back to the Late- (*ca.* 90 Ma) and Mid-Cretaceous (*ca.* 67 Ma), respectively. Most modern distichodontid genera, however, appear to have originated and diversified much more recently, mainly during the Miocene. By reconciling molecular-clock- with fossil-based estimates for the origins of the Characiformes, our results provide further support for the hypothesis that attributes the disjunct distribution of the order to the mid-Cretaceous fragmentation of Gondwana. Moreover, the striking overlap in tempo of diversification and biogeographic patterns between distichodontids and another African-endemic characiform family—the Alestidae, suggests that their evolutionary histories were strongly and similarly influenced by Miocene geotectonic events that modified the landscape and produced the drainage pattern of Central Africa seen today.

Towards a checklist of the fishes of Kahuzi-Biega National Park and its surroundings, Eastern Congo River basin (DRC)

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Even after more than a century of ichthyological research in the Congo basin, many rivers still remain almost “*terra incognita*”. The ichthyofauna of the rivers of the Kahuzi-Biega National Park (KBNP), a UNESCO World Heritage site, is no exception to this. Two major right bank affluents of the Congo flow through this park, i.e. the Luka (Lowa basin) in the northern and the Lugulu (Ulindi basin) in the south-western part of the park. A first overview of the current knowledge of the ichthyofauna of the region has been compiled based on the RMCA collection holdings from: (1) the Luhoho (headwater stream of the Lowa basin), (2) the downstream Lowa affluents and (3) recent collections (2009-2010) from the Lowa River itself. Unfortunately, data for the Luka and Lugulu, both situated inside the park, are missing. A total of 6 families, containing 12 genera and 24 species have been identified from the Luhoho basin near the northeastern border of the KBNP. With 12 species, Cyprinidae is the most species rich family followed by Amphiliidae (5) and Mochokidae (3). The downstream affluents of the Lowa harbour 15 families containing some 42 genera and, at least, 38 species as specimens of about 18 genera have not yet been identified up to species level. Here, Alestidae (8) appear to be most species rich followed by Claroteidae (7) and Cyprinidae (6). Finally, 10 families, containing 18 genera and 19 species, including a new *Marcusenius* species, are found in the Lowa River with both Mormyridae (4) and Cyprinidae (4) being the most species rich families. Respectively 18 (75%), 31 (82%) and 17 (89%) species are unique for each of these Lowa basin stretches. These observations probably do not simply reflect longitudinal patterns by distance but rather isolation

A geographic study of *Pollimyrus isidori* (Osteoglossiformes, Mormyridae).

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Mormyrid fishes comprise the largest endemic family of freshwater fishes in Africa. With more than 200 species, this fish family is widely distributed in the continent except for the Cape region and the

Maghreb. Characteristic for these fishes is the presence of an electric organ, which is located in the caudal peduncle. Amongst these elephant-fishes, *Pollimyrus isidori* has a widespread distribution in Africa and is currently divided into three subspecies: the nominate subspecies *Pollimyrus isidori isidori* (Valenciennes, 1846) occurs in the Nile basin and ranges widely in the Nilo-Sudan and Upper-Guinea ichthyofaunal provinces, while the other two subspecies *P. isidori osborni* (Nichols & Griscom, 1917) and *P. isidori fasciiceps* (Boulenger, 1920) show an overlapping distribution in the Congo ichthyofaunal province. We reviewed and analysed the different populations of *P. isidori*. A Principal Component Analysis on 27 log-transformed measurements clearly revealed the presence of two groups with no overlap. One group consists of specimens from the Congo River basin, and contains the holotypes of *P. isidori osborni* and *P. isidori fasciiceps*. The second group is associated with specimens from the Nile River system and the different river basins of West Africa. It includes the type specimens of *P. isidori isidori*. Both groups can be separated using (a combination of) the following characters: eye-diameter, inter-orbital width and anal-fin length. We also noted differences in color-pattern between both groups. A closer examination of the specimens from the Congo ichthyofaunal province could not reveal any difference between the populations. Considering the non-overlapping distributions and the various diagnostic differences between Nilo-sudanic and Congo basin specimens, both areas are believed to contain a single valid species without subspecies, *P. isidori* and *P. osborni* respectively.

***Steatocranus*: towards an integrative view on the systematics and taxonomy of a complex miniature species flock of rheophilic cichlids**

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The rheophilic genus *Steatocranus* Boulenger, 1899 (Cichlidae: Pseudocrenilabrinae: Steatocranini) currently comprises nine valid species distributed in rapids of the Central and Lower Congo basin and in the Volta Basin. Molecular phylogenetic analyses based on mitochondrial, and nuclear DNA sequences as well as on anonymous multilocus DNA fragment analyses (AFLPs) in combination with digital and classic morphometric analyses revealed the existence of at least 19 diagnosable *Steatocranus*-lineages in the Lower Congo, which are currently being described or redescribed as species-level taxa. The Volta-River species “*Steatocranus*” *irvinei* is not closely related to the Congo-*Steatocranus*, but is related to a West African haplotilapiine tribe Gobiocichlini, and consequently will be transferred to a new genus. A subgroup of the true *Steatocranus* has formed an ecomorphologically diverse miniature species flock along the Lower Congo rapids. Explicit tests for ancient reticulations based on AFLP multilocus data strongly suggest, that at least one taxon of the Lower Congo, *S. glaber*, is of hybrid origin, and that multiple additional reticulations have taken place in the course of cladogenesis of *Steatocranus*. The extent of reticulations in the phylogeny of *Steatocranus*, as well as in other rheophilic cichlid taxa at the base of the East African cichlid radiations has manifold implications not only for the potential hybrid origin of the cichlid radiations but also for the monophyly criterion as the conceptual basis for the description of higher cichlid taxa.

Generic and species-level diversity of Auchenoglanidinae (Siluriformes: Claroteidae)

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Auchenoglanidinae, one of two subfamilies of the African catfish family Claroteidae, has been revised. Until now, no study has included morphological data of all species, and for many species osteological data were altogether not available. Unfortunately, the number of known specimens of several species is still very small and molecular data are still lacking for most of the known species. Apart from the well demarcated genera *Auchenoglanis* and *Parauchenoglanis*, the subfamily suffers from poor resolution on the generic level. For the remaining genera (*Notoglanidium*, *Liauchenoglanis*, *Platyglanis* and *Anaspidoglanis*) current generic diagnoses are rudimentary or even non-existent. In addition, several included species of these genera and *Auchenoglanis* are poorly defined. Using computed tomography (CT scanning) as well as clearing and staining, osteological data were added to 31 biometric, four meristic and six other morphological characters to revise the status of these genera and included species. Based on our results *Liauchenoglanis*, *Platyglanis* and *Anaspidoglanis* cannot be discerned from *Notoglanidium*; their genus and type species descriptions fail to be distinguished from *Notoglanidium*. In addition, no other characters supporting these generic distinctions could be found. Therefore, their synonymy is proposed, resulting in a single valid genus, including eight species of which the validity is confirmed. A ninth, new species has been recognized from the Kouilou-Niari River (Republic of the Congo). In *Auchenoglanis*, eight species were recently recognized. These were mainly based on pigmentation-related characters and on the shape of the premaxillary tooth plates. However, their recognition opposed previous works without any mention of these. We re-evaluated the species diversity in the genus, and confirm the status of only two valid species: *A. biscutatus* and *A. occidentalis*. Finally, and for the first time, a comprehensive account of the subfamily morphology and osteology is presented, and the relationship to the sister group Claroteinae is discussed.

The geographic distributions of the paedomorphic freshwater clupeoids *Sierrathrissa leonensis* (Pellonulinae) and *Amazonsprattus scintilla* (Engraulinae): different continents, same strategy?

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The progenetic clupeomorph *Sierrathrissa leonensis* reaches a maximum of 30mm SL. The species occurs in river basins of West Africa, in a total area of about 3,500,000 km², of which approximately 2,110,000 km² corresponds to the Niger River basin. A wide geographic distribution is unusual among miniature freshwater fishes, which are typically stenotopic. The only other progenetic freshwater fish with such a wide geographic distribution is another clupeomorph, the pigmy herring *Amazonsprattus scintilla*, which occurs in the Amazon and Orinoco basins in South America. The fact that both species are freshwater members of the Clupeoidei, a group that has a marine ancestry, might help to explain their unusually large distributional ranges. Clupeoids typically have pelagic larvae, which are able to disperse through considerable distances in the absence of marked physical or environmental barriers. It is possible that the mega river basins of South America, Africa, and the marine environment, are being

explored in a similar way by larval clupeoids, or progenetic forms of the group. In addition, *r* strategists or opportunistic teleosts such as clupeoids are characterized by rapid maturation and small-sized adults. Other freshwater anchovies, to which *A. scintilla* are related, attain small sizes and are also characterized by the possession of some developmentally truncated traits, which are just pronounced to an extreme degree in *A. scintilla*. The phylogenetic position of *S. leonensis* in the Pellonulinae is still unresolved, but species of the group also typically reach small sizes. Paedomorphosis in *S. leonensis* and *A. scintilla* seems to represent an extreme investment in the opportunistic strategy already present in their ancestors. *Sundasalanx* is another freshwater progenetic genus of the Clupeoidei that occurs in river basins of Thailand and Borneo. A comparison between that genus, *Amazonsprattus*, and *Sierrathrissa*, provides an interesting view into the evolution of miniaturization among freshwater clupeoids.

Phylogeny and adaptation in subterranean catfishes in South America, Africa and Asia: phylogenetic homologies and convergences in *Phreatobius*, *Uegitglanis* and *Horaglanis* (Siluriformes: Phreatobiidae and Clariidae)

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The subterranean catfishes belonging to genera *Phreatobius*, *Uegitglanis* and *Horaglanis* occur in subterranean waters of, respectively, South America (Amazon basin), Africa (Somalia) and South Asia (India). The fact that the three taxa are subterranean raises doubts as to whether their perceived similarities are the result of homology (synapomorphy) or convergence. The most striking of such similarities involve traits of internal anatomy which are not evidently related to a subterranean life. To resolve the question, the phylogenetic position of each taxon is investigated and used as a baseline to infer specific cases of homology and non-homology. Affinities of *Phreatobius* are not yet completely unresolved, with some studies placing it as a subgroup of Heptapteridae (morphology) and others (sequences) as the sister group to Pseudopimelodidae and Pimelodidae. As for the other two genera, evidence is presented for considering *Horaglanis* and *Uegitglanis* as two successive sister groups to all remaining Clariidae. Species of *Horaglanis* are somatically reduced, probably as a result of small comparative body size and paedomorphic processes. However, their placement at the base of Clariidae relies on a number of non-reductive characters, supporting the view that their position is not an artifact of paedomorphosis. Further support for that hypothesis comes from some reductive synapomorphies identified for all clariids except *Horaglanis*.

Morphological, genetic and parasitological differentiations between four species of *Hemichromis* “five spots”: evidence on the existence of the new species from Central Africa

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There are many contradictions about the identity, number and geographical distribution of species composing the *Hemichromis* “five spots” polyspecific complex. With this study we want to clarify some of the existing problems regarding the taxonomy and distribution of this species complex. From

2007 to 2013 we sampled throughout the large distribution area of this species group, which runs from Senegal to Angola. Fresh or alcohol preserved specimens were identified phenotypically on the basis of their chromatic and morphometric characters, genetic differentiation was studied using the cytochrome b gene, monogenean gill parasites were studied to determine host-parasite co-speciation, and tree search analysis was performed under Maximum Likelihood, Parsimony, Distance and Bayesian Inference methods. Taxonomic congruence of these independent data sources suggests that there are at least four species in the examined *Hemichromis* “five spots” group. Morphologically, these species are distinguished by their phenotypic and morphometric characters. *Hemichromis fasciatus* Peters, 1858 is distributed widely in Western Africa, *Hemichromis* sp. “cameroon” is distributed in Lower Guinea from the Cross River to the Lobe River, *H. elongatus* (Guichenot, 1861) is distributed from the Ntem River to Angola including part of the Congo basin, and *Hemichromis* sp. “congo” is known from the Congo basin. There is an overlap zone including *H. elongatus* (Guichenot, 1861) and *Hemichromis* sp. “congo”. *Hemichromis frempongi* Loisel, 1979 could be a fifth species, known from Lake Bosumtwi in Ghana. According to our results the *Hemichromis* “five spots” polyspecific complex contains more species than expected.

Diversity, distribution and conservation status of freshwater fishes of Ethiopia: Revisited

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The diversity, distribution and conservation status of the freshwater fishes of Ethiopia were reviewed from collections recently conducted in different basins and review of current literature. The number of fish species described from the freshwater systems of Ethiopia is increasing. The report indicates that there are about 180 indigenous and 11 exotic fish species, two of which could not be traced recently. The freshwater fishes of Ethiopia can be categorized into three forms: Nilo-sudanic, East African and endemic forms. The Nilo-sudanic forms dominate the fish diversity while the endemic forms have now reached about 40 species. The species are found distributed in all seven drainage basins and the five freshwater ecoregions in the country. The highest fish diversity is found in the Baro-Akobo basin, a tributary of the Nile River in southwest Ethiopia. This high diversity is attributed to the basin's past and present connections to the sub basins of the Nile and those in Central and West Africa. The highest endemism has been recorded from the Blue Nile (Abay) basin in northwest Ethiopia. This is largely due to the cyprinid species flock in Lake Tana, the source of the Blue Nile. The conservation problems in Ethiopia are diverse including, but not limited to, overexploitation of the fish resources, habitat disturbance, water pollution, water abstraction and impoundments, lack of institutional capacity and linkage and lack of basic scientific studies as well as awareness on the importance and status of the fish species. The worst case scenarios are found around Lake Tana where the cyprinid species flock is at risk and in the Rift lakes where the high impact of human exploitation of the aquatic resources is noted.

First DNA Barcoding Assessment of Madagascan freshwater fishes

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Madagascan endemic freshwater fishes are considered to be the most threatened group of animals in Madagascar, even if they are still not well known and just phylogenetic relationships of only few groups have been investigated to date. In this study, we aim to get the first molecular assessment of the diversity of these fauna. Specimens and samples were collected from many water bodies in Madagascar, mainly between 2011 and 2013. Tissue samples (fin) removed from freshly collected specimens were stored in 95–99% ethanol. Laboratory work has been realized at the Zoological

Institute, Technical University of Braunschweig, Germany. One protein-coding mitochondrial genes was selected. The 5' region of the COI gene was selected as the basis for a DNA barcoding system due to the availability of primers aiding its recovery from a broad range of taxa. In total, more than 2000 COI sequences were gotten from our samples. Our preliminary phylogenetic analysis shows that almost all Malagasy fish families form monophyletic group. An unexpected and remarkable result has been detected within the Malagasy killifish *Pachypanchax*; our DNA assessment reveals the presence of just few valid species, because some recently described species are nested within the old ones. This study shows that morphological assessment only is not enough for the systematic assessment of Madagascan freshwater fishes.

Morphometric revision of *Barbus kerstenii* Peters, 1868

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The “red spot barb” *Barbus kerstenii* was first described by from East Africa. It is widespread in Central and East Africa to Lake Victoria basin, Cunene, Okavango, upper Zambezi, tributaries of the lower Zambezi and the Save-Runde Systems. It also occurs in Lake Tanganyika and Lake Kivu drainage basins. The species has been reported synonymously as *Barbus lumiensis*, *B. minchini*, *B. akeleyi*, *B. nigrolinea*, *B. salmo*, *B. zanzibaricus pauior*, *B. loveridgii*, *B. mohasicus*, *B. rufua*, *B. serrifer* and *Labeobarbus kerstenii*. There have been concerns that several populations included in this species might represent distinct taxa. This study undertook a morphometric revision of *B. kerstenii* from East, Central and southern Africa specimens at the RMCA. PCAs were carried on 10 meristics and 18 measurements on the specimens categorized by locality. Pre-pectoral length and body depth at dorsal expressed as percentages of standard length were the most diagnostic morphometric characters. Results showed a clear separation of specimens from Akagera (Nile system), from upper Congo. However, Lake Kivu specimens eclipsed the two groups, appearing intermediary. Akagera specimens compared well with the lectotypes for *B. kerstenii*, *B. loveridgii* and *B. lumiensis* holotype. Lake Kivu upper and Congo specimens corresponded with the syntypes of *B. minchini*. Specimens from Kenya coastal region clustered together with the holotype of *B. loveridgii*, from Amala River, Lake Baringo, Kenya. The apparent distinctions in specimens were largely associated to locality.

Unexpected species richness in the African pike *Hepsetus odoe* (Bloch, 1794) (Characiformes: Hepsetidae)

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The widespread African pike, *Hepsetus odoe* (Bloch, 1794), is a member of the monogeneric and, until recently, monospecific family Hepsetidae. Although in the past one additional nominal species and two subspecies have been described, these were all formally synonymized with *H. odoe* by Roberts (1984). This act, apparently, found general acceptance without any further reservation. Based on a detailed morphometric study including 36 measurements and 18 counts on approximately 450 preserved specimens, a complete revision of the genus *Hepsetus* was undertaken. This study revealed that *Hepsetus* contains six well-delineated, valid and mainly allopatric species instead of one: *Hepsetus odoe* (Bloch, 1794) occurring in the westernmost part of West Africa; *H. akawo* Decru et al., 2012 occurring in the eastern part of West Africa and the northern part of Lower Guinea; *H. lineata* (Pellegrin, 1926) occurring in Lower Guinea and some adjacent parts of the Congo basin; *H.*

kingsleyae Vreven et al., 2013, endemic to the Ogowe basin in Gabon; *H. microlepis* (Boulenger, 1901) occurring in the Congo and Chari basin; and *H. cuvieri* (Castelnau, 1861) in the south up to the Okavango. A mtDNA study (COI) confirmed the morphological results, revealing high levels of interspecific divergence, with high bootstrap support. Furthermore, there are indications that the haplotype distribution within certain species (e.g. *H. lineata*) is geographically related. *Hepsetus odoe*, the *H. akawo/kingsleyae* group and *H. lineata* appear to have diverged in quick succession followed more recently by the divergence of *H. microlepis* and *H. cuvieri* and most recently between *H. akawo* and *H. kingsleyae*. These divergences are putatively linked to important geo-climatological events; an attempt is made to use calibration points to estimate the date of these different clade divergences.

Distribution patterns of catfishes in the Congo River basin

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The Congo River basin is the second largest drainage system in the world, preceded only by the Amazon in South America. At present, about 1000 valid fish species are known from its drainage (excluding the endemics from lakes Tanganyika and Kivu), but many questions remain on the distribution of this rich ichthyofauna. This study focusses on the distribution of the relatively well-known catfishes, which are represented in the study area by just over 200 species. In a first step, the vast Congo basin was subdivided into ichthyogeographically meaningful subbasins, based on environmental and geographic parameters. This exercise resulted in the delineation of 29 subbasins for the Congo River basin *sensu stricto*, between its source and estuary, and an additional four for lakes Tanganyika and Kivu and their drainages. In a second step, the distribution of the catfishes of the Congo basin *sensu stricto* was mapped and analysed using the new subbasins. Mapping was based on the most important museum collection records of African fishes, localities from reliable literature sources and recent revisions, which were used to update distributions from collection records. This resulted in a data matrix with presence data for all catfishes in the various subbasins of the Congo basin *sensu stricto*. About three quarters of the studied catfish were found to be endemic to the Congo River system. One third was found to be restricted to a single subbasin. Endemic species richness varied between 0 and 12, or up to a maximum of 18.2% of the total catfish species in a subbasin. The number of species per subbasin varied from 8 to 81. Distribution patterns of individual species showed to be very variable, with relatively few species occurring throughout the Congo basin. In addition, some subbasins appeared to be characterized by a rather unique combination of species.

***Xenocharax crassus* Pellegrin, 1900 (Characiformes: Distichodontidae) from the Congo River basin, central Africa: in need of revalidation**

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Currently the genus *Xenocharax* is considered to be monotypic. However, two species have been described, *X. spilurus* Günther, 1867 from "Gaboon" and *X. crassus* Pellegrin, 1900 from the Alima

River (Congo basin, Republic of the Congo), with the latter synonymised with *X. spilurus* by Daget in 1960. However, collections from the Congo River in the Democratic Republic of Congo and the Republic of the Congo indicate that *Xenocharax* specimens from the Congo basin are not readily attributable to *X. spilurus*, which appears restricted in distribution to the Lower Guinean ichthyofaunal province. The presence of a large black mark on the anterior part of the dorsal-fin (vs. no such mark) and a small black spot on the root of the caudal (vs. large black spot) readily distinguishes them from *X. spilurus*. These observations led to the assumption that, contrary to the opinion of Daget (1960), *X. crassus* could be a valid species. To further investigate the taxonomic status of *X. crassus*, 12 meristics and 20 measurements were taken on 78 specimens of *Xenocharax* (42 Congo and 36 Lower Guinea respectively), including all available type specimens. In addition, osteological characters, geometric morphometric comparison, and divergence in 3 genes were also investigated. The study revealed that, in addition to colour pattern and body shape differences, *X. crassus*, endemic to the Congo River basin, is easily distinguished from *X. spilurus* by its wider mouth (29.6-33.4% vs. 24.5-28.7% HL) and a lower number of supraneurals [5-6 vs. 7-8 (exceptionally 6)]. Numerous non-synonymous base changes in three genetic markers also confirm the distinctiveness of *X. crassus*. Therefore we conclude that *X. crassus* should be revalidated.

Towards a better knowledge of ichthyofauna of the Shiloango basin (Lower Guinea)

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Many studies have already been undertaken on the African ichthyofauna, and the current state of ichthyologic knowledge for some African provinces, such as the Lower Guinea, is relatively well advanced. However, if some of the Lower Guinea province basins, such as the basins of the Cross, Ntem and Ogowe, have been subjected to fairly extensive studies, others like the Shiloango basin remain still poorly known. It is within this current context that we have initiated a study of the fish fauna of the Shiloango basin, which is situated at the ichthyogeographical borderline between the Lower Guinea and Congo ichthyofaunal provinces. The Shiloango River - also known as the Tshiloango, Chilungo or Louango - upstream forms the border between the Republic of Congo and the Democratic Republic of the Congo (DRC), while downstream it becomes the border between Angola (Cabinda) and the DRC. It flows into the Atlantic Ocean north of Lândana (Angola-Cabinda). Its watershed covers $\pm 5,170 \text{ km}^2$, and its main tributaries are the Lukula (DRC), the Fubu (DRC), and the Luali (Angola-Cabinda). A compilation of the existing information based on historical museum collections and newly made collections (2011-2013) arrives at a total of 124 species belonging to 77 genera and 34 families. With 16 species, the Cyprinidae is the most species rich family, followed by the Cichlidae and Clariidae with respectively 14 and 11 species. Fourteen species are marine, while seven other are brackish water species, following Whitfield's categorization (2007). Two species are endemic, i.e. *Labeobarbus aspius* (Boulenger, 1912) and *Mastacembelus shiloangoensis* (Vreven, 2004). The number of species currently inventoried largely exceeds the number of 57 as empirically predicted by the formula of Hugueny (1989), which seems general for Lower Guinea. In a next phase, the Lukula (DRC), which is the largest tributary but with only 22 species known, will be sampled.

What to know about FishBase and how to use it.

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FishBase was developed at the WorldFish Center (former ICLARM) by Rainer Froese and Daniel Pauly from 1987 onwards. It was financed by various grants of the European Commission between 1990 and 2000. Since 2001, FishBase is supported by a consortium that currently incorporates nine institutions: the WorldFish Center (Malaysia), FAO (Rome, Italy), the universities of Kiel (Germany), British Columbia (Canada) and Thessaloniki (Greece), the Chinese Academy of Fisheries Sciences (China), the Natural History Museum of Paris (France) and Stockholm (Sweden), and the Royal Museum for Central Africa (Belgium). Originally started as an information system on the economically most important fish species, FishBase has now become the largest online encyclopedia on fishes in the world, with information on more than 32.500 species. Within the FishBase Consortium, the RMCA is responsible for the data on African freshwater and brackish water fishes.

FishBase contains data about all marine and freshwater fish species. This includes data on taxonomy, morphology, distribution, ecology, life history, population dynamics, aquaculture, physiology and diseases. It is currently available in 24 different languages, including English, French and Spanish. With nearly 300.000 common names, in more than 350 different languages, also non-scientists are able to find valuable information in FishBase. There are various tools based on the information present in FishBase, such as ‘match names’, which can be used to verify the validity of names, or Aquamaps, which has become an important tool to predict the natural occurrence of marine species based on various environmental parameters. The RMCA and FishBase are currently developing AquaMaps for African freshwater fishes. This includes, among others, the delineation of basins and subbasins in Africa, and the updating of species distributions.

Two case studies on *Synodontis* Cuvier, 1816 (Siluriformes: Mochokidae) from the Congo Basin (DRC)

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Because of the large variability in colour pattern found within *S. decorus* (types with rounded spots) including its synonym *S. vittatus* (types with longitudinal bands), a detailed morphometric study has been undertaken including 27 measurements and two counts of 68 specimens. We distinguished three different colour pattern types: “banded”, “spotted” and “uniform”. “Banded” specimens were found only in the Upper Congo (i.e. above the Wagenia rapids at Kisangani), “spotted” specimens only in the Lower and Middle Congo (i.e. below the Wagenia rapids). “Uniform” specimens were rare and only found in the Middle Congo. In the Uele River exceptionally only “uniform” specimens were found. Although multivariate analyses demonstrated a weak morphometric difference between the “banded” specimens on the one hand and the “spotted” and “uniform” specimens on the other, none of the measurements revealed to be significantly different between colour pattern types. Our results thus confirm the synonymy of *S. vittatus* with *S. decorus*. During this study, we found a striking resemblance in colour pattern between small *S. decorus* and *S. nummifer* specimens. However the latter lack the typical branched maxillary barbels of *S. decorus* and the horizontal black band in-between the two caudal-fin lobes. The latter feature is typical for *S. decorus* at all sizes. Moreover, as reported by Poll (1971), the number of mandibular teeth is larger, 12 (rarely 8) to 19, in *S. nummifer* (vs. 0 to 10 in *S. decorus*). Finally, while *S. decorus* has 2 to 4 vertical dark brown/black bands in the caudal fin regardless of size, in *S. nummifer* this number increases with size, with larger specimens having approximately 7-8 bands.

Some osteological features of the anchovies *Encrasicholina heteroloba* and *Anchoviella lepidentostole* (Engraulidae) in relation to *Denticeps clupeioides*, the most basal clupeiform and sole Recent member of the Denticipitoidei.

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The Clupeiformes includes about 360 species of marine, estuarine and freshwater fishes commonly known as herrings and anchovies, with a worldwide distribution. The order is divided into the Denticipitoidei and Clupeoidei. Denticipitoidei includes one single living species, *Denticeps clupeioides*, a still poorly-known freshwater fish that inhabits a few isolated coastal streams in West Africa, from eastern Benin to Cameroon. Anchovies are members of the Engraulidae, a family that includes about half of the diversity of the Clupeoidei. *Encrasicholina heteroloba*, from the Indo-Pacific Ocean, is a basal member of the family. *Anchoviella lepidentostole*, on the other hand, is a member of a more derived clade of anchovies composed only by New World species. In this study we analyzed and described a set of characters from several osteological complexes of *Denticeps clupeioides*, *Encrasicholina heteroloba* and *Anchoviella lepidentostole*. Significant differences regarding the presence, absence and the arrangement of dentition on the branchial arches were found. Variations in the presence and form of the frontal fontanel and other characters of the skull, suspensory, branchial arches, vertebrae and associated structures were also found, and shed some light into the evolution of those morphological complexes in the Engraulidae.

Towards a reevaluation of *Labeobarbus* and *Varicorhinus* (Cypriniformes: Cyprinidae) species diversity of the Epulu River in D.R.Congo

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The Epulu River is one of the right bank affluent of the Ituri (headwater of the Aruwimi) and is separated from the latter by the Ngoy waterfalls (± 15 m high). Due to its isolation, it houses an impoverished, although interesting, fish fauna, which is mainly composed of cyprinids. For this study a total of 16 meristics and 30 morphometrics have been examined on 199 Epulu River specimens (181 *Labeobarbus* and 18 *Varicorhinus*). Currently three species of *Labeobarbus* have been identified: *L. macroceps*, which seems endemic to the Epulu, and *L. caudovittatus* and *L. mawambiensis*, which both seem widespread. In addition, this study reports the first record for *Varicorhinus* in this part of the Congo basin. As the specimens could not be attributed to any of the currently known species they are here referred to as *V. sp.* “Epulu”. In addition to these well identifiable species, the Epulu also contains specimens of different intermediate morphotypes. These can be situated between *L. mawambiensis*, characterized by fleshy lips with an apparent lobe on the lower jaw, two pairs of long barbels and the last unbranched dorsal fin ray rigid, and *Varicorhinus sp.* “Epulu”, characterized by a rectangular hardened mouth with a horny comb on the anterior edge of the lower jaw, one pair of short, posterior barbels and the last unbranched dorsal fin ray flexible. The presence of such intermediate morphotypes is reminiscent of the results of a detailed study on the Inkisi River (Lower Congo, DRC) where it has been shown that these intermediate morphotypes should be identified as interspecific hybrids. In the case of the Epulu River, this interpretation seems also supported by the preliminary mtDNA results which, as for the Inkisi, demonstrate that parental species and intermediate morphotypes cannot, in this respect, be distinguished from each other. Further research is ongoing.

FishBase and Fish Taxonomy training sessions at the Royal Museum for Central Africa

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FishBase is the world's most important online encyclopedia on fishes and incorporates numerous tools for ichthyologists and fisheries biologists. The Royal Museum for Central Africa (RMCA) is part of the FishBase Consortium and has been responsible for updating the scientific information on the African fresh- and brackish water fishes since 2001. Since 2005, the Ichthyology Unit of the RMCA organizes each year a comprehensive traineeship for 5 talented African scientists on the use of FishBase and the taxonomy of African fishes. This three months training, alternately held in French and English, is supported by the Belgian Development Cooperation and includes: (i) a detailed demonstration of FishBase in all its aspects; (ii) a practical training in the taxonomy of African fishes; (iii) a morphometric case study on taxa which are known to comprise taxonomic problems. With this training the RMCA aims to: (i) share its experience in FishBase and African ichthyofauna; (ii) encourage the trainees to teach their newly apprehended competencies and knowledge at their home institutions, to help in completing FishBase, and to spread the use of FishBase as a source of information and as a fisheries tool; (iii) establish new or maintain existing collaborations with the participants and their home institutions. We will introduce this training programme to a large group of potential trainees. The presentation will start with a short discussion of the concept, the contents, the goals and the application procedure of the training. Furthermore, some results and an evaluation will be given of the past sessions.

Extensive intergeneric hybridisation in the large cyprinids from the Inkisi River basin (Lower Congo, DRC): a unique case or a possible widespread pan-African phenomenon?

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A detailed morphometric, meristic and genetic study of 36 specimens of the large-size cyprinids with high lateral line scale numbers (i.e. 36 or more) from the Inkisi basin, revealed that only a few can readily be identified as belonging to *Varicorhinus* or *Labeobarbus* as based on diagnostic mouth shapes; however, the remaining specimens, exhibit intermediate and variable mouth-shape phenotypes. Mitochondrial COI haplotypes did not enable differentiation between *V.*, *L.* and intermediate phenotypes, but AFLP multilocus nDNA analyses strongly suggest that both, the *V.*- and *L.*- phenotypes, represent two identifiable lineages whereas the intermediates are most parsimoniously interpreted as a polymorphic *V. x L.* hybrid swarm. Although reports of possible *L. x V.* hybridisation are not new [Banister, 1972; 1973 (*V. tangericae*: now *Acapoeta*); De Vos & Thys van den Audenaerde, 1990], the major difference with the above mentioned cases is that in the Inkisi River

both yet undescribed parental species are, except for their mouth-shape phenotype, hardly distinguishable by meristics as well as mouth-morphotype-independent morphometrics. The implications seem far reaching. Though currently 37 valid *Varicorhinus* species are known, six of these species lack the typical cutting-edge on the lower jaw rendering them more similar to some of the Inkisi intermediate phenotypes. Further, eight of the 92 African valid *Labeobarbus* species have one or several *Varicorhinus* junior synonyms. In view of the current evidence, a high degree of intraspecific polymorphism seems less likely for these cases than a repeated case of intensive intergeneric hybridisation, which we hypothesize may be the rule rather than the exception. The results presented here might also shed new light on the Lake Tana *L. intermedius* shore complex - one of those *L.* species with a *V.* synonym. Including *Varicorhinus* in a review, is therefore critical to enhance our current understanding of the rapid *Labeobarbus* speciation in that lake.

Multiple origins of *Varicorhinus*-like scraping feeders among the African hexaploid barbins inferred from mtDNA sequences: a search for the second true *Varicorhinus*

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Specialized periphyton feeders with peculiar scraping morphology of the head evolved independently in a number of cyprinid lineages. The genus *Varicorhinus* (encompassing 36 nominative species) with the pan-African distribution was considered as a lineage of the African evolutionary hexaploid barbins with this type of trophic specialization. Recent molecular study showed some *Varicorhinus* species from Northern and Southern Africa (Tsigenopoulos et al., 2010) evolved independently of the type species of the genus *V. beso* from Ethiopia, East Africa. This finding put a question: whether other scrapers with *Varicorhinus*-like morphology belong to the *Varicorhinus* lineage or they originated independently from some local barbids (*Labeobarbus*)? We studied mtDNA sequences of >120 specimens (control region and cytochrome b) in the different populations *Varicorhinus beso* and some other hexaploid barbids exhibiting and not-exhibiting scraping morphology, and distributed in the same or adjacent river drainages of Ethiopia. In particular, we studied *V. jubae* whose range among the congeneric species is nearest to that of *V. beso*. Our results demonstrated an independent origin of the specialized periphyton scrapers in at least four different basins of Ethiopia: the Indian Ocean, White Nile, and Omo-Turkana basins in addition to the Blue Nile and Atbara basins and northern part of the Ethiopian Rift Valley inhabited by *V. beso*. In the first three basins the local scraping forms cluster together with local *Labeobarbus* species but not with *V. beso*. Thus our results and that of earlier authors give evidence to a monotypy of the genus *Varicorhinus*. It is interesting to contrast the monophyletic origin of the West-Asian scrapers of the genus *Capoeta* (with more than 20 species – Levin et al., 2012) and independent origin of some (if not all) African scrapers previously considered as related to the genus *Varicorhinus*. Study was partially supported by Joint Ethio-Russian Biological Expedition (Jerbe-III), and Russian Foundation for Basic Research, grants Nos. 11-04-01252, 13-04-01319.

***Brycinus leuciscus* (Günther, 1867) and *B. luteus* (Roman, 1966) (Characiformes: Alestiidae) in West Africa: similar species or synonyms?**

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While revising the ichthyofauna of the Mono and Ouémé basins, we were confronted with identification problems in the characiform genus *Brycinus*. Numerous specimens catalogued as *B. leuciscus* from these basins were re-identified as *B. nurse* (Rüppel, 1832). Both species can be distinguished from each other by the number of outer row premaxillary teeth and the size of the parietal fontanella (Paugy, 1986). We found fontanella length to be negatively allometric ranging from 13.1 to 27.5% HL in *B. leuciscus* versus 0 to 11.3 % HL in *B. nurse*. In the latter species, the fontanella is closed in specimens > 65.5 mm SL. Likewise, *B. luteus* has often been confused with *B. leuciscus*. According to Paugy (1986), both species differ in gill raker length. However, this difference was not quantified making it difficult to use. For this study, 13 meristics and 28 measurements were taken on a total of 89 specimens, including all types. The gill raker length showed to be negatively allometric and completely overlapping for type specimens of comparable size of both species. As further detailed analysis of the data failed to find any distinctive character between both nominal species, the results suggest that *B. leuciscus* and *B. luteus* are conspecific. Therefore the synonymy of *B. luteus* with *B. leuciscus* is proposed. The distribution of *B. leuciscus* remains unchanged as *B. luteus* was considered to be sympatric with *B. leuciscus* in the Upper Volta. Paugy (1986) illustrated two different phenotypes for *B. leuciscus* – one with and one without a predorsal bump. Our study confirmed these phenotypes to represent intra-specific variation.

Georeferencing Fish Collections: a Community-Based Model to Georeferencing Natural History Collections

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The FishNet2 network is a collaborative effort among fish collections around the world to share and distribute data on over 3.5 million specimen holdings. Over the past few years a number of developments have been made to address the needs of acquiring baseline data from FishNet2. Specifically, we have improved upon the data harvesting architecture, added geospatial query capabilities, improved result summaries, made significant changes to the UI and produced an API to facilitate third party integration. The underlying architecture for FishNet2 has been generalized as the Biological Object Search Service allowing us to create instances applicable to other taxonomic networks. HerpNet2 is an example of such an instance utilizing the same architecture. More recently, a collaborative georeferencing and data enhancement project has been funded by the United States National Science Foundation. Twelve collaborating institutions are working to expand and improve data quality within the FishNet network with a primary focus on geospatial referencing records lacking geographic coordinates (approximately 45% of the network holdings at the time of funding).

Diversity and phylogeography of African suckermouth catfishes (*Chiloglanis*: Mochokidae) from Guinea, West Africa.

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Species of the genus *Chiloglanis* occur within most sub-Saharan waters in tropical Africa. An enlarged oral sucking disc and relatively diminutive size allow these fishes to feed and maintain position in fast flowing waters. There are currently 55 recognized species but it is likely that many species remain to be discovered. A 2003 expedition to Guinea, West Africa revealed the presence of previously unknown diversity within *Chiloglanis*. The headwaters of three important West African

rivers (Senegal, Gambie, and Niger) originate in the highlands of central Guinea. Multiple coastal rivers also originate in Guinea, flowing west and south into the Atlantic Ocean. A 2013 expedition presented an opportunity to collect additional populations that were not sampled previously. A molecular phylogeographic analysis of *Chiloglanis* specimens from these populations, utilizing mitochondrial and nuclear markers resulted in the discovery of additional undescribed taxa. The molecular variation is compared to morphological variation among populations and assessed relative to the three currently recognized taxa from the area. The pattern of molecular phylogeography in *Chiloglanis* is also compared to patterns in other co-occurring fish species complexes to produce a general hypothesis of the biogeography of the freshwaters of Guinea and surrounding areas.

Headwater captures effect on phylogenetic freshwater fish structure

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The diversity of Neotropical fish is the result of historical and ecological processes intrinsically related to the geomorphological evolution of this region. Headwater captures stand as important biogeographic processes spanning and isolating fish populations between watersheds. This study investigates the effect of these headwater captures on the phylogenetic diversity of stream fishes between watersheds in the highlands of the Brazilian Shield. It is hoped that Tocantins basin presents major phylogenetic diversity by receiving clades from adjacent basins (*i.e.* Paraná and São Francisco). Headwaters of watersheds (*i.e.* Upper Tocantins, Upper Paraná e São Francisco) in central Brazilian Shield, Neotropical region, were sampled. From the phylogenetic relationships of 70 native fish species, was quantified the phylogenetic diversity of each basin, as well as the phylogenetic beta diversity between basins. The Upper Paraná basin showed greater phylogenetic diversity than expected by chance, indicating phylogenetic distant species composition. The sharing species and phylogenetic beta diversity values not differing from expected by chance indicate recent species exchange between the basins. By combining the values of phylogenetic diversity with phylogenetic beta diversity suggests that the Upper Tocantins and São Francisco have species/strains derived from the Upper Paraná. The studied stretch of the Upper Paraná basin shows up older and being captured by neighbouring basins.

Upper Congo Fishes Project: ichthyological study and collection building at the University of Kisangani, Orientale, D.R. Congo

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The Upper Congo Fishes Project is an international collaboration of ichthyologists working to improve our knowledge of the fish fauna of the Upper Congo Rapids and the surrounding region while developing expertise and institutional capacity at the University of Kisangani (UNIKIS) in D.R. Congo. Funding came from a U.S. Fulbright African Regional Research Fellowship and an Encyclopedia of Life Rubenstein Fellowship awarded to Dr. John P. Sullivan of Cornell University who spent February to October 2010 in Kisangani working with UNIKIS faculty and students. Supplemental funding received from the U.S. Embassy in Kinshasa made possible the purchase of jars for the reference fish collection at UNIKIS. Province Orientale of D.R. Congo harbors high fish diversity within a wide range of aquatic habitats, including a series of rapids over a 100 km stretch of the Lualaba (Upper Congo) River between Ubundu and Kisangani. The Tshopo and the Lindi Rivers

join the Congo just below the rapids near Kisangani. Principle collection sites included Ubundu, at the head of the Upper Congo Rapids, Batkamoundje and Wanie-Rukula in its middle reaches, and the Wagenia rapids at Kisangani. Other areas sampled include the Tshopo and Lindi Rivers, the Epulu and Ituri Rivers within the Okapi Faunal Reserve and the Congo and Lubilu Rivers near Yangambi. Joining the project for fieldwork and lectures at UNIKIS were Drs. J. Armbruster of Auburn University, USA and Sebastien Lavoué of the Institute of Oceanography, National Taiwan University. Fieldwork in 2010 resulted in collection of approximately 150 species of fishes, several hundred DNA tissue samples and more than 300 photographs. The signals of more than 400 mormyrid weakly electric fishes were recorded. Manuscripts are in preparation for two new species of Momryidae and work on other undescribed species from these collections continues at Cornell, Auburn and UNIKIS.

Molecular phylogenetic and phylogeographic evidence of unrecognized diversity within nominal species of *Labeobarbus* from Indian Ocean drainages and Endorheic Rivers of the Great Rift Valley of Kenya

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Studies of molecular phylogenetics and phylogeography of freshwater fishes from major river drainages of the Indian Ocean and endorheic basins of the Great Rift Valley of central, western and southern Kenya have revealed deep genetic divergences within several nominal species. The present study focuses on phylogeography of Kenyan populations of putative hexaploid cyprinid fishes, originally described as species of *Barbus* or *Labeobarbus*, and now regarded as species of *Labeobarbus* Rüppell. The nominal species under study here are the Ripon Barbel, *Barbus altianalis* Boulenger, the Pangani Barb, *Barbus oxyrhynchus* Pfeffer, and *Labeobarbus intermedius* Rüppell. All of the studied species and populations are recovered as a monophyletic group with strong bootstrap support. The most basal lineage is a population from the Yala River (Lake Victoria Basin), which is sister to a lineage comprising all other nominal species. *Barbus altianalis* and *Labeobarbus intermedius* form a group sister to *Barbus oxyrhynchus*, which itself comprises several divergent lineages. The phylogeny provides evidence that *L. intermedius* and *B. altianalis* are co-distributed in the Lake Victoria Basin. We present preliminary morphological evidence in an attempt to diagnose species.

Hyperdiverse freshwater ichthyofaunas in Africa and the Neotropics; overview and comparisons

RP Vari

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The freshwater ichthyofaunas of Africa with over 3000 fish species and the Neotropics with well over 6000 species are remarkable on multiple levels. Not only do these faunas encompass over one-fourth of known species of fishes, in both fresh and marine waters worldwide, but they demonstrate a remarkable degree of species and morphological diversity at levels ranging from the species through generic and familial levels. The continental fish faunas to the two sides of the Atlantic demonstrate dramatic asymmetries in species-richness and morphological variation in several major monophyletic assemblages. These differences are discussed with an emphasis of the Characiformes; an order that is particularly species-rich in the New World, but that is conversely more morphologically innovative in Africa. Convergencies in various lineages are also discussed.

Molecular phylogenetic evidence of unrecognized diversity within *Barbus kerstenii* and a broad zone of introgression with *Barbus neumayeri* in Kenya

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Ongoing studies of molecular phylogenetics of freshwater fishes from major river drainages and endorheic basins across central and southern Kenya (Lake Victoria, Lake Naivasha, Ewaso Nyiro, Ewaso Ng'iro, Athi, Tana and Pangani basins) have revealed evidence of unrecognized diversity within the Redspot Barb, *Barbus kerstenii* Peters. Here we present results of sequencing of nuclear and mitochondrial genetic markers for populations of *Barbus kerstenii* and *B. neumayeri* from throughout the study area, and a preliminary analysis of morphological differences between the two species. *Barbus kerstenii* was described from the Paganini Basin in Tanzania. The reported range of *B. kernstenii* in Kenya extends across southern Kenya from the Pangani system to Lake Victoria. We detected genetically distinct populations of *B. kernstenii* in the Athi River system and the Lake Victoria basin. *Barbus neumayeri* Fischer was described from rivers of the Lake Natron Basin, Kenya. The reported distribution of *B. neumayeri* in Kenya extends from Lake Victoria to the Athi Basin. *Barbus kerstenii* and *B. neumayeri* are not closely related genetically, yet our genetic results provide clear evidence of ongoing hybridization and/or past mitochondrial introgression between *B. kerstenii* and *B. neumayeri* across an area, extending from Lake Naivasha to the Athi River system.

Genetic Variability in Cultured and Wild Populations of *C. gariepinus* using Random Amplified Polymorphic DNA (RAPD) Marker

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The genetic variability was study between cultured and farmed *Clarias gariepinus* in Southwest Nigeria using randomly amplified polymorphic DNA (RAPD) with view to provide baseline genetic data on their relatedness. 240 pieces of *C. gariepinus* (680 ±3.28g) broodstocks were obtained from both wild (Osun, Owena and Oluwa river) and cultured (hatcheries from Akure, Ilesa and Ado-Ekiti) and transported to Teaching and Research Farm of Fisheries and Aquaculture Department Federal University of Technology, Akure. The DNA of various samples was extracted from the blood and was amplified by the Polymerase Chain Reaction. A total of 85 reproducible bands were obtained in the six populations for the nine RAPD primers used. The number of amplified bands varied from six to twelve, with the size range varying from 150 to 5500 bp. The Analysis of Molecular Variance AMOVA indicated that the sampled populations are significantly different from each other, and that 99% of the total variation resided within the population. The percentage of genetic identity GI of RAPD-PCR profile among six populations under study ranging from 90.9% to 95.8%. Also, genetic distance of *C. gariepinus* from six population based on RAPD-PCR profile ranged from 0.401 to 0.837. The RAPD-PCR banding patterns across the six population under study revealed that the mean heterozygosity for the six populations ranging from 0.374 to 0.402 and was higher in the wild compared with the farmed fish. In conclusion, this study has established that there is genetic variability in both wild and cultured *C. gariepinus*. Also RAPD results showed that samples from the some populations (wild and cultured) under study were closer to each other than the other population.

In future, additional methods such as microsatellite, AFLP and sequence techniques can be used to maximize the efficiency of the study.

The rise of the modern freshwater fish fauna of Africa

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In Africa, modern freshwaters harbor around 48 families of fishes, 15 of which are endemic. This high level of endemism is one of the most striking features of the African freshwater together with the high number of basal and archaic families. A vast majority of the fishes on this continent are obligatory freshwater, such as the numerous African members of the highly diversified group Ostariophysii (including catfishes, carps, minnows and tetras) and representative of archaic and relict taxa such as the African lungfish *Protopterus*. Conversely, peripheral freshwater fish families are relatively poorly represented in African inland waters with generally relatively low specific diversity, and only a few of them include obligatory freshwater members in Africa. Here we depict the rise of the modern African freshwater fish fauna notably on the base of new paleontological data. Furthermore, we discuss possible pattern(s) and cause(s) of diversification of these fishes of various origin. Depending on their origin and diversity, we distinguish four groups, and we review their fossil record and the elements that might have constrained their history on the continent. Among others, we conclude that most of the modern genera with a fossil record appeared in the Late Eocene (ca 40Ma), which is over 20Ma older than previously supposed (Otero & Gayet 2001, Stewart 2001), while the specific diversity seems to take place diachronically during the Neogene time period (23Ma to modern). We were able to identify environmental constraints, such as topographical modification and related hydrographical divide, which probably drove certain diversifications (e.g. Pinton et al. 2013). Moreover, some regions seem to have played a special role in the evolutionary history of certain taxa. We will conclude on that later aspect with a special focus on the great Lake Region which seems to have acted as a refuge in some cases, at least for the genus *Protopterus* which suffered extinction threat during the Early Neogene (Otero 2011).

The riverine fishes of Burundi (East Central Africa)

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Unlike the work devoted to Lake Tanganyika, the Burundese riverine ichthyofauna has received far less attention during the earliest freshwater explorations. Based on a thorough literature search, an overview of the specimen holdings available in various natural history museums, and new collecting efforts undertaken in the Upper Malagarazi and the Rusizi River basin (Burundi), a checklist of the riverine fishes of Burundi was compiled. A total of 16 riverine fish families containing at least 112 fish species including 11 introduced and/or translocated species and at least 18 endemic species was reported for the country. With 36 species, the family Cyprinidae is by far the largest, followed by the families Cichlidae (17), Clariidae (nine), Mormyridae (eight) and Mochokidae (seven), the remaining families being represented by only five or less species. The riverine fishes of Burundi consist of a mixture of fish fauna's belonging to different ichthyofaunal units reflecting the two river systems to which the Burundese hydrographic network belongs, i.e. the Congo and the Nile System sensu lato. Their distribution highlights the differences in species richness between these two main river systems, with the Congo system component being more species rich compared to the relatively species poor

Nile system component. The Upper Malagarazi, which belongs to the Congo system, represents one of the Burundese riverine fish diversity hotspot with 75 species all native. Indeed, a new species, '*Barbus devosi*' from the Malagarazi basin was recently described and three new species were found in there, including '*Barbus*' sp. "ascutelatus", *Chiloglanis* sp. "musasae" and *Clariallabes* sp. "nyaruhandazi", the description of which are currently underway. Some taxa such as the catfish genus *Synodontis* (Mochokidae) and the haplochromine cichlids require further taxonomic attention; their actual species numbers are certainly underestimated.

Fish diversity of the Bagoé river in Mali

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In order to update the inventory of the fish fauna in the Bagoé river, a tributary of the Niger in Mali, and in preparation of the classification of this river, ichthyological investigations were carried out along part of the main course of the Bagoé river divided into upper (Sinti to Fourou), middle (Tiekoungo to Madina) and lower (Farawoyo to Sorokoro) sections. Inventorisation of fish species was based on artisanal fisheries landings and experimental fishery catches using active and passive gears. Indices of diversification, diversity and equitability were calculated. Seventy different fish species were identified, belonging to 43 genera and 19 families. Cyprinidae, Cichlidae and Mormyridae were most represented in the catches. In the upper section 46 different species were found, while 31 and 44 species were found in the middle and lower section respectively. The presence of *Paradistichodus dimidiatus*, *Pellonula leonensis*, *Rhabdalestes septentrionalis*, *Micralestes elongatus*, *Chelaethiops bibie*, *Tylochromis jentinki*, *Barbus baudoni* and *Barbus callipterus* in the Bagoé river expands their present distribution in this part of the Niger river Basin. The diversification index varies from one section to another, but suggests three habitat types for each section against 4 for the entire river. The index of diversity is decreasing from the upper to the lower sections (4.49 to 3.68). The equitability is high in the upper and middle sections (0.82 and 0.87) and low in the lower section (0.67). The decrease of the diversity index from upper to lower sections shows that in the Bagoé river the longitudinal gradient of diversity is reversed. According to the diversity indices calculated, the fish diversity is important because the Shannon diversity represents 84% of maximal diversity (5.15/6.13), the equitability is 84%. The results of this study can be used as a reference for future developments in the Bagoé river and as indicators of the fish stock condition in this stream.

Parsing parallel evolution: ecological divergence and differential gene expression in the adaptive radiations of thick-lipped Midas cichlid fishes from Nicaragua

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The study of parallel evolution facilitates the discovery of common rules of diversification. Here, we examine the repeated evolution of thick lips in Midas cichlid fishes (the *Amphilophus citrinellus* species complex)—from two Great Lakes and two crater lakes in Nicaragua—to assess whether similar changes in ecology, phenotypic trophic traits and gene expression accompany parallel trait evolution. Using next-generation sequencing technology, we characterize transcriptome-wide differential gene expression in the lips of wild-caught sympatric thick- and thin-lipped cichlids from all four instances of repeated thick-lip evolution. Six genes (apolipoprotein D, myelin-associated glycoprotein precursor, four-and-a-half LIM domain protein 2, calpain-9, GTPase IMAP family

member 8-like and one hypothetical protein) are significantly underexpressed in the thick-lipped morph across all four lakes. However, other aspects of lips' gene expression in sympatric morphs differ in a lake-specific pattern, including the magnitude of differentially expressed genes (97-510). Generally, fewer genes are differentially expressed among morphs in the younger crater lakes than in those from the older Great Lakes. Body shape, lower pharyngeal jaw size and shape, and stable isotopes (d13C and d15N) differ between all sympatric morphs, with the greatest differentiation in the Great Lake Nicaragua. Some ecological traits evolve in parallel (those related to foraging ecology; e.g. lip size, body and head shape) but others, somewhat surprisingly, do not (those related to diet and food processing; e.g. jaw size and shape, stable isotopes). Taken together, this case of parallelism among thick- and thin-lipped cichlids shows a mosaic pattern of parallel and nonparallel evolution.

Homology of segments of the mandibular and hyoid arches within Gnathostomata: a first glance from the perspective of the comparative developmental anatomy

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Although it is traditionally accepted that visceral arches of Gnathostomata are serially homologous, the fact is that the homologies between the elements of the first two – the mandibular and hyoid arches – are not clearly established because these are significantly modified when compared to the most posterior, branchial arches. Recently, the use of fate-mapping techniques added fine developmental support for this theory, but only for principal dorsal and ventral endoskeletal segments. These changes are marked even in basal and morphologically-conserved gnathostome lineages, such as chondrichthyans and basal actinopterygians, namely Polypteriformes, Acipenseriformes, Lepisosteiformes, and Amiiformes, leading to the use of distinct terminologies for some elements. In this study, we investigated specifically the homology of elements called symplectic, inter-hyal, and hyomandibula by means of anatomical comparisons among chondrichthyans and actinopterygian polypteriforms, acipenseriforms, lepisosteiforms, amiiforms, and some teleosts at different stages of their early ontogenies. Our preliminary results indicate that the symplectic and inter-hyal are serially homologous to each other belonging to the mandibular and hyoid arches, respectively, which are, in turn, the first two anteriormost pieces of the recently recognized accessory elements of the gill arches. Interestingly, these elements are formed in domains of each arch where the *Dlx 1,2,5,6* genes are expressed. The hyomandibula of adult teleosts and *Amia* seems to have a complex origin, incorporating a dorsal (pharyngeal?) segment early in development. The fusion of these pieces ultimately entraps the hyomandibular nerve trunk, resulting in the typically pierced teleostean 'hyomandibular' bone.

A Preliminary Phylogenetic Studies of Populations of *Tilapia zillii* Gervais, *Oreochromis niloticus* Linn. and *Sarotherodon galilaeus* Linn. in Three Selected Reservoirs in Osun State, Nigeria.

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The study investigated the phylogenetic relationship among the populations of *Tilapia zillii*, *Sarotherodon galilaeus* and *Oreochromis niloticus* from Aiba, Erinle and Osinmo reservoirs in Osun State, Nigeria. This was with a view to assessing level of admixture in the populations of the three species in the sampling sites. A total of 50 specimens each of *T. zillii*, *S. galilaeus* and *O. niloticus*

were sampled from the three reservoirs. DNA was extracted from the caudal fin clips and the extraction procedure was based on the cetyl-trimethyl ammonium bromide (CTAB) method. The pure DNA was analysed in a polymerase chain reaction (PCR) using 16S rRNA and COI mitochondrial genes' primers. The phylogenetic trees generated from the sequence data of the amplicons depicted sister group relationship between *Sarotherodon* and *Oreochromis* but with low bootstrap support. The *T. zillii* samples from Aiba reservoir consistently clustered into two clades in all the phylogenetic trees. Further analysis shows that the identity of one of the clusters was *T. zillii* while the identity of the other cluster may be *T. rheophila*, a species endemic to Guinea. This argues for the first time for a westward expansion of a species that was formerly believed to be endemic to Guinea. However, the likelihood of the species being a new species could not be ruled out. The study therefore confirmed that there was admixture in the population of *T. zillii* in Aiba reservoir and its implications in the management of genetic resources of fish populations in Nigeria was discussed.

Convergence of Species of “Barbus” in Cameroon

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The small barbs of Africa are a complex taxonomic pattern made all the more complex by the fact that they are recognized in a genus (*Barbus*) that they clearly do not belong to. The anatomy of species of “*Barbus*” is diverse with some species less than two centimeters long, and some 15 cm; some species elongate, and some deep-bodied; some with serrated dorsal-fin spines, some with thick but non-serrated spines, and some with just unbranched rays. This diversity of morphologies suggests that the African small barbs will eventually need to be recognized in multiple genera, but it also suggests that there is a wealth of information in the body shapes of the organisms. We examined the geometric morphometrics and molecular phylogeny of specimens of “*Barbus*” from the Dja River of Cameroon in order to understand potential mimicry between two presumably distantly related species (“*Barbus*” *aspilus* and “*B.*” *guirali*) that form schools together and are remarkably convergent in coloration and body shape. Landmarks were placed on digital images with TPSDIG2 and the data analyzed in MorphoJ. Principal Components Analysis and Canonical Covariates Analyses were conducted on the data, and centroids for each species determined. Specimens were sequenced for the Cytochrome *b* gene and a phylogeny constructed using RAXML. The phylogeny with branch lengths was imported into MorphoJ and placed over the PCA and CCA with tips at species centroids and nodes constructed using phylogenetic least squares. By fitting the phylogeny onto a plot of the geometric morphometrics the convergence is readily observed. This method allows for a more robust approach of examining convergence in morphologies between species, and a good way of excluding phylogenetic influence.

Phylogenetic relationship between *Clarias anguillaris* and *Heterobranchus bidorsalis* from three ecological zones in Nigeria

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The phylogenetic relationship among Clariidae species (Teleostei Siluriformes) from different ecological zones in Nigeria were assessed using Histone 3 gene promoter. Two different species from

two different genera were examined namely, *Clarias anguillaris* and *Heterobranchus bidorsalis*. The result showed that the species have a common ancestor though the distance in relationship revealed variations among them. There were also variations in the sites of the nucleotides in the different strains. Estimated genetic distances between populations were directly correlated with geographical distances. The unweighted pair group method with averages (UPGMA) dendrogram showed three clusters, the Maiduguri, Onitsha, Kainji, Yola *C. anguillaris* and India *C. gariiepinus* population forming one cluster. Kainji *H. bidorsalis* was alone on the second cluster and Maiduguri *H. bidorsalis* and the Genbank AF416497.1 on the third cluster. Genetic variation of *C. anguillaris* is a useful trait for developing a good management strategy for maintaining genetic quality of the species.

Identification and morphological characterization of African catfish (*Clarias* sp.) populations in Burkina Faso

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Present in Southeast Asia and Africa, the Clariidae family includes fifteen genera. The greatest species diversity of this family is in Africa where about 77 species have been recorded. The genus *Clarias* includes six subgenera in Africa. In a review of the African *Clarias* species, Teugels (1982, 1986) recognized two valid species in the subgenus *Clarias* (*Clarias*): *Clarias anguillaris* (Linnaeus, 1758) and *C. gariiepinus* (Burchell, 1822). The almost identical external characteristics make it difficult to distinguish the two species macroscopically. The main character for their identification throughout their geographic range is the number of gillrakers located on the first gill arch. Furthermore, they occur sympatrically in many basins of the Nilo-Sudanian zone (Nile, Chad, Niger, Volta, Senegal). Consequently, many studies carried out in Burkina Faso have confused them. This study aims to identify the distinguishing characteristics of both species, based on the study of ten populations collected throughout in Burkina. The majority of these populations belong to the Volta basin, where *C. gariiepinus* was found for the first time in Burkina Faso. Each sample consisted of 30 individuals including all stages of growth, in which various biological parameters (morphometric and meristic) were studied. Preliminary results suggest the existence of only a single species, namely *Clarias gariiepinus*. However, there could be morphological differences between widely separated populations.

Theme 1

**Fish systematic, biodiversity research
and data management**

Poster presentations

Fish Biodiversity of the Kwilu River, under southern affluent of the river Kasai (ichtyogeographic province of Congo).

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Kwilu, like much of other rivers of the Kasai basin, is extremely poorly known ichthyologically. The study of fish Biodiversity of the Kwilu River was carried out between September 2010 and September 2012. Infact, length of 965km, Kwilu were prospected along a 50 km within this study. Fish samples were primarily provided from artisanal fishing. From the biodiversity point of view, our study allowed to inventory 161 fish species in the Kwilu River basin. These species belong to 79 genera, 24 families and 10 orders. Among the 161 listed species, 144 are known for the first time in the Kwilu River basin among which three are new for Science: *Alestopetersius conspectus* Mbimbi & Stiassny, 2012, *Alestopetersius sp.* "mbuji" and *Mastacembelus sp.* "kwilu " and of these 50 species are recognized as representing new records for the Kasai basin. While preliminary, this contribution serves as a useful starting point for efforts to understand the ichthyofaunal composition and biogeographic history of the Kasai system; one of the most poorly documented river systems in central Africa.

Fish Diversity of the Mayi-Ndombe River (Congo River, DR Congo)

Tobit Liyandja

The current study reports on a survey of the fishes of the Mayi-Ndombe River, one of the poorly known rivers of the Kinshasa Region in the Democratic Republic of Congo. Fish specimens were collected using standard techniques, and physical and physicochemical parameters were taken at collection sites, which were selected to sample available habitat types. The effect of rapids on the longitudinal distribution of species was investigated, and the impact of human activities on fish species was noted. Results were analyzed using several biodiversity indices, and factorial analysis of correspondence and the Kruskal-Wallis test. A total of 128 species (in 10 orders, 24 families and 68 genera) were recorded for the Mayi-Ndombe River basin indicating high diversity as measured by the Shannon index. Most of the species recorded are restricted to the surrounding ecoregion, although about 12% of species are widely distributed in the Congo basin. The family Mormyridae is the most diversified both in terms of the number of genera and species represented in the basin. Rapids exert a considerable influence on the longitudinal distribution of species in the Mayi-Ndombe basin, acting as selective barriers to upstream movement of some species. Most species were recorded as present in both the main channel and in tributaries, but 13 species have so far only been recorded in tributaries. The study is a contribution to the improvement of knowledge on the geographical distribution of fish species in the Congo basin.

Fishes of the Nsele River (Affluent of the Congo River, Pool Malebo, Ichthyogeographic region of the Congo)

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A list of fishes collected in the N'sele River, a large affluent tributary of Pool Malebo, in the Democratic Republic of Congo is provided. Sites along the main channel and affluent tributaries were sampled and 148 species distributed in 27 families are reported. Despite close proximity to the megacity of Kinshasa, the ichthyofauna of the N'sele River has not previously been documented, and in the course of the current study, 19 of the 148 species are recognized as new records for the region.

Due to difficulties of access much of the middle reach of the N'sele River remains to be inventoried and, while the present report documents high diversity in this system, the list is likely to be incomplete. Although preliminary, the current report provides a solid foundation for further work in a region that is undergoing rapid environmental degradation.

The ichthyofauna of the Upemba National Park (DR Congo): diversity, ecology, conservation and sustainable management

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The Upemba National Park (UNP), located in the Katanga province in the Democratic Republic of the Congo (DRC), is drained by the basins of the lower Lufira and the Lualaba-Upemba, which flow together towards the northern edge of the park. Poll (1976) described 116 species, including 19 endemics, belonging to 24 different families from the area. However, the Royal Museum for Central Africa (RMCA) actually houses specimens of 193 nominal fish species from the UNP with the family of Cyprinidae being the most diversified with 45 species including 23 '*Barbus*' species, followed by the Mormyridae (24 species), Mochokidae (18 species), Cichlidae (16 species), Distichodontidae (14 species) and Alestiidae (11 species). A comparison of the ichthyofauna of the two basins shows that all families of the lower Lufira also exist in the Lualaba. However, Channidae, Citharinidae, Clupeidae, Eleotridae and Protopteridae occur in the Lualaba but have not been found in the Lufira. Of the 68 genera, 30 are common to both basins, 26 exist only in the Lualaba and 12 are specific to the Lufira. The ichthyofauna of the Lualaba-Upemba counts 132 species while there are 94 species listed for the lower Lufira; 45 species overlap between the two systems.

However, our knowledge of this fish fauna remains poor. Indeed, several unidentified museum collections from the UNP are still available (RMCA and the IRSNB, Belgium) and only the north-eastern part of the UNP has been thoroughly explored. As part of a new project, we will revive the study of the ichthyofauna of the UNP. We will concentrate especially on the fishes of the Northern Kalule river and their ecology, and will attempt to formulate directives for the conservation and the sustainable management of the ichthyofauna of the UNP.

Phylogeographical patterns in the Congo Basin: understanding the Pan-African evolution of the catfish *Clarias gariepinus* (Burchell, 1822)

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During the Miocene, some 25 million years ago, faunal barriers between the hydrographical systems of Africa were less distinct than today. The Congo Basin features among the oldest, largest and biologically richest on earth after the Amazon and before the Mekong. Sadly enough, it is the least known. It is within this framework that phylogeographical research has been initiated to understand the origin of its ichthyofauna. The model chosen is the African catfish *Clarias gariepinus*. This fish occurs in the Congo River from source to mouth, as well as throughout large parts of the African continent. A total of 133 mtDNA cytochrome *b* sequences (509 bp) from 36 localities of the Congo

and neighboring basins such as the Nile and Zambezi Basins, as well as Lake Victoria (Eastern Africa) were aligned and their patterns analyzed. Thirty seven unique haplotypes were identified. The results show the presence of four clades (Nilo-Sudan, East Coast, Zambezi and Congo) and several clusters of *C. gariepinus* in the Congo Basin. Network analysis confirmed the results and showed a higher diversity in the Congo clade. Some clusters of the Congo Basin are included in clades of neighboring African ichthyofaunal provinces, i.e. the Kando cluster in the Zambezi clade, the Tanganyika cluster in the Eastern clade and the Ubangi cluster in the Nilo-Sudan clade. As such, the *C. gariepinus* inhabiting the peripheral zones of the Congo Basin are affiliated with the Zambezi, Eastern and Nilo-Sudan. The genetic patterns of *C. gariepinus* in the Congo Basin are influenced by a combination of processes such as barriers, a long history of divergence, with an impact of refuges and new dispersal opportunities. Congo Basin fish species with a widespread African distribution outside the basin are probably relics and have inhabited the Congo basin before the isolation of basins in Africa.

Morphometric and meristic variation between two endangered tilapiine fishes *O. esculentus* and *O. variabilis* and the exotic tilapias *O. niloticus* and *O. leucostictus* in Lake Kanyaboli, Kenya

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Lake Kanyaboli is unique as a living museum. The most important fishery of this lake is that of an indigenous tilapiine fish, *Oreochromis esculentus*, which is virtually extinct in Lake Victoria. *Oreochromis variabilis* has been infrequently reported to occur in this lake while two exotic species *O. niloticus* and *O. leucostictus* although less dominant, frequently appear in catches. The indigenous tilapiine species have been listed as endangered and it is postulated that hybridization may have taken place with the exotic tilapias. Morphological and meristic variation was examined in samples of the four tilapia species; *Oreochromis esculentus*, *O. variabilis*, *O. niloticus* and *O. leucostictus* from Lake Kanyaboli and its environs, to distinguish populations and identify hybrids. All samples of *Oreochromis variabilis* were collected from the nearby Kalenjuok and Mauna dams as none was found in Lake Kanyaboli. A total of 20 morphological and 8 meristic characters were examined. Discriminant Function and Principal Component analyses indicated no correlation in the morphological characters between *Oreochromis esculentus* and *O. niloticus* and between *Oreochromis esculentus* and *O. leucostictus*. The overall DF was significant ($p < 0.05$). The species were best discriminated by the inter-orbital width (IOW) the pre-pectoral length (Ppl), the anal fin length (Afl) and the anal spine length (AsL) with a 97% correct classification of specimen. However there were some overlap of individuals between populations of *O. niloticus* and those of *O. leucostictus* and *O. variabilis*. The present analyses do not suffice to state the overlap as due to the presence of hybrids and therefore this necessitates some biochemical analysis.

***The *Petrocephalus catostoma* (Pisces, Osteoglossomorpha, Mormyridae) subspecies: clarifying the status. Is it one species?**

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Petrocephalus catostoma (Günther, 1866) has four different subspecies; *Petrocephalus catostoma catostoma*, *P. c. congenericus*, *P. c. haullevillei*, and *P. c. tanensis*. This study was set out to find out if there are morphological and meristic variability among specimens of *Petrocephalus*. We examined 132 specimens from Burundi, Tanzania, Zambia, Botswana, Gabon, Angola and Malawi. The collections were from the Musée royal de l'Afrique Centrale, Tervuren (MRAC) and type specimens

from the British Museum of Natural History (BMNH). Methods for taking counts and measurements followed those of Boden *et al.* 1997. Covariance of matrix for measurements resulted in a single group which was impossible to divide logically into subgroups. However, correlation matrix for counts, resulted in two subgroups, with *P. c. haulleville* completely differentiating from the other subspecies. The *P. c. haullevillei* group had fewer scales from the origin of dorsal and anal fin, 8-9 SDLL, 9-11 SALL, compared to 9-17 SDLL and 9-18 SALL in the other group. The number of lower teeth was 14-20 compare to 14-24 in the other group. *P. c. haulleville* is probably a different species and should be classified as such.

***Problématique de *Synodontis* (Siluriformes: Mochokidae) du bassin du Congo (DRC)**

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Les analyses multivariées et l'observation des patrons de coloration ont servi pour réaliser cette étude. Un des problèmes est celui lié au *S. decorus*. L'espèce est endémique au bassin du Congo. Bien que *S. decorus* a une grande distribution, l'étude morphométrique sur 68 spécimens ne montre qu'une faible divergence morphologique géographique. Par contre une analyse des patrons de coloration sur 72 spécimens révèle une variabilité géographique importante dans la coloration. On peut distinguer trois types de patrons de coloration à savoir: le patron 'lignes', le patron 'taches arrondies' et le patron 'uniforme'. Les individus à patron lignes se localisent au Congo supérieur et ceux à patron taches arrondies sont présents dans le Congo moyen et inférieur. Les spécimens à patron uniforme se trouvent limités au Nord Est et à l'Ouest de la RDC. Un autre problème est celui de l'existence d'une variation intraspécifique au sein de *Synodontis nummifer* Boulenger, 1899. Une variation de patron de coloration de la nageoire caudale a été observée. Le nombre des bandes sur la nageoire caudale augmente avec la taille chez l'espèce *S. nummifer*. La caudale ponctuée des taches plus ou moins arrondies, sont plus fines chez les jeunes et plus grandes chez les spécimens de plus de 100 mm LS. Cette espèce qui se confond au stade de la jeunesse au *S. decorus* peut se distinguer rapidement et simplement par le fait que les deux lobes de la nageoire caudale ne sont jamais séparés entre eux par une bande noire horizontale comme le cas chez *S. decorus*.

Barcoding fish along the West African Coastline

Reinold Hanel

It has long been recognized that DNA sequence diversity, whether assessed directly or indirectly through protein analysis, can be used to discriminate species. Empirical support for the barcoding concept ranges from studies of invertebrates (e.g. springtails and butterflies) to birds as well as fishes. But despite several initiatives for fish barcoding, the worldwide coverage is still relatively low. Recent data published by the FishBol initiative show that only 29% of the bony fishes and 53% of sharks and rays have been barcoded so far (www.fishbol.org). The coverage of species regionally differs substantially, with areas like Africa and South America being significantly underrepresented. Considering the status of threat of many of the intensely fished fish stocks along the West African coast, a rapid assessment of the genetic diversity of the most important species of that region is highly recommended. Western African species regularly show up at the European market as illegal surrogates of popular and high-priced European seafood products. This was the case for tropical sole species marketed as European sole *Solea vulgaris* and recently culminated with Prickly pufferfish (*Ephippion guttifer*) fillets being imported into the European Union labelled as African monkfish (*Lophius* spp.).

One important measure is to provide tools for a correct identification of fish and fisheries products (mainly fillets) to a species level as a first step to prove geographical origin outside European waters. A joint Moroccan-German research project starting in 2013 within the frame of the Moroccan-German Programme of Scientific Research (PMARS) addresses this issue and aims at an assessment of genetic barcodes for all commercially valuable fish species of Morocco, many of them not yet listed in any genetic database. Within the scientific innovation programme of the German Federal Ministry of Food, Agriculture and Consumer Protection this approach shall be extended to all commercially valuable fish species of the Central Eastern Atlantic as part of a larger project on „Adaptation and Development of Innovative, Non-Invasive Monitoring and Evaluation Systems for Fisheries Research“.

The Marine Mangrove Park (DR Congo, Bas-Congo): towards a better knowledge of a largely neglected ichthyofauna

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Situated along the Atlantic coastline of the DR Congo, the Marine Mangrove Park (MMP), covering an area of ±65.800 ha, includes: (1) a Core Zone consisting of islands covered by mangroves at the mouth of the Congo River; and (2) a Buffer Zone consisting of a coastal strip along the ocean and a humid savannah strip more upstream along the Congo river. The coastal strip is crossed by two small coastal rivers (i.e. Kumbinanimi and Tonde), while the wet savannah is crossed by eight small Congo River tributaries (i.e. the Kabemvo, Tshikayoko, Kimpenza and Luibi flowing directly into the mangroves and the Lukunga, Yuba, Samba and Mbola situated more upstream). A compilation of the collections housed at the Royal Museum for Central Africa (MRCA), these made between 1901 and 2006, gives a total of 166 nominal species distributed over 56 families. Most rich species are the Cichlidae (13), Carangidae (12), Gobiidae (8), Anabantidae (7), Mormyridae (7), Mugilidae (7), Carcharhinidae (6), Clariidae (6), Claroteidae (6) and Clupeidae (5). In addition, 24 species known from the vicinity of MMP have not yet been collected within its borders yet. Further, the Kumbinanimi River as well as seven of the eight Congo tributaries, i.e. except the Luibi River, and many small ponds still remains unexplored. Although fishing is artisanal, sustainable harvesting is threatened by the use of mosquito nets. In addition, water pollution due to oil exploration as well as oil exploitation and refineries becomes worrying. Therefore, the aims set by the present study are, not only, (1) to document the fish species diversity of the MMP, and (2) to study their ecology at some target localities; but also to (3) identify the most harvested and possibly endangered species as well as the major fishing areas; and (4) this in order to develop conservation and sustainable management guidelines for its fish fauna.

***Clarias/Clariallabes* sp. «kundelungu" (Siluriformes: Clariidae), a new species from the Kundelungu National Park (DR Congo)?**

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During an expedition to the Kundelungu National Park (KNP) in September 2012 within the framework of the CTB-PRODEPAAK project, a clariid species was collected from the Lofoi River system (1392-1421m altitude) upstream of the 384m high Lofoi Falls. The species could not be placed unequivocally in either *Clarias* Scopoli, 1777 or *Clariallabes* Boulenger, 1900. In fact, the species corresponds best to the definition of *Allabenchelys* Boulenger, 1902, currently a junior synonym of *Clariallabes* Boulenger, 1900 following Teugels (1986), this due to the following combination of characters: (1) reduced lateral skull bones with no contact between the infraorbital IV (behind the orbit) and the suprapreopercular bone; (2) eyes with a free margin and as such surrounded by a furrow; and (3) unpaired fins not confluent; However, these features are also found in some species of the genus *Clarias*. Although no *Clariallabes* species are known from the Upper Lualaba and the Luapula-Moero, two species, *Clariallabes centralis* (Poll & Lambert, 1958) and *Clariallabes laticeps* (Steindachner, 1911), have been reported from the Lower Lualaba. The Kundelungu specimens clearly differ from the former because of the absence of serrations on the posterior side of the pectoral spine, and from the latter, because of the absence of white spots on the body. Seven valid *Clarias* species are recognized from the Upper Lualaba and Luapula-Moero (Teugels, 1986). However, only two, i.e. *C. dumerilii* and *C. liocephalus*, both belonging to the subgenus *Brevicephaloides*, are similar to our specimens in having a pectoral spine serrated on its anterior side only. The possible new species differs, amongst others, from *C. liocephalus* by the open gap in-between the infraorbitale IV and the suprapreopercular, even in large specimens. Although *Clarias/Clariallabes* sp. "kundelungu" does resemble *C. dumerilii*, it nevertheless differs from it by the lack of the diagnostic lateral notch on the suprapreopercular.

Molecular phylogenetics of the Claroteinae (Claroteidae: Siluriformes) and affinities of the Tanganyikan clarotein species flock

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Lake Tanganyika is known for the endemism of its fishes and species flocks of cichlids, *Lates*, mochokid catfishes and mastacembelid spiny eels. While the term "species flock" is sometimes applied to Tanganyika's clarotein catfishes, knowledge of how many lineages are represented and their extra-lacustrine affinities has been lacking. Tanganyikan claroteins include three genera endemic to the Lake—*Phyllonemus* (3 spp.), *Bathybagrus* (1 sp.) and *Lophiobagrus* (4 spp.)—as well as seven endemic species referred to *Chrysichthys*, a genus with more than 40 valid species widespread across Africa. We conducted a phylogenetic study of 58 specimens representing 42 clarotein species using nuclear (*rag2*) and mitochondrial (cytochrome *b*) DNA sequences. We included one species of *Phyllonemus*, two species of *Lophiobagrus*, *Bathybagrus tetranema*, and six of the seven Tanganyikan endemic species of *Chrysichthys* (all but *C. stappersii*) along with 24 nominal species of *Chrysichthys* from central, western and eastern Africa drainages as well as *Clarotes laticeps*, *Amarginops platus*, *Gephyroglanis congicus*, *Rheoglanis dendrophorus* and undescribed taxa from the Congo basin. We find that the three Tanganyikan genera—*Phyllonemus*, *Bathybagrus* & *Lophiobagrus*—belong to a monophyletic group that includes five of the six Tanganyikan *Chrysichthys* sampled (*C. grandis*, *C. graueri*, *C. platycephalus*, *C. sianenna*, and *C. acsiorum*). This clade is most closely related to *Clarotes laticeps*, a widespread species in East Africa, the Nile, and West Africa. However, *C. brachynema*, the only clarotein in Lake Tanganyika with a well developed postcleithral process, belongs to a large clade of Congo basin species. Using fossils and the inferred age of Lake Tanganyika as a temporal calibrations, we conducted a Bayesian relaxed clock analysis in the software BEAST to estimate the age of the impressive clarotein radiation in the Congo basin. We discuss implications of our results for future taxonomic revision of this important group of African catfishes.

A Preliminary Phylogeny of West African ‘*Barbus*’ (Cyprinidae)

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Of the over 800 species of *Barbus* within Cyprinidae, more than 300 species are attributed to the sub-Saharan ‘*Barbus*’ group. Despite the large number of species within this region, little is known regarding the relationships within the genus, and taxonomic revision is necessary to distinguish the group from the Eurasian *Barbus* sensu stricto. Recent work has separated *Pseudobarbus* and *Labeobarbus* from the ‘*Barbus*’ group in Africa, but additional taxonomic resolution within the genus is needed. In this study, over 25 species of ‘*Barbus*’ from West Africa are analyzed using the mitochondrial marker cytochrome b. A preliminary phylogenetic framework for the relationships within the ‘*Barbus*’ of West Africa is constructed using maximum likelihood and Bayesian inference. The monophyly of the group is tested as well as the relationships of the ‘*Barbus*’ to other closely related genera.

Comparative phylogeography of annual *Nothobranchius* fishes from southern Mozambique

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The genus *Nothobranchius* is a group of small fishes that inhabit temporary savannah pools in Eastern Africa. All species are annual; the adults die when the habitat desiccates and new generation survives in the form of eggs encased in the dry mud. We analyzed population genetic structure of three species complex (*N. furzeri/kadleci*, *N. rachovii* complex a *N. orthonotus* complex) from the southern periphery of *Nothobranchius* range, using samples covering entire of their ranges. Their similar distribution and habitat requirements make them an ideal model for comparative studies. We used a set of 12-13 microsatellite loci for a sample of 1638 fish from 96 populations and cytochrome *b* sequences for a sample of 463 fish from 152 populations to describe the population genetic structure and test hypotheses of the *Nothobranchius* dispersal (adult dispersal during large floods versus egg dispersal in mud on bodies of large mammals). We found profound genetic differences among populations, including adjacent populations that are separated by as little as few kilometres. Genetic structuring was strong and, surprisingly, large rivers (Save, Limpopo) formed major barriers to gene flow. This is scarce for a fish taxon and comparable to the situation known for terrestrial animals (fish populations tend to be structured according to the river basin, barriers are typical between river). There is no indication that the eggs are transported by large mammals and dispersal is likely mediated by flooding and geological events. The results of comparative phylogeography identified the main refugia in which the populations survived periods of major climatic changes during the Plio-Pleistocene.

A re-evaluation of species diversity within the *Labeo* (Cypriniformes: Cyprinidae) with papillary lips from the Congo basin

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The taxonomy of the African representatives of the paleotropical genus *Labeo* is confusing and difficult. Indeed, in spite of the revisions conducted by Reid (1985) and Tshibwabwa (1997), taxonomical inconsistencies are still encountered and hamper the correct identification of species. This study focuses on the *Labeo* Cuvier 1816 species with papillary lips from the Congo basin. Currently five species are reported from this basin: *L. altivelis* Peters 1852, *L. mesops* Günther 1868, *L. lineatus* Boulenger 1898, *L. weeksii* Boulenger 1909 and *L. maleboensis* Tshibwabwa 1997. One hundred and eighty-eight specimens, including all types, were studied using 16 counts and 22 measurements. The results indicate that only two species, *L. altivelis* and *L. lineatus*, remain valid. *Labeo altivelis* is widespread across the Congo basin and also found in the Zambezi and in neighbouring eastward-flowing rivers; *L. lineatus* is a widespread Congo endemic, but absent in the Tanganyika basin. These morphometric results were confirmed by a preliminary DNA (COI) barcoding study. As dorsal fin shape has often been identified as one of the principal criteria to discriminate between *Labeo* species, special attention was given to this character. This revealed that intra- as well as inter-specific differences in allometric growth shape the differences observed both in size and contour of the dorsal fin. In *L. lineatus*, the dorsal fin remains small and with a straight edge in all sizes and regardless of the geographical origin of the specimens. However, in *L. altivelis*, the dorsal fin becomes larger with increasing size and different populations have a differently shaped dorsal fin edge: concave for specimens from the Lower and Central Congo, and convex for those of the Zambian Congo. The occurrence of *L. rosae* Steindachner 1894, in the Lufira (Upper Congo), reported here for the first time, is most likely the result of an introduction.

Towards a revision of the large-sized *Distichodus* Müller & Troschel, 1844 (Characiformes: Distichodontidae) species from the Congo basin

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Currently 14 valid *Distichodus* species are known from the Congo basin, eight of which belong to the group of large-sized species (max. size ≥ 310 mm TL). Within this group, three species are easily identified, i.e. *D. maculatus* by its round, blackish spots all over the body, *D. lusosso* by its terminal mouth and distinctively prolonged snout and *D. sexfasciatus* by its strongly compressed snout and orange-reddish body coloration, the latter only shared with *D. lusosso*. However, identification of the five remaining species is more problematic and has been subject to numerous misidentifications in the past. Species included within this group are *D. antonii*, *D. atroventralis*, *D. fasciolatus*, *D. langi* and *D. mossambicus*. Eight meristics and 28 measurements were taken on a total of 126 specimens. Results of Principal Component Analyses and Mann Whitney U-tests confirmed *D. antonii*, *D. fasciolatus* and *D. langi* to be valid species, even though the latter has for long been considered a possible junior synonym of *D. antonii*. *Distichodus antonii* can be distinguished from the other two species by its terminal mouth and larger internasal distance, while *D. fasciolatus* can be separated from *D. langi* by its lower dorsal, pectoral and pelvic fin ray counts. Reports of *D. mossambicus* from the Congo basin are found to be based on misidentifications. Results show these Congo basin specimens to be more similar to *D. atroventralis*, and were put together in the *D. atroventralis* complex. This complex is currently under study, but preliminary results already revealed it to contain two new species, one from the Kasai basin and another from Inga, Lower Congo.

Upper Congo Fishes Project: ichthyological study and collection building at the University of Kisangani, Orientale, D.R. Congo

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The Upper Congo Fishes Project is an international collaboration of ichthyologists working to improve our knowledge of the fish fauna of the Upper Congo Rapids and the surrounding region while developing expertise and institutional capacity at the University of Kisangani (UNIKIS) in D.R. Congo. Funding came from a U.S. Fulbright African Regional Research Fellowship and an Encyclopedia of Life Rubenstein Fellowship awarded to Dr. John P. Sullivan of Cornell University who spent February to October 2010 in Kisangani working with UNIKIS faculty and students. Supplemental funding received from the U.S. Embassy in Kinshasa made possible the purchase of jars for the reference fish collection at UNIKIS. Province Orientale of D.R. Congo harbors high fish diversity within a wide range of aquatic habitats, including a series of rapids over a 100 km stretch of the Lualaba (Upper Congo) River between Ubundu and Kisangani. The Tshopo and the Lindi Rivers join the Congo just below the rapids near Kisangani. Principle collection sites included Ubundu, at the head of the Upper Congo Rapids, Batkamoundje and Wanie-Rukula in its middle reaches, and the Wagenia rapids at Kisangani. Other areas sampled include the Tshopo and Lindi Rivers, the Epulu and Ituri Rivers within the Okapi Faunal Reserve and the Congo and Lubilu Rivers near Yangambi. Joining the project for fieldwork and lectures at UNIKIS were Drs. J. Armbruster of Auburn University, USA and Sebastien Lavoué of the Institute of Oceanography, National Taiwan University. Fieldwork in 2010 resulted in collection of approximately 150 species of fishes, several hundred DNA tissue samples and more than 300 photographs. The signals of more than 400 mormyrid weakly electric fishes were recorded. Manuscripts are in preparation for two new species of Momryidae and work on other undescribed species from these collections continues at Cornell, Auburn and UNIKIS.

Africhthy.org: a virtual research environment and web portal for African fishes

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Africhthy.org is an online information management system and social networking site for everyone interested in African ichthyology. We created Africhthy.org to facilitate efficient networking and collaboration among systematists, conservationists, fisheries managers, aquaculturists, aquarists, and university students & faculty who work with African fishes, wherever they are based. Africhthy.org makes available an up-to-date taxonomy of African fishes, identification keys, species descriptions and images, an archive for the voluminous “gray literature” on African fishes, discussion forums, an announcement bulletin board, and a multi-authored blog. New publications in African ichthyology are added and featured on the site regularly. Species pages on Africhthy.org aggregate data and media from the Encyclopedia of Life, IUCN and GBIF, sequence data from NCBI, and literature citations from the Biodiversity Heritage Library. All content is tagged with taxon and watershed IDs from controlled, updatable vocabularies. A new publication module allows for direct preparation and submission of manuscripts to the Pensoft journal ZooKeys. Proposed enhancements will facilitate crowd-sourcing identification of fishes from uploaded images. Since its inception in January 2012, more than 1400 references have been added and more than 120 individuals have registered on the site. Africhthy.org uses the Drupal-based Scratchpads platform developed at the Natural History Museum, London and is one of nearly 600 Scratchpad sites hosted at the NHM. Scratchpads are available to any scientist who completes an online registration form at <http://scratchpads.eu> and are a product of the

Virtual Biodiversity Research and Access Network for Taxonomy (ViBRANT) project, funded by the European Union FP7.

Aquatic biodiversity in Kenya: Discoveries from the 2010-2012 International Research Experiences for Students (IRES) expeditions.

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For three years, teams of undergraduate and graduate students from the US and Kenya joined Kenyan and US researchers for five weeks of field and laboratory freshwater aquatic biodiversity research in Kenya with support from the U.S. National Science Foundation's International Research Experiences for Students (IRES) program and a pilot project from US Agency for International Development's Partnership Enhancing Expertise in Research program (USAID-PEER). For two weeks each summer, the teams collected fish and invertebrates and gathered data on physical and chemical characteristics of rivers across southern and Central Kenya. The USAID-PEER funding allowed for further sampling and training while the US participants are not in the country. Over the course of three years nearly 100 localities were sampled and more than 10,000 fish specimens were collected. Fish and invertebrate samples were identified and summarized by region and in comparison to physico-chemical characteristics of the rivers sampled. The fish specimens are cataloged in the Ichthyology Section of National Museums of Kenya in Nairobi. The students also received basic training in molecular sequencing methods which allowed for the production of mitochondrial and nuclear gene sequences for some of the collected fishes. Studies of the collected fish specimens have resulted in the discovery of a number of previously unrecognized species and unresolved taxonomic issues. This presentation provides an overview of the project and findings to date.

An update overview of freshwater and brackish fish diversity in Gabon

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The Gabon is a country of 266000 km² and comprises 59 watersheds. The major one is the Ogowe with 217000 km², which is quite completely inside the Gabon (with the Ngounié, and the Ivindo rivers as major tributaries), the Ntem, the Woleu, the Rio Utamboni (Noya) and Rio Ncomo (Komo).

At the request of WWF and for the policy of "Green Gabon", we have performed an up-date of the knowledge on fish biodiversity in Gabon. The aim of this work was to know the areas with low sampling effort, the history of ichthyology and biodiversity distribution, to put forward where sampling efforts have to be implemented. We collected data available from web database (faunafri, fishbase) and bibliography (books, scientific papers, grey literature, reports, thesis...). The fish fauna include 50 families, 130 genera for 380 species (with some doubts which have to be investigated). 540 stations for 25 watersheds have been sampled in the past. Many of the coastal small watersheds are completely unknown. Quite 1000 stations (some several times) have been sampled but 60% in the last 20 years. First stations are known from 1866. However, 42% of the stations have been sampled 1 or 2

times, 47% less than 4 times. As can be expected, major samples belong from short time missions and are along the roads. Several are from aquarist for killi fish. All factors, show that the watersheds of Gabon are under sampled. With the increase of forestry, building of major dams, industry and anthropic disturbances, it is now necessary to increase the samples on unknown areas.

A field survey on Lake Albert in DRC in 2007

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Lake Albert Lake is located to the north of the Albertine Rift. It belongs to two countries, Uganda to the west and DRC to the east. The lake is known to be with a high biomass of fishes. However, due to armed conflict, many problems have been days with the movements of displaced and refugee populations. Congolese part of the lake has been very little known and only few stations of scientific investigations are published. We have, in this study, sampled more than 26 stations along the Congolese side of the lake, providing new knowledge about the biodiversity of this Lake and its current state. The distribution of species is not as homogeneous as it looks at first. The southern area tends to become a swamp and fauna that appears is typical of this type of biotope. In the central area, almost exclusively rock, the number of species observed is largely lower than in other parts of the lake, but we recorded a probable new species of algae grazers Haplochromines. Thus, the fishing methods used, always in conjunction with a maximum production are not completely uniform throughout the lake. The state of fishing gear and the ease of access to certain sites and thus the supply or marketing of the products are also not consistent along the lake. It is clear that some fishing gear must be abandoned so remain as gillnets and catsnets that can suffice for artisanal fishing. The reduction in catches by fishermen can have several causes but the main cause seems to be the reduced level of the lake, resulting in the south and in the north part, the formation of swamps and therefore, a deoxygenation causing the disappearance of these areas, major target species marketed. The activities of fishermen are an important additional pressure on the lake, since no state or village structure is put in place for the rational management of natural resources. This related, of course, in fact, that Lake is a fast option to get animal protein and cash without excessive work and an important background setting, so for people back after the hostilities, a certain ease to settle on the Lake.

The statement on fisheries and diversity in the Congolese northern part of Lake Tanganyika in 2007

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Lake Tanganyika is particularly well known for its biodiversity. It is also an important animal protein resources area and close to 30 million people live in its watershed. However, due to conflicts and movements of populations, several facts have led to a depletion of fish stocks.

We have studied the area of the Congolese northern part of Lake Tanganyika. More than 30 stations were visited and were the subject of collecting information on fishing, the fishermen but also the biodiversity of environments. If we synthesize all the information: About 60% of the known species of the area were captured or seen; There is a heterogeneity in the catches according to geographic location; The rocky areas seem more stable than other habitat compared to previous data; A major influence of the variability in catches is the presence or not of reeds and, to lesser effect, the moment of capture; Catches are best at night as the day in the northern part of the area investigated. All suggests that there are areas more or less affected by various external factors that have seen their

numbers in species and in number per species reduced. With regard to fisheries, all gathered information suggests that fishing pressure is heterogeneous across the zone of throughout the area of action and does not necessarily ensure a sufficient fish production from a point of view subsistence production. Structuring also fisheries needed to be revised to better monitoring of catches. Cannot be considered the State of Lake Tanganyika in the North without also considering what happens on its basin watershed. Much of the problems are external to the Lake, which is the receptacle of what is happening around. It is a currently particularly in danger and requiring awareness and actions on the part of the political leaders of the riparian countries, what begins to be the case.

The biodiversity of fishes in the part of the St John and St Paul rivers in Liberia

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After more than 15 years of war, Liberia became a destroyed country. The main animal protein intake is by fish. However, the biodiversity of the basins of Liberia is very little known. These basins have the particularity of belonging to the ichtyoregion of Upper Guinea with a high rate of endemism. In 2004/2005, we have studied more than 60 site in the neighbouring part of Guinea conakri, in the basins of the Saint John and Saint Paul rivers. Generally, the number of specimens caught is low. We have observed a very low number of species by stations (on average 4 then this average is 8 in Guinea), which is correlated with the number of captured specimens. In some stations, there was a significant imbalance with a very important number of predators, or even the presence of high densities of invertebrates such as snails and shrimp. In other stations, nothing has been captured. Different hypotheses have been days: (i) Pollution linked to plantations of rubber, (ii) direct human pollution (organic, soap...), (iii) environmental degradation due to the practices promoting erosion, destruction of forests galleries, (iv) overfishing. Indeed, a daily and constant fish, even of very small size (2 cm), was observed. These isolated environments are therefore a priori threatened by direct and indirect human activities.

The genus *Pollimyrus* in the Nile system: a species plus, a species minus

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The color morphs of *Pollimyrus isidori* occurring in the tributaries of the White Nile in south-western Ethiopia appeared to be different in a complex of characters. During the dry season (from November to April) the light form inhabiting the midstream of rivers is represented exclusively by grown-up individuals (SL > 45 mm) whose gonads are resting, while in the same season the dark form inhabiting the patches of macrophytes along the river banks is represented by individuals of various size (SL from several mm to 70+ mm) whose gonad maturity stages are correlated with individual size being in pre-spawning state in the largest individuals. It is reasonable to suggest that in the light form reproduction occurs during rainy season, while in the dark form it occurs all over a year. Some differences between these forms in the waveform of the electric organ discharge were also revealed (Golubtsov et al., 2012). Analyses of the mtDNA sequences (full cytochrome b gene) from 16 specimens of every form demonstrated that these forms are the closely related but phylogenetically distinct lineages. Thus, according to Bigorne (1991) the light form should be identified as *Pollimyrus isidori* (Val.), while the dark form is most probably an undescribed species distributed in the White Nile basin and adjacent Omo-Turkana enclosed system. The medium-sized mormyrid previously considered as *Pollimyrus petherici* (Blgr.), endemic to the Nile system, appeared to be quite distantly

related to most other *Pollimyrus* species as follows from the mtDNA analyses, it clustered together with *Hippopotamyrus wilverthi* (Blgr.) and some other Congolese taxa. Study was supported by Joint Ethio-Russian Biological Expedition, Russian Foundation for Basic Research, grants 11-04-01252, 13-04-01319, and Program of President of Russian Federation for young scientists, MK-476.2012.4.

Hypertrophied lips in species of *Crenicichla* (Cichlidae: Cichlinae: Geophagini) from the rio Iguaçú, upper Paraná basin, Brazil: convergence with big-lipped cichlids from Central America and Africa

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During the taxonomic revision of the species of *Crenicichla* from Paraná and Paraguai river basins, specimens with hypertrophied lips were found in the rio Iguaçú basin. Cichlids with hypertrophied lips are widely recorded in the literature, mainly for species of the African and Central American lakes, but also for African riverine cichlids and some South American, rheophilic species of the tribes Cichlasomatini *sensu* Kullander 1998 and Geophagini *sensu* López-Fernández *et al.* 2005. Lips hypertrophy has been treated as species-specific or as intraspecific variation in Cichlidae. Based on comparisons of morphological characters, big-lipped forms from rio Iguaçú were considered as correspondent to three different species with thin or typical lips, two of them described (*Crenicichla iguassuensis* and *C. tesay*) and a new species informally named *Crenicichla* sp. "Iguaçú". This classification partially agreed with the results of a simultaneous phylogenetic study based on molecular data (Piálek *et al.* 2012). The expression of the big lips in those species seems to be independent of sex or ontogeny, and there is a gradation from typical to extreme hypertrophied lips within the material studied. Therefore, the expression of big lips in the species of *Crenicichla* from rio Iguaçú is considered as intraspecific variation, contrasting with that found in *C. tendybaguassu* of the rio Uruguai, in which the invariable presence of hypertrophied lips is considered one of the diagnostic features of the species. Hypertrophied lips are convergent in African, Central American, and Neotropical lineages, as previously pointed out by some authors. However, further studies on anatomy and variation of this character in a comparative way are needed to investigate possible differences in the structure and function of the hypertrophied lips and their taxonomic significance within those lineages.

Fishes of the streams flowing from the Mulanje Massif, Malawi

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The streams flowing from the north of the Mulanje massif drain into the shallow Chilwa/Chiuta basin in the headwaters of the Lugenda branch of the Ruvuma River system. Streams from the southern slopes drain into the Ruo River, a tributary of the Lower Shire River and hence the Lower Zambezi system. The upper reaches of the Ruo support a unique fauna, with Zambezian affinities but distinct from the Lower Zambezian fauna in the lower parts of the river near its confluence with the Lower Shire. The 60 m high Zoa Falls over the ancient Thyolo escarpment form the boundary between the two faunas. New studies have provided further definitive genetic evidence for the distinct elements in the fish fauna, in addition to the two endemic *Varicorhinus* species described earlier. A paper now in preparation will describe five new species; a species in the *Barbus eutaenia* species-complex, a striped *Barbus* species, a mormyrid in the *Hippopotamyrus ansorgii* species-complex, an *Amphilius* species, and a *Zaireichthys* species. All of these are apparently endemic to the Upper Ruo. In addition, two unique *Chiloglanis* species were recognised, but these are covered in a separate study, while three new

spotted *Barbus* species are more widely distributed in Malawi and further afield. These will be described in a separate paper. The Mulanje research also revealed at least two more new fish species in the Chilwa fauna. This research contributes towards a guidebook on the river fishes of Malawi currently in preparation, but more live colour photos and DNA barcoding are needed to complete this project.

Theme 2



Biology, ecology and behavior
Oral presentations

Novel nasal anatomy suggests enhanced olfactory acuity in a subfamily of African catfishes: oddly lost in large male *Parauchenoglanis cf. balayi*.

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Diffusion of waterborne odorants, even over very short distances, is extremely slow when compared with aerial diffusion rates. Consequently, hydrodynamic aspects of water flow assume a particular importance for understanding the potential role of specialized nasal anatomy in fish olfaction. The nature of water flow over the olfactory epithelium, and how that flow is harnessed to ventilate the olfactory region of fishes is poorly understood. Despite many advances made in recent years in the understanding of olfactory neurophysiology, ultrastructure of sensory surfaces, and gene expression of odorant receptors - for most fishes basic information on gross nasal anatomy is lacking. The present study, which was initiated to investigate a putatively novel nasal sexual dimorphism in a species of African claroteid, *Parauchenoglanis cf. balayi*, has revealed a series of anatomical specializations of the olfactory chamber that characterizes all members of a subfamily of claroteid catfishes (Auchenoglaninae). Interestingly, many features of the architecture of the auchenoglanine olfactory chamber and associated structures appear to mirror those predicted to function in augmenting flow into and around the olfactory chamber and to maximize the entrainment of odorants over the olfactory epithelium. Interestingly, seemingly functional features of this specialized system are lost in large male individuals of a single species, *Parauchenoglanis cf. balayi* from the Louesse River, Republic of Congo.

Reproductive activities of two clupeid zooplanktivores in relation to the seasonal abundance of copepod prey in the northern end of Lake Tanganyika

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Reproductive activities of two commercially exploited clupeid fishes (*Stolothrissa tanganicae* and *Limnothrissa miodon*) in the northern end of Lake Tanganyika (Bujumbura subbasin) were investigated during two different years (2004-2005 and 2007-2008). We hypothesized that the timing of largest reproductive investment in these pelagic species coincides with the onset of the rainy season and the largest abundance of copepod prey. For *S. tanganicae*, the gonadosomatic index (GSI) was significantly higher prior to the onset of the rainy season, and this was observed in both years. For *L. miodon*, however, this pattern was overall weaker and only statistically significant in 2004-2005. We conclude that these clupeid fishes of Lake Tanganyika synchronize their investment in reproductive activities with copepod population dynamics as to maximize the survival of their larvae which feed on these copepods. However, the importance of this strategy seems species-specific, and might be influenced by climatological variation.

Secondary sexual characters of the small alestids *Micralestes acutidens* (Peters) and *Rhabdalestes septentrionalis* Boulenger: a comparative anatomy, with comments on these characters in American characids

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Various components of the family Alestidae demonstrate secondary sexual dimorphism in diverse traits, such as body coloration and fins morphology. Some of these dimorphic characters are traditionally utilized in the diagnosis of small alestid genera (e.g., *Ladigesia*, *Lepidarchus*, *Virilia*) and have been used more recently as evidence of close relationships of some alestid taxa (e.g., elongation of dorsal-fin rays shared by *Alestopetersius*, *Duboisialestes*, *Nannopetersius*, and *Phenacogrammus*). However, a detailed analysis of the secondary dimorphic characters within Alestidae is inexistent in the literature. The information is available only as short comments in a few taxonomic studies. In the present study we describe and compare the secondary sexual dimorphism of two representative species of the related genera *Micralestes* and *Rhabdalestes*. Preliminary results reveal shared dimorphic characters on the overall morphology of the anal fin, which includes the elongation and thickening of the fin-rays of males. The present study aims to describe in detail this dimorphism and infer primary homologies among them, through a comparative anatomy analysis. Convergence between these modifications found in alestids and Neotropical taxa is discussed.

Evolutionary ecology of annual *Nothobranchius* fishes: the model taxon for ageing studies

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Nothobranchius fishes possess unique life strategy by surviving in temporary savanna pools in Africa. Their post-hatching lifespan is limited to existence of the pools which varies from 2 to 11 months throughout of their range. In the dry phase of the pools, the populations survive as the eggs buried in the sediment. Because they deteriorate their vital function rapidly also in captive conditions, they become widely used in ageing studies. The talk will summarize our field and experimental work (2008-2013) on evolutionary ecology and life history in a *Nothobranchius* fishes from Mozambique, including *N. furzeri*, *N. kadleci*, *N. orthonothus* sensu lato and *N. rachovii* sensu lato. We studied populations of *Nothobranchius* across a cline of aridity and compared their life history traits between populations within a species and between coexisting species. Comparisons were made from field data and common garden experiments in the lab (all populations exposed to the same environmental conditions). I present data on species distribution and their sympatry, seasonal cycle and synchrony of hatching, the diet analysis including the stable isotope analyses, habitat associations and sex ratios. The most significant outcome is that the populations vary in their rate of ageing; *N. furzeri* and *N. kadleci* populations from the driest part of the range aged most rapidly. Species differ in their diet and habitat preference, but are flexible if food is limited. Hatching is synchronous and associated with large monsoonal precipitation. Sex ratio is male biased, apparently due to increased male adult mortality. *Nothobranchius* fishes promise to become valuable models species for the future of ageing studies – the genome of *N. furzeri* is being read, transgenic *N. furzeri* are available and research on them is conducted at many labs worldwide. We stress the importance of relating the lab data with the natural history of the species.

Extraordinary life history in African annual fishes

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Extreme environmental conditions can give rise to extreme adaptations and associated trade-offs in life history traits. We document extremely rapid growth and maturation, high fecundity and possibly extremely short generation time in two related species of African annual fish inhabiting temporary savanna pools in Mozambique (Eastern Africa). Experimental fish were kept in low densities and fed with highly nutrient-rich food. *Nothobranchius kadleci* started to reproduce at the age of 17 days and

size of 31 mm and *Nothobranchius furzeri* at 18 days and 32 mm, which is clearly the fastest maturation ever observed among vertebrates. All four study populations demonstrated rapid growth rates of up to 2.72 mm (23.4% of their total length) per day. Both species may produce diapausing embryos or embryos that are able to hatch in as few as 15 days, resulting in a plausible generation time of only 1 month. Incubation on the surface of damp peat moss results in high embryo survival (73%) and high proportion of rapidly developing embryos (60%) that skip the diapauses and hatch in less than 30 days. We further demonstrated that rapid growth and maturation is not compromised by low fecundity. Our experimental fish commonly produced several hundreds eggs in a 2.5 hour spawning cycle with maximum of 583 eggs laid by a single female of *N. kadleci*. Our data suggest that both species have the most rapid sexual maturation and minimum generation time of any vertebrate species, and their rapid maturity is not compromised by paedogenesis.

Spatial and temporal patterns in Nile perch populations in southern Lake Victoria with possible indications of a recruitment peak

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In 2009-2011 the distribution and composition of the Nile perch (*Lates niloticus*) population of southern lake Victoria were sampled. A total of 16,874 Nile perch were caught during 153 gill net settings and 87 trawl hauls. At a spatial macro-scale (ca. 100 km), comparing different lake regions, the density of Nile perch in Mwanza Gulf was 10 to 40 times higher than in Speke Gulf to the east, or in Sengerema, to the west of Mwanza Gulf. Depth appeared to be the best predictor of abundance here. At a meso-scale (ca. 10 km), within Mwanza Gulf, the density of Nile perch was also negatively related with depth. Overall, the shallow parts of southern Lake Victoria appear to sustain a disproportionately large part of the Nile perch population. Moreover, in Mwanza Gulf the proportion of juveniles <10 cm was higher than in the other regions, especially in waters <8 m depth in the wet seasons from November to February. Taking known growth rates into account, this suggests a seasonal recruitment peak during the dry season from June to September.

***Fish assemblage and resource partitioning in self-stocked ponds in lower Rufiji floodplain, Tanzania**

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This paper examines assemblage structure and resource partitioning of fish species trapped in eight ponds constructed adjacent to two floodplain lakes, Ruwe and Uba in lower River Rufiji floodplain. Fish assemblage structure and resource partitioning were analysed using Canonical Correspondence Analysis (CCA) and Schoener's index respectively. *Astatotilapia bloyeti* contributed the highest numbers in both sites. *Oreochromis urolepis* became the second and the third in terms of biomass in Uba ponds in Ruwe ponds respectively. The CCA showed a clear separation among fish species density trapped in the self-stocked ponds between two sites. In Ruwe ponds the diet similarity was relatively high between *Eutropiellus longifilis*, *Petrocephalus steindachneri*, and *Astatotilapia bloyeti*. In Uba ponds the highest diet similarity was between *Clarias theodora* and *Synodontis maculipinna*. The influence of floodplain processes on fish assemblage structure was related to flooding period and distance from the lake. It can be concluded that to some extent there was resources partitioning with the exception of few species.

Nile perch is an opportunistic feeder with a greater taste for fish than for shrimp

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Diet composition of 6,322 Nile perch (*Lates niloticus*) from Mwanza Gulf (Tanzania, southern Lake Victoria) was analysed in 2009-2011, covering a 50 km transect in all seasons. The importance of the shrimp *Caridina nilotica* in the diet increased with its abundance in the environment for all length classes of Nile perch up to 50 cm. However, its relative amount decreased from 55% in Nile perch sizes <10 cm to 0 at Nile perch sizes >50 cm. Already in 5 cm long Nile perch, fish was a part of its diet and its proportion rapidly increased with Nile perch size. Haplochromine cichlids appear to be the preferred fish prey for Nile perch of all length classes, although also *Rastrineobola* and juvenile Nile perch are eaten. However, despite the high abundance of *Caridina* shrimp in the open, deep waters, this does not support a high density of small Nile perch, probably because of avoidance of cannibalism by larger conspecifics.

Some osteological features of the anchovies *Encrasicholina heteroloba* and *Anchoviella lepidentostole* (Engraulidae) in relation to *Denticeps clupeioides*, the most basal clupeiform and sole Recent member of the Denticipitoidei.

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The Clupeiformes includes about 360 species of marine, estuarine and freshwater fishes commonly known as herrings and anchovies, with a worldwide distribution. The order is divided into the Denticipitoidei and Clupeoidei. Denticipitoidei includes one single living species, *Denticeps clupeioides*, a still poorly-known freshwater fish that inhabits a few isolated coastal streams in West Africa, from eastern Benin to Cameroon. Anchovies are members of the Engraulidae, a family that includes about half of the diversity of the Clupeoidei. *Encrasicholina heteroloba*, from the Indo-Pacific Ocean, is a basal member of the family. *Anchoviella lepidentostole*, on the other hand, is a member of a more derived clade of anchovies composed only by New World species. In this study we analyzed and described a set of characters from several osteological complexes of *Denticeps clupeioides*, *Encrasicholina heteroloba* and *Anchoviella lepidentostole*. Significant differences regarding the presence, absence and the arrangement of dentition on the branchial arches were found. Variations in the presence and form of the frontal fontanel and other characters of the skull, suspensory, branchial arches, vertebrae and associated structures were also found, and shed some light into the evolution of those morphological complexes in the Engraulidae.

The parasite, *Henneguya gaffari* (Myxozoa: Myxosporea), infecting the Nile perch *Lates niloticus* in Lake Victoria Kenya.

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The study of 107 fresh fish specimens of *Lates niloticus* in the Lake Victoria Kenya revealed the presence of the parasite *Henneguya gaffari* in the host. *Henneguya gaffari* was first described in 1999 in *Lates niloticus* in the north of Africa Lakes; Wadi El- Raiyan in Egypt, Lake Chad in Chad and in

Senegal. Fish samples were obtained between February 2012 and February 2013, from the fishermen in the open waters of Lake Victoria in Mbita west and analyzed at the International Centre for Insect Physiology and Ecology (ICIPE) Laboratory. Samples from Dunga and the rest of the inner gulf were analyzed at the Kenya marine and Fisheries research Institute Kisumu Centre. On the spot field identification was by detection of a tiny white spot at the base of the second or third gill filament representing a colony. The spore (parasite) was characterized by a triangular thickening at the base of the caudal processes which run adherent to each other for two-thirds of their length in a Microscopic examination. The infection was concentrated along the intestinal tract (outer and inner walls of the intestine), and in the gills and the gill rakers. The intestinal plasmodia were very pathogenic (induces lesions of the infected tissues) due to their very large numbers and sizes. Prevalence was 44.8%.

Comparative study of the effect of the diet ration on the oxygen consumption of juvenile cichlid fish *Oreochromis niloticus*, *Sarotherodon melanotheron* and *Tilapia guineensis* reared in concrete tanks.

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The effect of feeding on oxygen consumption (O_2) was studied in juvenile *Oreochromis niloticus*, *Sarotherodon melanotheron* and *Tilapia guineensis*. The experiment was conducted in an open circuit in 18 concrete tanks (1m x 1m x 0.8m). The height of the water in the tanks was 35cm. The water renewal rate is ½ liter per minute. The physico-chemical parameters of the water, after adjusted the flow and stopped the air diffusers were measured several times to achieve the standardization of values in the tanks. Three diet rations were tested with a witness R1 = 0% (fish fasting) and two others corresponding to R2 = 3% and R3 = 6% of the biomass. The Coppens food is manually distributed at 7:30 am, except in the control tanks. At 8:00 am (after 30 min), the oxygen values were taken every hour at the entrance and exit, until 5:00 pm, for a total of 10 measurements. The experiment was conducted in duplicate and no mortality was recorded. Rations influenced differently the oxygen consumption in three species. For *S. melanotheron* and *T. guineensis*, the R2 did not differ significantly from the R1 ($p > 0.05$), which is significantly different from R3 ($p < 0.05$). For *O. niloticus*, R2 and R3 differ significantly from the R1 ($p < 0.05$), but showed no significant difference between them ($p > 0.5$). Peaks of O_2 consumption in all treatments were obtained 2:30 time after feeding. These peaks account for 20% and 30% of O_2 consumption before feeding, respectively for the rations R2 and R3. For the three species, *S. melanotheron* and *T. guineensis* consume after feeding, less oxygen than *O. niloticus*. The post-feeding metabolic rate is significantly higher for *O. niloticus* than in *S. melanotheron* and *T. guineensis*. These results provide a basis for the domestication of *S. melanotheron* and *T. guineensis*, which are potential candidates for aquaculture in brackish water.

Revisiting Roberts (1972): an updated view of the fish fauna of the Congo and Amazon rivers, with a discussion of the Madeira River ichthyofauna

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Since Roberts' (1972) seminal paper on the similarities of the fish faunas of Amazon and Congo basins, our knowledge on the subject has increased substantially. The Congo River fish fauna was updated and summarized, and the Amazonian ichthyofauna has been considerably better sampled, including the deep river channels of its main tributaries. Despite the inspiring evidences provided by Roberts, size differences between the Congo and Amazon basins impair a comprehensive comparison

of their faunas, in function of the known effects of species-area relationships. We compared the fish faunas of Congo and Madeira rivers, which also have different drainage areas (4,014,500 km² and 1,380,000 km², respectively) but a very similar length (~4,700 km). This comparison was based on information obtained as part of environmental impacts studies of two large hydroelectric power plants in the Brazilian portion of Madeira River, developed in the last 10 years, and on nearly 250,000 collected specimens. The Madeira River ichthyofauna in Brazil harbors at least 950 species, a number that may grow up to nearly 1,500 species when including the Bolivian and Peruvian portions of the basin, whereas the Congo fishes sum ~700 species. Considering its smaller drainage area, the Madeira River ichthyofauna stands out as an extremely rich fish assemblage in a worldwide basis. This outstanding diversity probably results from the faunal interchange with the many Amazon tributaries and its different water types (turbid, clear, black), draining heterogeneous landscapes (ancient plateaus, sedimentary plains) and phytophysionomies, coupled with a complex network of forest streams and rivers. Moreover, the Amazon system was subjected to a complex history of geological and hydrological events, such as the orogenesis of the Andes, and the repositioning and intermingling of river channels resulting from the occurrence of megafans at the interface of higher terrains and the Amazon lowlands.

Ecologie alimentaire de *Schilbe multitaeniatus* (Pellegrin, 1913) (Siluriforme, Schilbeidae) de la rivière Rembo Bongo au Gabon (Afrique Centrale)

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Le régime alimentaire de *Schilbe multitaeniatus* a été étudié par l'analyse de 292 estomacs de poissons pêchés de juin 2010 à décembre 2011, dans la rivière Rembo Bongo au Sud ouest du Gabon au moyen des filets maillants installés entre 17h30 et 7h30. Le taux de vacuité global a été assez important (53,5%), mais chez les juvéniles (40,5%), il n'a pas différé significativement ($\chi^2 = 2,25$; $p > 0,05$) de celui des adultes (55,5%). De façon générale la vacuité a présenté des fluctuations saisonnières et a été plus importante en saison des pluies (62,64%) qu'en saison sèche (39%). Le spectre alimentaire a été large et constitué d'une fraction animale dominante composée principalement de poissons, d'insectes, de crustacés, de némathelminthes, d'araignées, et d'une fraction végétale faible composée de fruits et de débris végétaux. Ce spectre alimentaire est significativement différent (Indice de Schoener $\alpha = 0$) entre jeunes et adultes d'une part et entre saison des pluies et saison sèche d'autre part (Indice de Schoener $\alpha = -20$). Dans l'alimentation de l'espèce, il y a eu une récurrence des insectes chez les jeunes et une forte tendance à l'ichtyophagie chez les adultes. Le caractère éclectique et opportuniste de l'espèce s'est affirmé au stade juvénile alors que la sélectivité alimentaire est observée au stade adulte. La variation saisonnière du régime alimentaire a été caractérisée par une restriction du spectre alimentaire en saison sèche. En définitive l'espèce est omnivore à tendance ichtyophage dans la rivière Rembo Bongo.

Biologie de reproduction de *Schilbe multitaeniatus* (Siluriforme, Schilbeidae) de la rivière Rembo Bongo au Gabon.

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La reproduction de *Schilbe multitaenaitus* a été étudiée de juillet 2010 à juin 2011 dans la rivière Rembo Bongo au Gabon. Les poissons sont issus de la pêche expérimentale réalisée entre 17h30 et 7h30 dans deux stations (Mafoumi et Moanda) au moyen des filets dormants de mailles 10, 15, 20, 25, 30, 35, 40, 50 mm. Les femelles sont relativement de tailles plus grandes que les mâles et le sex-ratio ($\sigma:\varphi$, 1: 1.7) est en faveur des femelles ($\chi^2 = 17.2$, $p < 0,0001$). La taille de première maturité sexuelle est plus faible chez les mâles (22,7 cm) que chez les femelles (26,3 cm). L'espèce se reproduit pendant les hautes eaux de novembre à février, puis de mars à mai. Le repos sexuel survient pendant la saison sèche, de juin à octobre. La fécondité relative moyenne est estimée à 139,6 ovocytes/g. Le diamètre ovocytaire moyen avant la ponte est de 0,67 mm. La structure ovarienne est multimodale suggérant que l'espèce pratique au cours de l'année une ponte multiple.

Local variation in functional morphology of the feeding system of two haplochromines cichlids from Lake Kivu (Rwanda): *Haplochromis kamiranzovu* Snoeks 1984 and *H. insidiae* Snoeks 1994 (Teleostei: Cichlidae)

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Eastern-African cichlids are characterized by a rapid adaptive evolution, where changes in trophic morphology reflect one of the major levels of adaptive radiation. Less well known is to what degree these patterns also exist at a more localized scale, where trophic divergences could reflect local adaptations of populations within a single species to divergent ecological niches. This study aims to explore the relation between the variation in the cranial musculoskeletal shape of the feeding apparatus and morphology-based proxies for functional performance in feeding, focusing on two sympatric species occurring throughout Lake Kivu (*Haplochromis kamiranzovu* and *H. insidiae*). Both species show shape divergence between littoral and pelagic populations, so we hypothesize that these differences reflect local adaptations to different feeding niches (open water in the pelagic zone, versus benthic in the littoral zone). To test this, we compared morphological variation in musculoskeletal traits that are known to influence feeding performance, such as jaw muscle size and attachment (lever system geometries), bite force estimates based on muscle morphology, and kinematic transmission coefficients for jaw protrusion. Preliminary data shows that in both species head shape variation and feeding performance exhibits differences at all levels: species, sex, region (north-south) and habitat (littoral vs. pelagic). Most pronounced was the variation in the length of the ascending arm of the premaxillary, the volume of the A_2 jaw adductor muscle and the extension of the preorbital region. The relation between the observed shape differences and the differences in habitat is further discussed.

***Morphological differentiation of *Oreochromis niloticus* (Linnaeus, 1958) populations found in extreme conditions of temperature and alkalinity in Kenya**

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Nile tilapia (*Oreochromis niloticus*) is an important species of fish in aquaculture. The species has been cultured in different parts of the world and is currently ranked as one of the most cultured species of fish. Some of its natural populations have the ability to survive in adverse conditions, where other species of fish cannot survive. In Kenya, such populations have been found in three hot springs at L. Bogoria (36°C) and Crocodile Lake (peri-alkaline), a crater lake in central islands of L. Turkana. Morphological studies using geometric morphometric to establish the effect of the environment on the

form of the populations was carried out. Initial results of the study shows distinct morphological differences between Chelaba population (from the hot springs) and Crocodile Lake population (perialkaline). The differences between the populations can be explained by variations of conditions in their habitats.

Diverse world of African gyrodactylid parasites (Monogenea: Gyrodactylidae) under molecular and morphological magnifying glass

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In order to understand parasites diversity and host-parasites relationship in unexplored area diverse African freshwater fishes are becoming to be more intensively studied for their parasites. Since 2004, we have studied the diversity of fish parasites in five African countries (Senegal, Sudan, Kenya, Zimbabwe and South Africa) where a wide range of host fishes have been collected and investigated. Haptor sclerites morphology and sequencing of the nuclear rDNA revealed the presence of parasites representing six genera of Gyrodactylidae when only four of them are currently known for the sciences (*Gyrodactylus* Nordmann, 1832, *Macrogyrodactylus* Malmberg, 1957, *Afrogyrodactylus* Paperna, 1968 and *Diplogyrodactylus* Přikrylová, Matějusková, Musilova, Harris & Gelnar, 2009). Molecular phylogeny including all-but-one African genera were inferred from ITS and 18S rDNA sequences. The maximum likelihood and Bayesian analyses pointed to a paraphyletic nature of African *Gyrodactylus* species. They formed well-supported clades possibly indicating speciation within host taxa: 1) parasites of cichlids (Cichlidae); 2) parasites of catfishes (Siluriformes), consisting of a lineage infecting mochokids and one infecting clariids. *Macrogyrodactylus* spp. firmly clustered into a monophyletic group. An example of unexpected diversity of *Gyrodactylus* species parasitizing African Cichlids shows that different localities represent specialized host-parasites system which requires interest of researchers. Gyrodactylid fauna on African continent seems to be very diverse and many hidden are waiting to be explored. The descriptions of many new species and new genera will make us busy for a while.

***Diet composition and food selectivity of edible oyster *Crassostrea gasar* in Lake Nokoue, Benin (West Africa)**

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The mangrove oyster *Crassostrea gasar* (Adanson, 1757) is harvested in Lake Nokoue (Benin-West Africa) by local populations as source of income and animal protein. Strong harvest pressure on the oyster species leads to a destruction of natural stocks. An alternative solution to address wild stocks decline is the development of aquaculture of this oyster species with high commercial potential. Data on oyster ecology and biology are needed for farming success. This study aimed to provide preliminary data on *Crassostrea gasar* food composition in Nokoue Lake. Oyster stomach contents and phytoplankton in surrounding water were sampled in July, August and September 2012 in Lake Nokoue. Food composition and phytoplankton abundance were analyzed microscopically. A total of 102 specimens of *C. gasar* were examined with 83 stomachs containing food. Oyster diet was

composed of 27 food items. The Index of Preponderance (IP) revealed a dominance of phytoplankton (96.04%) followed by detritus (2.16%) and zooplankton (1.80%). The main prey is the Chlorophyte *Stigeoclonium aestivale* (IP = 44.86%). The diatom *Gyrosigma sp* (10.97%) and cyanophyte *Lyngbya sp* (8.89%) were secondary foods. The food composition varies monthly and by size class, but Chlorophyte remains the main food component. Correlation with phytoplankton abundance in stomach contents and in the lake revealed oyster selectivity for the Chlorophyte species *Stigeoclonium aestivale* more abundant in the stomach. An opposite trend is noticed for the diatom *Aulacosira sp*. *C. gasar* diet composition in Nokoue Lake confirmed the phytoplanktivore feeding habits of oyster. Phytoplankton availability in lake is of great importance for aquaculture development and bivalve natural stocks restoration.

Microbial assessment of selected smoked fishes in Akokoland, Ondo State, Nigeria.

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The density and diversity of microflora of cold smoked *Clupea harengus* and *Trachurus trachurus* in Akoko area of Ondo State for public health purposes were investigated. Various parts of the fish (skin, muscle, gill and intestine) were sampled for isolation and characterisation of its microbial contaminants. The results of isolation revealed the presence of *E. coli*, *Klebsiella mobilis*, *Serratia marcescens*, *Citrobacter spp*, *Staphylococcus aureus*, *Shigella spp.*, *Bacillus cereus* and *Proteus vulgaris*, others are *Aspergillus*, *Rhizopus*, *Penicillium*, *Fusarium*, *Neurospora spp* and *Candida albicans*. There were observable differences in the microbial load of the different parts analysed; specifically the skin and intestine had greater microbial load. There were also differences in the range of microbial load among the local government areas studied. Akoko Northwest had the highest bacteria count of 3.90×10^6 cfu/g while the least bacteria count of 0.009×10^6 cfu/g was recorded in Akoko South local government. Highest fungal count of 31×10^5 was from Akoko Northwest and the least was from Akoko Northeast. It was observed that some parts of fish had more than acceptable limit of bacteria and fungi load for wholesome food. Environmental factors may be responsible for the differences in the microbial count but handling during sales might also have contributed. Hence, there is need for environmental health education in the area.

Key words: Microbial assessment, smoked - fish, microflora, *Clupea harengus*, *Trachurus trachurus*, Public health, Akungba Akoko

Size-specific dietary habits, trophic level and foraging preference of the reticulate knife fish, *Papyrocranus afer*, (Gunther, 1868) from a tropical lagoon in south western Nigeria

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Investigation were carried out to determine the dietary habits, trophic level and foraging preference of *Papyrocranus afer* inhabiting Lekki Lagoon in Lagos State, Nigeria from January 2010 – December 2012. A total of 1,059 specimens that ranged from 3.2 – 71.4 cm standard length (mean = 34.87 ± 11.16) and weighed 10.9 – 1958.3 g (mean = 293.68 ± 279.72) were obtained from landing site of fishermen from the lagoon. The specimens were grouped as juveniles which ranged from 5.3 – 21.9 cm (n = 107); sub-adults 22 – 33.9cm (n=606) and two groups of adults 40 – 59.9cm (n = 254) and 60

– 25.9 (n = 92). Their stomach contents were analyzed using numerical, frequency of occurrence and volumetric methods and corroborated by relative importance index and geometric index of importance to determine dietary habits and trophic level. A plot of prey specific abundance plotted against the frequency of occurrence revealed the feeding preference. Seven groups of prey namely fishes, crustaceans, rotifers, bivalves, gastropods, insects and nematodes as well as detritus were identified in the stomach contents. There was a progression from a planktivorous (zooplankton) diet in the juveniles through a transitional insectivorous diet in the sub-adults to a predominantly molluscivorous/piscivorous diet in adults; thus indicating a switch from a relatively passive filter-feeding habit when young to an active predatory habit at the adult stages. Feeding strategy indicated that juveniles and sub-adults were specialist in their foraging preference while the adults were generalist. Estimated dietary trophic level for the juveniles, sub-adults and adults were 3.44, 2.86 and 3.53 respectively indicating carnivorous feeding habits. *P. afer* culture may require high protein diet since it feeds on virtually animal matter. This information is important because *P. afer* is becoming popular in the ornamental fish industry in Nigeria.

Impacts des coccidioses digestives sur les performances zootechniques des poissons-chats : cas de *Clarias gariepinus* Burchell, 1822.

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As a result of the chronic nature of the catfish *Coccidia* infection, mortality is gradual (Ahmed *et al.*, 2010) and is often neglected in most farms, with losses becoming evident only at the end of the production cycle. The purpose of this study was to characterize and quantify the actual effects of coccidiosis on intensive livestock production of *Clarias gariepinus*. The first phase of the work, carried out on 42 specimens of *C. gariepinus* consisted of coccidia oocysts collection which served as inoculum. The experimental phase was conducted on 81 juvenile of *C. gariepinus* divided into three lots (T, I and II) of 27 individuals each. Lot T served as the control group; lots I and II were infected orally, respectively with 600 and 500 oocysts from the inoculum. The results show a high parasite load in specimens of *C. gariepinus* adults collected in the wild. Collection of oocysts allowed to identify four species of *Cyclospora* and two species of *Eimeria* which oocysts have endogenous sporulation. After infection of *C. gariepinus* juvenile, the presence of lesions including intestinal congestion and distension of the stomach indicates the pathogenicity of the infestation. The performance analysis showed that the weight of alevin in the control group was significantly higher ($p < 0.001$) than those infected batches I and II at Day7, Day14 and Day21. Lots I and II have also lost weight at Day7 and Day21, characterizing negative or unexpressed specific growth rate (SGR). Infection rates of groups I and II induced the respective mortality rates of 33.33% and 29.62%. These results observed show the real impact of coccidiosis in juvenile of *C. gariepinus* reared in captivity, including the effectiveness of heavy infestation and deterioration of zootechnical performance of fish.

Habitat use and downstream migration of 0+ juveniles of the migratory riverine spawning *Labeobarbus* species (Cypriniformes: Cyprinidae) of Lake Tana (Ethiopia)

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To infer their habitat preferences and downstream migration, spatial and temporal distributions of larvae and juveniles of the migratory riverine spawning *Labeobarbus* species were studied from December 2009 to November 2010 in the Gumara and Gelda Rivers, tributaries of Lake Tana. Larvae and age 0+ juveniles were collected using D-frame and seine nets. Physico-chemical variables were also assessed. Based on qualitative observations of the flow gradients as well as principal component and cluster analyses of physico-chemical variables, the seventeen sampling sites were categorized into five major habitat types: downstream pools, upstream pools, margin pools, steady flow and riffles. Larvae were present only in the highly oxygenated riffle habitats. The highest mean monthly abundance of 0+ juveniles was found in the margin pools (627 juveniles/100 m²; $P < 0.05$), followed by upstream pool habitats (117 juveniles/100 m²). The lowest monthly abundance was found in the downstream pool habitats located near the lake (12 juveniles/100 m²). Age 0+ juveniles were rare in the steady flow habitats and missing in the riffles. In the relatively pristine river, Gelda, juveniles move into the downstream pools when upstream and margin pools became water stressed in the driest months (March-May) and enter into the lake in the onset of the rainy season (June/July). However, in the highly perturbed river, Gumara, downstream movements of 0+ juveniles were impeded due to disconnection (in April/May) of the pools, because of water pumping for irrigation. After this disconnection, the mean monthly abundance of juveniles in the upstream pools of this river sharply declined by 57%. This study showed that age 0+ juveniles of the migratory riverine spawning *Labeobarbus* species stay in the pools of the rivers until the rainy season. Thus, loss of these functional habitats in the rivers would accelerate extinction of the already declining endemic *Labeobarbus* species flock.

Ecological niche modeling of the invasive potential of Nile tilapia *Oreochromis niloticus* in African river systems: concerns and implications for the conservation of indigenous congenics

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This study applied ecological niche models to determine the potential invasive range of Nile tilapia (*Oreochromis niloticus*) with a particular focus on river systems in southern Africa where it is now established and spreading. Computational tools such as niche models are useful in predicting the potential range of invasive species, but there are limitations to their application. In particular, models trained on native records may fail to predict the full extent of an invasion. This failure is often attributed to changes in either the niche of the invading species or the variables used to develop the models. In this study, we therefore evaluated the differences in the predictive power of models trained with different environmental variables, the effect of species range (native vs introduced) on model performance and assessed whether or not there is evidence suggestive of a niche shift in Nile tilapia following its introduction. Niche models were constructed using Maxent and the degree of niche similarity was assessed using Schoener's index. Null models were used to test for significance. Model performance and niche conservatism varied significantly with variable selection and species range. This indicates that the environmental conditions available to Nile tilapia in its native and introduced ranges are not congruent. Nile tilapia exhibited broad invasive potential over most of southern Africa that overlaps the natural range of endemic congenics. Of particular concern are areas which are free of exotic species but are now vulnerable due to the promotion of fish introductions mainly for aquaculture and sport fishing.

Comparative study of helminth parasites of *chrysichthys nigrodigitatus* and *Bagrus filamentosus* from lower river benue

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Helminth parasites of *Chrysichthys nigrodigitatus* and *Bagrus filamentosus* in River Benue were determined. Examination of the fish species revealed that, the fish were infected with three helminth species: *Diphillobothrium latum*, *Camallanus* species and *Eustrongylides* species respectively. Out of the 80 *Chrysichthys nigrodigitatus* examined, it was observed that 20(25%) were not infected, while 60(75%) were infected and were observed to harbour 127 parasites belonging to one species of Cestode (*Diphillobothrium latum*) and two species of Nematode (*Camalanus* species and *Eustrongylides* species). *Diphillobothrium latum* had the highest number of parasites 56(44.1%), while *Camalanus* species, 28(18.1%) had the least while out of the 80 *Bagrus filamentosus* examined, 17(21.3%) were not infected by any helminth parasite while 63 (38.7%) were infected and were observed to harbour 163 parasites belonging to one species of Cestode (*Diphillobothrium latum*) and two species of Nematode (*Camalanus* species and *Eustrongyllus* species). *Diphillobothrium latum* was also found to be the most abundant species 63 (38.7%) while *Camalanus* species 39 (23.9%) had the least. Of the *Chrysichthys nigrodigitatus* examined, It was observed that the females had the highest percentage parasite load 86 (67.72%) while the male had the least 41 (32.28%). The percentage infestation was higher in females (45%) than in males (28.75%). Parasitic prevalence of *Bagrus filamentosus* in relation to Sex also showed that the females had the higher percentage parasitic load 96 (59.51%) than the male 67 (41.10%). Percentage infestation followed the same trend as 47.5% for female and 31.25% for male. Fish with larger body weight harboured more parasites than fish with smaller body weight in *Chrysichthys nigrodigitatus* while smaller body weight fish harboured more parasites than those with larger body weight in *Bagrus filamentosus*. Parasitic prevalence was observed to be high for *Bagrus filamentosus* than *Chrysichthys nigrodigitatus*.

Theme 2

Biology, ecology and behavior
Poster presentations

Plankton communities of Ikpa River, south east Nigeria exposed to sand-dredging activities

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The Plankton communities of Ikpa River, downstream from a sand-dredging area were studied for a period of 12 months (March 2010 to February 2011), covering dry and wet seasons. Most Physico-chemical parameters (pH, Turbidity, Silicates, Transparency and Conductivity) exhibited highly significant spatial variation ($p < 0.01$), whereas seasonal variation of these variables was not statistically significant ($p > 0.05$). Significant seasonal variation ($p < 0.05$) was however observed in temperature, Dissolved Oxygen, Biochemical Oxygen Demand (BOD), Total Dissolved Solids (TDS), Phosphorus, Nitrates and Conductivity. A total of 51 Taxa of Phytoplankton belonging to 43 genera and 5 families were identified during the period of study. Bacillariophyceae recorded the highest relative abundance with 52.41%, followed by Chlorophyceae with 32.05%, Cyanobacteria with 13.35%, while Euglenophyceae and Dinophyceae contributed 1.26% and 0.83%, respectively. Among the Diatoms, *Melosira granulata* was the most dominant species with Shannon – Weiner's Diversity Index (H^1) of 0.23 and Simpson's Dominance Index (D) of 0.017. A highly significant variation ($p < 0.01$) was observed in spatial distribution and seasonal abundance of most of the algal groups, whereas taxa occurrence showed no significant difference ($p > 0.05$) between the stations and the seasons. A total of 13 taxa of Zooplankton belonging to 8 genera were identified. Rotifera were the most prevalent group with 4 taxa, followed by Cladocera with 3 taxa, while Protozoa and Copepoda recorded 2 taxa each. A highly significant spatial and seasonal variation ($p < 0.01$) was observed in Zooplankton abundance between the stations. The Zooplankton dominance profile also showed Rotifers ranking the highest with Shannon – Weiner's Diversity index (H^1) of 0.21 and Simpson's Dominance Index (D) of 0.014. Correlation coefficient also showed a highly significant relationship ($r = 0.881$; $p < 0.01$) between Zooplankton and Phytoplankton abundance. Also, a highly significant relationship ($r = 0.961$; $p < 0.05$) existed between overall plankton distribution and abundance and water quality parameters.

Habitudes alimentaires de *Bryconaethiops bouleengeri* dans le cours inférieur de la rivière Djiri (affluent de la rive droite du fleuve Congo)

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Le régime alimentaire de 180 spécimens (dont 156 contenaient des aliments) de *Bryconaethiops bouleengeri* provenant de la rivière Djiri (Congo Brazzaville) a été étudié en fonction de la taille de poissons, des stations d'échantillonnage, de la saison hydrologique et du sexe. L'échantillonnage a porté sur douze prélèvements annuels réalisés pendant trois ans. L'indice d'importance relative combinant les pourcentages d'occurrence numérique et pondéral a été utilisé et le sexe ratio calculé. Il apparaît que *Bryconaethiops bouleengeri* est invertivore et éclectique. Il consomme les invertébrés aquatiques, les insectes terrestres ainsi que tout ce qui tombe à l'eau (plumes d'oiseaux, débris végétaux etc.). Sur les trois stations d'échantillonnage retenues et quelque soit la saison ou le sexe, nous n'avons pas observé une différence significative du régime alimentaire. La présence d'écailles de poisson montre que ce poisson pratique la scaliphagie. Le sexe ratio est toujours autour de 1 (0,83 dans les deux premières stations et 0,93 dans la troisième).

Histological description of Cyclic Changes in the Gonads of *Bagrus Docmak* Forsskal 1775 (Pisces: Bagridae)

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Gonadal cyclic changes of *Bagrus docmak* from River Nile were histologically examined to ascertain their importance in identifying maturation patterns and breeding season that provide a significant basis for inducing the species to spawn. Samples were collected between 2005 and 2007. Histological elucidation of structural development and maturation process in gonads of *B. docmak* revealed eight discernible stages of oocyte development in ovaries. They included; oogonia, chromatin nucleolar, perinucleolar, primary oocyte, secondary oocyte, tertiary oocyte, atresia and post ovulatory follicle stages (POFs). The study found that there were several cohorts of oocytes in ovaries of mature females and sustained asynchronous mode of spawning, occurred all year around. Prominent occurrence of tertiary oocytes and POFs during the rainy months of March to May and September to November, confirmed two spawning peaks. Cystic spermatogenesis occurred throughout the year transforming through five stages that included spermatogonia, primary spermatocytes, secondary spermatocytes, spermatids and spermatozoa. The identified spawning peaks and maturation patterns will provide a basis for scientists to induce the species to spawn.

Canals and pores of the cephalic laterosensory system of Characiformes (Ostariophysi): anatomy and its phylogenetic information

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The laterosensory system of fishes is responsible, among other functions, for the perception of water movement and vibration. The functional unit of this system is the neuromast, which can be present on the skin surface or in grooves on it, or also in canals that are distributed along dermic bones, reaching the skin surface by pores. The ossification pattern related to the laterosensory canals is conserved among distinct fish lineages so that this morphological complex may represent a rich source of phylogenetic information. This system has been extensively used in cladistic analysis on several ostariophysans, such as in Siluriformes. However, the laterosensory system of Characiformes, one of the most diverse order of teleosts and also a member of the superorder Ostariophysi, has not been described in details yet, and its phylogenetic implications are poorly investigated. The present study carried out an exploratory analysis of the homology of the various component elements of the laterosensory system in Characiformes, namely: 1) survey information about the branching and ossification patterns of the sensory cephalic canals among its main lineages; 2) map the ending points of these branches, i.e. the sensory pores, which open on skin surface. For that, cleared and stained representatives of families of the order Characiformes were analyzed, and illustrations and descriptions of the laterosensory system were prepared. Results were examined in the light of the phylogenetic relationships available for Characiformes, and the homologies of many structures of the laterosensory system were discussed.

Evaluation de l'exploitation des ressources halieutiques des lacs peu profonds du Bénin au moyens d'indicateurs biologiques : cas des lacs Azili et Hlan

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La pression de pêche sur la communauté des poissons a été évaluée sur deux lacs (Azili et Hlan) du même bassin jouissant ainsi des mêmes conditions hydroclimatiques et pouvant avoir le même apport faunique fluvial. L'étude est basée sur le suivi des pêches artisanales pendant trois mois (octobre – décembre 2011), et à partir desquelles l'inventaire de l'ichtyofaune et l'analyse des captures de pêche ont été faits. L'effort de pêche et la capture par unité d'effort (CPUE) ont été calculés. L'impact de la pêche sur l'ichtyofaune a été analysé à partir des abondances, de la taille de capture des poissons, de l'histogramme des tailles, de la diversité spécifique et de la structure trophique de la capture. Les résultats ont montré que l'effort de pêche est faible à Hlan (6h de pêche/jour) qu'à Azili (10h). Contre toute attente, la CPUE est faible à Hlan ($207,0 \pm 421,06$ g/h/engin/pêcheur) mais très élevée à Azili ($3308,5 \pm 11289,3$) et la richesse spécifique est plus faible à Hlan (31 espèces) qu'à Azili (36 espèces). Les autres indicateurs sont élevés à Hlan et faibles à Azili. Il s'agit de l'indice de Shannon (2,45 bits contre 0,90), de l'Equitabilité de Pielou (0,77 contre 0,27), du nombre d'espèces abondantes dans la capture (5 contre 2) et de la structure trophique (6,86% contre 95,03% de consommateurs primaires). La taille des individus capturés (entre 8,3 et 106,4 cm à Hlan contre 5,2 et 75cm à Azili) et les tailles moyennes ($28,87 \pm 3,81$ cm contre $19,05 \pm 11,47$) sont aussi élevées à Hlan avec un histogramme des tailles bimodal mais unimodal à Azili. Ces bio-indicateurs, à l'exception de la CPUE et de la richesse spécifique, montrent que le lac Azili est surexploité et que la pression de pêche élevée est une menace pour sa biodiversité et pour l'équilibre écologique du plan d'eau.

Theme 3

Aquatic conservation and management

Oral Presentations

Toxicity of sub-lethal concentrations of Monocrotophos (MCP) on the haematological, biochemical and growth responses of hybrid catfish, *Heteroclaris* and contaminated-*Heteroclaris* fed rats

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Toxicity of sub-lethal concentrations of Monocrotophos (MCP) on the haematological, biochemical and growth responses of hybrid catfish, *Heteroclaris* and contaminated *Heteroclaris*-fed rats were investigated. *Heteroclaris* were assessed in a static renewal bioassay for 28 days using varying concentrations (0.00µg/l, 0.15µg/l, 0.20µg/l, 0.25µg/l, 0.30µg/l, and 0.35µg/l) of MCP, while the rats were fed with diet compounded with MCP-contaminated fish for 30 days. At the end of the experiments, the fish and the rats were sacrificed and blood samples were collected. The gill and liver of fish as the liver and kidney of rats were removed for bioassay. Values of haematological variables such as red blood cell counts (RBC), haemoglobin (HB), haematocrit (PCV) and glucose showed a significant reduction ($P < 0.05$) compared to the control in both fish and rats. While the values of white blood cell (WBC) and protein increased insignificantly ($P > 0.05$), the mean corpuscular volume (MCV), mean cell haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) significantly decreased ($P < 0.05$) when compared to the control in fish; but MCH decreased insignificantly ($P > 0.05$) and MCHC increased insignificantly ($P > 0.05$) in rats. Compared with the control, the result showed a significant increase ($P < 0.05$) in the activities of alanine aminotransferase (ALT), aspartate aminotransferase (AST), superoxide dismutase (SOD), lactate dehydrogenase (LDH) and creatinine in the blood, gill and liver of exposed fish as well as in the blood, liver and kidney of exposed rats. The specific growth rate of the fish and the rats decreased significantly ($P < 0.05$) as the concentration increased. This study shows that sub-lethal concentrations of monocrotophos are harmful to *Heteroclaris* and rats. The implication of these results in rational exploitation and conservation of fishery resources and the public health risk of consuming MCP-exposed fish are highlighted.

Coastal Resource Management through Enhanced Stewardship: A Nested and Integrated Approach

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As one of the world's largest lakes with great biodiversity of fish species, Lake Malawi is an important source of nutrition, social and economic wellbeing for Malawi's population. The Lake is vulnerable to high level of activities of the burgeoning population, including agriculture, animal grazing, increasing shoreline occupancy, tourism development and deforestation, all of which affect the socio-economic fabric of the country and upset the natural balance. Following integrated coastal management concept, and with joint funding from Canadian International Development Agency, Malawian Department of Fisheries, Lilongwe University of Agriculture and Natural Resources and Marine Institute of Memorial University of Newfoundland, we perform a range of nested activities, aiming at policy, institutions and communities. At policy level, we engage government and non-governmental stakeholders from various sectors ranging from fisheries, forestry, agriculture, tourism and education, and faculty members from different scientific disciplines, in the discussion about ways to collaborate, share data, and develop integrated policy to promote sustainable coastal resource development and stewardship. At institutional level, we conduct needs assessment survey to gauge knowledge and capacity to offer courses in integrated coastal management. Based on this, we design a 12-14 week

syllabus and deliver it in a one-week intensive and interactive training workshop. At community level, we conduct household surveys aiming to describe livelihood folio and level of resource dependency, and to identify changes and vulnerability of coastal people to these changes in Maldeco and Cape Maclear, Mangochi district. We also conduct gender focus group discussions to further explore key issues, challenges and concerns. Based on these findings, community awareness messages are developed and delivered. Lessons and experience from this project endorses the importance of taking the nested and integrated approach to coastal resource management in order to progress towards sustainability and to strengthen stewardship.

The Great Lakes in East Africa – a novel biological conservation strategy for species flocks

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The three largest water bodies of East Africa, Lake Victoria, Tanganyika and Malawi contain an estimated number of endemic 2,000 cichlid fish species, in addition to a mostly uncounted wealth of invertebrates. While the terrestrial diversity is reasonably well protected, as economic and touristic interests coincide with biological conservation strategies, this is not the case for most African lakes and rivers. Nonetheless, it must be promoted that these aquatic ecosystems also deserve protection. Conservation strategies for aquatic biota have so far been the same as for terrestrial environments, i.e. by declaring biodiversity hotspots national parks. Such parks also contain rivers and lake shores. Here I argue that it seems questionable that this strategy will work, given strong micro-geographic structure of the species flocks and the great degree of local endemism. I suggest a novel strategy for protecting African Lake communities that accounts for local endemism, derived from recent molecular phylogenetic and phylogeographic studies on East African cichlid fishes. While connectivity is the major problem for terrestrial and marine national parks, to ensure a large enough effective population size of the protected animals, this is not the case for most taxa in African rivers and lakes, where local endemism prevails. For example, most littoral cichlid species are subdivided into numerous distinct “color morphs” or sister species with highly restricted distribution, and unlike marine fishes with planktonic larvae display brood care with small offspring numbers. It is argued that the establishment of “micro-scale protected areas”, a large number of small stretches of strictly protected coast line, each only some hundreds of meters long, is likely to work best to preserve the littoral communities in African lakes. Such protected zones can sustain a reasonably effective population size of littoral species, serve as protected spawning ground or nursery area for pelagic species, and at the same time re-seed neighboring populations that are exploited continuously. As long-term stability of littoral fishing grounds is in the immediate interest of village communities, such small protected areas should ultimately be managed and controlled by the local communities themselves, supervised by governmental institutions.

Nile perch and the transformation of Lake Victoria: fifty years on

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Changes in the biophysical environment of Lake Victoria over the last half of the past century have been variously attributed to anthropogenic and natural environmental perturbations. We review the situation in the lake prior to and after fish introduction and relate to other satellite lakes in the region in which Nile perch (NP) was introduced and some that remain free of the NP. Just like in other lakes where NP was introduced, haplochromine cichlid species were virtually extirpated and the lake

changed from a mesotrophic state to eutrophic. Initially home to hundreds of native cichlid and non-cichlid fish species anchoring a rich multispecies fishery, the lake transformed into a simplified system based on only two alien and one native species. Prior to fish introduction, >80% of the biomass in the lake comprised small bodied native cichlid species, 30 years later 90% of the catch was Nile perch. Now, 50 years after introduction it is again dominated by the small pelagic species. Fish production grew from 0.2 million tonnes (m t) prior to the 2nd half of the past century to 1,000,000 t presently. Currently, > 65% of the catch is a combination of the native small pelagic cyprinid *Rastrineobola argentea* locally “dagaa” and haplochromines, and introduced Nile perch (25%), and Nile Tilapia (7%). Fishing effort increased alongside increasing human population in the catchment mainly targeting the introduced Nile perch that transformed from artisanal to industrial fishery. We conclude that Nile perch was responsible for both ecosystem changes and increased fish production.

Ecological quality assessment of the Porto-Novo Lagoon through the biodiversity of macroinvertebrates

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Nowadays, macroinvertebrate communities are widely used as bioindicators for their ability to reflect the disruption of aquatic ecosystems. Their diversity depends on the quality of water and the diversity of substrates. As such, species that are highly correlated with sites can be used as good indicators in a management process of a given environment for an appropriate ecological interpretation of the classifications of the communities or habitats. However, they have never been used to assess the ecological status of the fisheries in Benin. A study on the benthic macroinvertebrates of the lagoon of Porto - Novo, conducted between July 2007 and June 2009, identified the characteristic species of the main sampled sites. For this purpose the IndVal method has been applied through two typologies using the Self-organizing Map (SOM). On 88 benthic invertebrate taxa having a minimum of 5% occurrence in the lagoon, only 22 indicator taxa have emerged as opposing strongly mineralized sites with sites enriched with organic matter. A large number of taxa appeared as "generalists", thus reflecting the heterogeneity of the habitats of organisms in the lagoon. The small number of 'specialists “taxa” suggests that these are sensitive to all environmental change of the lagoon and are therefore stress detectors. The study on the preferences of habitats of organisms provides important information on the spatial distribution of these organisms and the quality of the aquatic environment. These observations show the emergence of new perspectives for subsequent ecological assessments of waters in Benin.

The role of multi-disciplinary aquatic research in enhancing conservation and co-management of aquatic ecosystems in East Africa

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The Kenya Wetlands Biodiversity Research Group <http://kenweb.museums.or.ke/> is a consortium of wetlands researchers affiliated with the National Museums of Kenya and the French Institute of Research for Development (IRD). This team has initiated inter-disciplinary assessments of East African Wetlands with an aim providing information on biodiversity for conservation and wise or

sustainable use of ecosystem services. The team has developed and adopted wetlands biodiversity rapid assessment methods using two wetlands the Tana River Delta, a coastal wetland and Loboï Swamp, a warm-water inland swamp associated with two Rift valley lakes. Both wetlands served as models for wetlands assessments. These studies have been used to expand to other wetlands of the country including in Laikipia Country where the team has developed a monitoring and assessment manual for aquatic biodiversity and water quality to be used by the local communities and land owners. This presentation will give an overview of the impact the team has in research and capacity building for *inter alia* biodiversity, socio-economic, GIS, water quality studies, and the consequent application of knowledge and information for conservation of species, habitats and ecosystems, and maintaining livelihoods of local communities in four wetlands of Kenya. In addition, the work of the team in bridging the science policy gap at a national and international level will be highlighted including the listing of the Tana River Delta as a wetland of international importance under the Ramsar Convention. The presentation also outlines the enhanced value of teamwork in fulfilling species-specific studies, socio-economic and wetlands management studies, and impacts these have on enhanced co-management of aquatic resources.

Indigenous species paradigm for African aquaculture development: Prospects of African lungfish.

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Aquaculture is improving food security and livelihoods of vulnerable communities dependent on fish in Africa. However, climate change and limited technologies threaten aquaculture production in the region. Hence, resilient fish species that tolerate stressful environmental conditions would be suitable candidates. African lungfish, an air-breathing and declining fish, fits the criteria; low dissolved oxygen may not be a limiting factor. Field and experimental studies were conducted to understand the aquaculture potential of African lungfish in Uganda. Indigenous knowledge, practices and socio-economic conditions that shape the culture of lungfish on farms, natural water bodies and reservoirs was assessed. Growth trials on wild-caught fingerlings in culture tanks were also performed. Lungfish is highly valued as a food in Uganda with certain nutraceutical benefits, and competes favorably with traditional commercial fish species (Tilapia and Nile perch). Fish farmers have developed indigenous means for handling and managing lungfish in natural water bodies and fish farms. These are a beginning to be discovered and codified. Meanwhile, wild caught fingerling accepts high- protein-artificial diets but grows moderately under experimental conditions. Promoting wider levels of production of lungfish will require articulation of model production strategies and management systems that account for the burrowing and mobility of this fish. Future studies will explore the relative advantages of different culture systems (tanks, ponds and cages), while addressing strategies for sustainable captive breeding of African lungfish.

Impacts of human activities on fish communities in Lake Nokoué and Porto-Novo Lagoon, Benin

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Lake Nokoué and the Porto-Novo Lagoon form the largest area (180 km²) of brackish waters in Benin. Located in the most populated part of the country, this complex of lagoons has suffered since the early 1960s disturbances due to developments that have greatly affected its ecology, especially in terms of hydrology and salinity. The current situation of the two lagoons is analyzed based on results of several studies from 1990-1991 until 2009. The aquatic living resources could be affected by two major risk factors: increased fishing pressure (30,000 fishermen in 1982, from 100 to 130,000 in 1987, 150,000 to 200,000 in 2006) and the sophistication of fishing techniques. Overexploitation of fish and the risk of depletion or extinction of certain species (Bagridae and Clariidae) are analyzed using the example of *Chrysichthys* (*C. nigrodigitatus* and *C. auratus*), highly representative of the lagoons ichthyofauna and very valued in the local markets. Between 1987 and 1990, the annual production of *Chrysichthys* fell to 1,500 tons (-54.5%). The decrease continued until 2010, reflecting the overall decline in fish catches in the three southern departments. In addition, the analysis of the size structure of fish caught by traditional techniques reveals that 86% of *C. nigrodigitatus* are caught below the size at first maturity (L_{50} = 30.3 cm for males and 29.3 cm for females). From this first analysis, recommendations are made to improve the management of fish resources in southern Benin.

Studies on the toxicity of dispersed pahs of petrogenic origin on *Oreochromis niloticus* (Linnaeus, 1757)

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The use of chemical dispersants in crude oil spill situations may alter the behaviour of Polyaromatic Hydrocarbons contained in the oil by increasing their functional solubility; resulting in increased bioavailability and altered interactions between oil, dispersants and biological membranes. One such dispersant widely used in the Niger Delta basin, Nigeria is Goldcrew. We used a static bioassay to study the effects of PAHs of petrogenic origin dispersed with Goldcrew on the tilapia, *Oreochromis niloticus*. A control experiment was also set up using the Water Available Fraction, (WAF) of the Bonny Light crude oil without the dispersant. The exposure concentrations of the WAF of the mixture of the dispersant and Bonny Light crude oil, Dispersed Crude Oil, ($DCO_{WAF-PAH}$) were 2.0, 2.2, 2.4 and 2.6ml/L while the WAF of the Bonny Light crude oil alone ($CO_{WAF-PAH}$) were 60, 80, 100 and 120ml/L. The $DCO_{WAF-PAH}$ had 48hr, 72hr and 96hr LC_{50} of 3.0, 2.93 and 2.56ml/L respectively. The corresponding values for Crude Oil, $CO_{WAF-PAH}$ were 241.1, 158.5 and 149.6ml/L for the 48hr, 72hr and 96hr respectively. Determination of the synergistic ratio (toxicity factor) showed that the dispersant potentiated (increased) the toxicity of the Bonny Light crude oil by 58 times. It can be concluded that the Bonny Light crude oil was made more toxic to *O. niloticus* in the presence of the dispersant; increasing the susceptibility of exposed organisms to the inherent components of the crude oil in the WAF amongst which are the PAHs. There is need therefore to apply dispersants with caution especially around fish breeding and nursery grounds.

Nile perch and the transformation of Lake Victoria: fifty years on

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Changes in the biophysical environment of Lake Victoria over the last half of the past century have been variously attributed to anthropogenic and natural environmental perturbations. We review the situation in the lake prior to and after fish introduction and relate to other satellite lakes in the region in which Nile perch (NP) was introduced and some that remain free of the NP. Just like in other lakes where NP was introduced, haplochromine cichlid species were virtually extirpated and the lake

changed from a mesotrophic state to eutrophic. Initially home to hundreds of native cichlid and non-cichlid fish species anchoring a rich multispecies fishery, the lake transformed into a simplified system based on only two alien and one native species. Prior to fish introduction, >80% of the biomass in the lake comprised small bodied native cichlid species, 30 years later 90% of the catch was Nile perch. Now, 50 years after introduction it is again dominated by the small pelagic species. Fish production grew from 0.2 million tonnes (m t) prior to the 2nd half of the past century to 1,000,000 t presently. Currently, > 65% of the catch is a combination of the native small pelagic cyprinid *Rastrineobola argentea* locally “dagaa” and haplochromines, and introduced Nile perch (25%), and Nile Tilapia (7%). Fishing effort increased alongside increasing human population in the catchment mainly targeting the introduced Nile perch that transformed from artisanal to industrial fishery. We conclude that Nile perch was responsible for both ecosystem changes and increased fish production.

The effects of riparian land use on water quality and fish species composition in the headwater streams of Tana, Athi and Ewaso ngiro rivers within central Kenya.

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Land use changes on riparian zones of streams have profound impacts on water quality and fish diversity. Sampling took place in 17 streams and in two dams along the streams in central Kenya and Nairobi which join up to form the three major rivers Tana, Athi and Ewaso ngiro. The physico-chemical parameters which contribute to the quality of water studied were temperature, dissolved oxygen, turbidity, flow rate, depth and width, conductivity and nutrients (Phosphates and Nitrates). Land use patterns included National park, ranches, built-up areas, flower farms, vegetable gardening areas and natural vegetation. Temperatures ranged from 13.4 °C to 22.4 °C and dissolved oxygen concentration ranged between 4.47 mg/l to 1.76 mg/l. Turbidity varied according to soil types and activities in the areas surrounding the streams. Kinania stream on Athi river had the highest conductivity of 71 µs and high nutrient concentrations, being in a vegetable gardening area. Most other streams had low nutrient concentrations. Fish species obtained were *Poecilia reticulata*, *Garra dembeensis*, *Chiloglanis brevibarbis*, *Barbus* sp., *Clarias gariepinus*, *Amphilius uranoscopus*, *Labeo cylindricus*, *Oreochromis* sp., *Neobola fluviatilis* and *Mormyrus* sp. The genus *Barbus* had more diversity than any other fish. *Clarias gariepinus* was the biggest fish and was found in lower parts of Athi river and in more turbid steam waters. Most of the fishes were small in total length (TL). The head water streams were dominated with species like *Garra*, *Amphilius*, and *Neobola* sp. At Hippo point dam on Ewaso ngiro, *Labeo cylindricus* was the largest fish obtained while at Karen on Athi river, *Micropterus salmoides* was the largest fish. The head water stream fishes were indicators of high water quality.

Effects of climate change and fishing practices on fish yield of Lake Kivu

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To verify the effects of climate change and fishing practices on fish stocks of Lake Kivu, we first tested the effectiveness of climate change from the statistics of the last 40 years, and then we put in parallel the evolution of climatic factors for the 12 last years with fishery statistics. The analysis of biological data obtained from experimental fishing achieved in some main stations of the lake, as well as surveys nearby of fishermen teams, permitted to put better in evidence the phenomena. The results reveal that during 40 years, the ambient temperatures increased 1.4 °C and relative humidity decreased

6%. Rainfall knew significant disruptions as for example a difference of 75 mm between March 1987 and March 1992. There is a strong correlation between climatic variation and the fishing efficiency. The gear performance is in reduction and fish production in decrease, with 11 tons on average by station during the 12 last years. The fished fishes are on average more and more small sizes (with total length of 10.9 cm for the *Oreochromis* genus) by reason of thin mesh size of nets used by fishermen, the individual size of individuals fished on carrelate net defers significantly those one of individuals fished on mosquito net, with $p = 0.0002$.

Assessing conservation priorities for endemic species with narrow distributions: the case of two imperilled South African fishes

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Range restricted South African endemic headwater stream fishes are increasingly being threatened by human mediated impacts such as habitat destruction and invasion by non-native fishes. Two headwater species, the Eastern Cape redbfin *Pseudobarbus afer* and the Border barb *Barbus trevelyani* are IUCN redlisted as ‘endangered’ primarily due to these factors. This study assessed their current status, distribution and threats based on case studies from the Swartkops and Keiskamma River systems in the Eastern Cape, South Africa by: 1) Quantifying the area of occupancy for native and invasive species to estimate the proportion of stream habitat lost to native fishes by invasion; 2) Assess factors influencing distribution and abundance of fishes in the headwater streams and impoundments of both river systems; 3) Use the rapidly evolving mtDNA cytochrome *b* gene region to map the current distribution of genetic diversity for *P. afer* and *B. trevelyani*. Two broad types of invasion were documented, downstream invasion by non-native salmonids *Oncorhynchus mykiss* and *Salmo trutta* and upstream by centrarchids *Micropterus salmoides* and *M. dolomieu*. The Swartkops and Keiskamma Rivers were heavily invaded and numbers of introduced species surpassed that of natives. Where non-native predatory fish occurred, *P. afer* and *B. trevelyani* had been extirpated. As a result both native species exhibited contracted distributions (>20% habitat loss due to invasion). Upstream invasion by centrarchids isolated and fragmented *P. afer* populations into headwater refugia while top down invasion by salmonids excluded *B. trevelyani* from invaded, more pristine reaches by forcing the species into degraded unsuitable lower stream reaches. While *P. afer* exhibited little within or between drainage genetic structuring, *B. trevelyani* was >4% divergent between drainages and up to 2% between streams within the Keiskamma River system. These data indicate an imminent loss of genetic diversity without immediate conservation interventions. The consequences of invasions, suggestions for prioritising conservation efforts and potential management interventions are discussed.

Macroinvertebrate Assemblages as Indicators of Water Quality and Ecological Integrity of Laikipia Rivers, Kenya

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Macroinvertebrate assemblages were sampled at various stations along Laikipia Rivers using 0.5 mm mesh size scoop net in the riffles, pools and runs from February 2010-January 2013. The overall objective of the study was to assess the structure and composition of macroinvertebrate assemblages as indicators of water quality and ecological integrity of the rivers. Sampled stations were chosen to correspond to different land-uses in the catchments. Sampled macroinvertebrates were identified, and taxon diversity, richness, evenness and dominance estimated for each station. Minitab for Windows

version 14.0 and Microsoft Excel computer packages were used for statistical analyses. A total of 45 macroinvertebrate genera for River Nanyuki, Ewaso Nyiro and Ewaso Narok dominated by the Ephemeroptera, Plecoptera and Trichoptera (EPT). Other orders like Hemiptera, Coleoptera, Diptera, Pulmonata and Odonata besides EPT also registered a greater percentage in all the rivers sampled. Some orders such as Annelida, Amphipoda, Pelecypoda, Decapoda, Prosobranchiata and Lamellibranchiata did not dominate the rivers but their abundance were felt in some rivers like R. Ngare Narok, R. Gobit, R. Pesi, R. Burguret and R. Sirmon. Significant differences in the mean abundance ($F= 16.371$; $p = 0.000$) and diversity ($H=7$; $p=0.0032$) between the rivers were found that indicated differences in water quality. The results indicated that ecological integrity of Laikipia Rivers were experiencing intermediate levels of disturbance that influenced taxon composition, distribution, abundance and diversity. The study recommends that habitat quality should be maintained along the rivers. Macroinvertebrate assemblages in Rivers should also be used as indicators of ecological integrity to aid in management of the rivers.

Temporal trends in life history traits of Nile perch *Lates niloticus* in Lake Victoria, Uganda

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Over-harvest of fish populations may result in life history trait responses that can negatively affect fish population growth and contribute to major losses in fisheries yield. It is not known whether or not fishing mortality in the Nile perch fishery of Lake Victoria is a major driver in life history changes of the fish. We postulated that increased fishing mortality in Nile perch could be a driving force in shifts in life history parameters especially the size/age at first maturity. The predator's key life history traits were quantified during a period of intense fishing activity and compared to earlier phases of the Nile perch invasion. Nile perch samples were collected from three fish processing factories between October 2004 and February 2007, supplemented by experimental gillnetting conducted at various sites in the Uganda part of Lake Victoria. Published historical and unpublished records were used to detect changes in life history traits coincident with increasing fishing pressure in Lake Victoria.

Over the past 15 years, Nile perch has experienced a downward shift in maturation size/age with reductions in both size and age at first maturity. The maximum age of Nile perch in this study (7 yr) versus earlier estimates (13 – 14 yrs) likely reflects the size selective mortality induced by the fishery. In comparison to earlier findings, size at first maturity (L_{50}) reduced by 24% and 45% for both males and females respectively. Sexual maturity was attained by males at 1 year (40 – 44 cm total length [TL]) and 1.5 years (45 – 49 cm TL) for females. Decreased L_{50} may reflect size-selective fishing in addition to other changes in the lake basin such as eutrophication and associated hypoxia. Temporal trends in life history traits of Nile perch should continue to be monitored and incorporated into future management plans for the fishery.

Rehabilitation of a Freshwater Ecosystem Priority River in South Africa using a piscicide to kill alien smallmouth bass

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The most severe threat to the freshwater fishes of South Africa's Cape Fold Mountain aquatic eco-region is predation by and competition with invasive alien fishes that were introduced for angling. As a result 19 of the 24 endemic fish taxa are IUCN-listed as threatened. To more effectively conserve its

inland waters and their biota, South Africa has recently mapped its Freshwater Ecosystem Priority Areas (FEPA). Some FEPAs are rivers that have sections which are invaded with alien fishes, with severe impacts on indigenous fishes. The aim of the current project was to determine whether invasive alien smallmouth bass could be eradicated from a 4km reach of the lower Rondegat River, a small FEPA river about 300km north east of Cape Town. Cape Nature treated the lower sections of the river with the piscicide rotenone to eradicate smallmouth bass. In this paper we describe the rotenone treatment and present monitoring data that illustrate the efficacy of the rotenone treatment. Sampling demonstrated that the treatment was successful. No smallmouth bass were observed in the river immediately after treatment nor were any bass recovered during the second treatment. Native fishes began recruiting into the treated zone almost immediately after the first treatment and in March 2013 small native fishes were observed in the lower Rondegat River for the first time in 14 years. These results are discussed with special reference to the expected rates of recovery of the native fish fauna following the rotenone treatment. Monitoring of invertebrate fauna showed that while some taxa were removed by the first rotenone treatment, many had returned to the treated area by the time of the second treatment. The project has confirmed that fish removals using rotenone can improve conservation of FEPA's in South Africa, by increasing habitat available to threatened and endemic fish species.

***Variations spatio-temporelles des macroinvertébrés du lac Nokoué**

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Peu de travaux de recherches ont été réalisés sur les variations spatio-temporelles des macroinvertébrés des lagunes ouest africaines. Ce travail a pour objet de faire l'inventaire de la faune benthique du lac Nokoué et d'étudier ses variations spatio-temporelles. Pour cela, cinq stations ont été choisies sur le Lac Nokoué en fonction de la salinité et du niveau supposé de perturbation du milieu par les activités anthropiques. Les substrats artificiels «fagots» et «panier rempli à moitié de substrat du fond du lac» ont été utilisés pour l'échantillonnage. La fréquence des campagnes d'échantillonnages a été dictée par le souci d'obtenir des données pendant la crue, l'étiage, les transitions crue-étiage et étiage-crue. Ainsi sept campagnes d'échantillonnage ont été réalisées. Des mesures des paramètres physico-chimiques ont été effectuées lors du retrait des substrats. Au total, 76 taxons (ordres, familles ou genres) d'invertébrés aquatiques ont été recensés sur l'ensemble du lac pendant notre étude. Ces taxons se répartissent dans les grands groupes zoologiques représentés par les Annélides (6) les Mollusques (12), les Crustacés (17), les Insectes (38), et Divers (Nématodes, Arachnides et indéterminés) (3). La plupart des taxons d'insectes (groupe zoologique le plus diversifié) ne se rencontrent dans le lac que pendant la grande crue et seulement à l'embouchure des fleuves et surtout dans les racines des macrophytes. Quelques rares Crustacés (Caprellidae) et Polychètes (Terebellidae) n'ont été rencontrés que pendant une période très courte de l'année (juin et juillet) et seulement aux stations proches de la mer. Parmi les 76 taxons identifiés, 30 ont été observés toute l'année dans le lac dont plusieurs ne comportent qu'un genre ou qu'une espèce. Ce qui laisse supposer qu'il existe une grande variation temporelle des espèces composant la communauté étudiée. En effet, très peu d'espèces d'eau douce survivent à des salinités supérieures à 5 g/l, alors que les espèces marines ne supportent guère une salinité inférieure à 18 g/l. Dans ces conditions, seules persistent des espèces saumâtres ou des espèces marines à large potentiel d'adaptation.

***The role of beach management units on fish catch in the Nyando river wetland, Lake Victoria basin.**

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The study was conducted in the Nyando River Wetland, Kenya to determine the role of Beach Management Units (BMUs) on fish catch in the area, the socioeconomic benefits of BMUs, the role played by BMUs in the enforcement of appropriate fish Catch methods, investigate the use rate of recommended fishing gears since BMUs were introduced; and compare fish catch in beaches with and those without BMUs. Information and data were collected from five beaches namely Nyamware, Ogenya, Singida, Wasare and Kusa. It was established that the role BMU played in the years 2009-2010 include enforcement of fisheries rules, improved sanitation, and also resolving disputes. It was also found that 79% of fishers use legal fishing gill nets while 21% do not, thus BMU's helps in ensuring compliance to fisheries regulations on the use of legal fishing gears. It was also found that household age, household size, household income, level of education, boat ownership, presence of employees, experience of the fisher and presence of BMU are positively correlated with fish catch. Fishing income had a coefficient of 0.324 and a t-value of 4.191 indicating a significant direct relationship between quantity of fish caught and income received from fishing activity. With an increase in income, one would always use the increased income to possibly increase effort by buying new boats, better nets and employing more people and hence higher catch. Experience of the respondent has a coefficient of 0.164 and a t-value of 2.321 thus a significant direct relationship between fish catch and the experience of the fishermen. Experience is an important factor in fishing as in any other business which enhances the fisher's productivity. According to the findings of this study, the majority of the respondents have been in fishing for more than four years. This indicates that with experience, the fishermen understand the types of winds flowing and fish hiding places where the fishermen may easily catch the fish. This makes fishing experience to be very important in fisheries activities. Empowering BMU's promises to improve the management of fisheries resources and socio-economic status of fishers in Lake Victoria Basin.

Assessing ecological impacts and socio-economic benefits of alien fish introductions: a case study of the Amatola trout?

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Alien fish introductions are considered a means for fisheries development in many African countries. Ecological research on alien fishes has largely focussed on their impacts and in many regions they are the primary threat to native biota. In contrast, few studies have focused on the trade-offs between the socio-economic benefits and ecological impacts associated with introductions. Given the need for rural

economic development, conservation authorities will ultimately have to make species management decisions based on such trade-offs. The current paper presents the results of a multi-disciplinary assessment of the ecological impacts and socio-economic benefits of introduced trout in an area of high biodiversity value in South Africa. The Keiskamma River was chosen for such an assessment because it exemplifies the situation faced by many African conservation planners: an imperative to promote economic development within the confines of biodiversity conservation. The Keiskamma River headwaters are a National Freshwater Ecosystems Priority Area based on criteria of water quality, flow and native biodiversity. The region is rural and in need of economic development. We assessed the economic impact of naturalised alien trout (*Salmo trutta* and *Onchorhynchus mykiss*) populations on tourism and determined their impact on an endangered barb *Barbus trevelyani*. Social-surveys indicated limited direct use of the resource but a qualitative Sustainable Livelihoods Framework survey revealed that 24% of local community members reported some form of welfare benefit from trout-angling related tourism, although the activity was only a small contributor to financial flows and job creation. The primary ecological impact of trout was the exclusion of the barb from an estimated 24% of their global distribution which is now fragmented and limited to degraded stream reaches resulting in an increased risk to population persistence. These results are discussed in the context of economic development opportunities, potential rehabilitation costs and environmental policy.

***Conservation and sustainable use of the riverine fishes of Burundi: challenges and opportunities**

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Burundi has made a great biodiversity conservation effort during the last 50 years. For the 11 legally recognized parks and protected areas covering 135139 ha; three of them have important water bodies and cover approximately 72742 ha. These include the Ruvubu National Park (RNP) with only 11 native fish species, the Rusizi National Park with 45 native species known from the whole basin where, however, results from a recent survey (2008-2010) show a very low recovery rate of the species reported in literature and in museum records; and finally the Bugesera Protected Aquatic Landscape with 12 native species currently known. The Upper Malagarazi River basin in Burundi which is not included in any legally protected area today is a particular case for the country. Once less inhabited, the Malagarazi valley currently has attracted many immigrants from highly populated provinces of Burundi and seasonal migrations for cattle pasture. Fishing there is mainly for subsistence and remains a secondarily activity after agriculture although a few people rely on it for their livelihood. With at least 75 native species the Upper Malagarazi is without any doubt, Burundi's main riverine fish hotspot. However, wetland conversion into cropland is dangerously increasing. It seems that the best and fastest way to save this aquatic biodiversity of the country is to support the current project of creation of the Malagarazi Natural Reserve. Based on the above mentioned species richness, we expect to stimulate a political awareness of the uniqueness of Burundi's fish biodiversity in that area and the need to protect it. The Malagarazi Reserve is a great opportunity to establish a framework for trans-border collaboration with Tanzania to the protected areas level; interconnection of the Malagarazi Natural Reserve to the Malagarazi-Muyowosi Game Reserve in Tanzania being the target with the consecutive benefit of faunal exchanges.

***The fish fauna of the Kundelungu National Park (DR Congo): diversity, ecology, conservation and sustainable management**

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Created in 1970, the Kundelungu National Park (KNP) includes: (1) a Core Zone (2200 km²) situated on the highly elevated Kundelungu plateau (altitude ±1300-1700m) with multiple springs and headwaters, the majority of which flow West (Lufira basin), while some flow East (Luapula basin); and (2) a Buffer Zone (5300 km²), situated downstream of the eastern edge of the Kundelungu plateau and crossed by the Lufira River. Sampling surveys undertaken between 1938 and 1960 in the buffer zone revealed 70 species distributed over 15 families with the Cyprinidae (21 species), Cichlidae (10 species), Mochokidae (7 species) and Clariidae (5 species) being the most species rich. Except for the Luanza River, situated on the eastern side of the Kundelungu plateau, and intensively studied by Malaisse between 1965-1968, the Core Zone remains under-explored. His collections contain an impoverished fish fauna of only four families and six species: Kneriidae (*Kneria wittei*); Cyprinidae (*'Barbus' motebensis* and *'Barbus' neefi*); Amphiliidae (*Amphilius uranoscopus* and *Amphilius* sp.); and Clariidae (*Clarias theodora*). A recent survey (2012) within the PRODEPAAK project (CTB/BTC), of two main rivers situated within the Core Zone [the Lofoi and its tributary Fibila (western part) and the Lutshipuka and its tributary Mansansa (eastern part of the plateau)] revealed the presence of the same four families : (1) Kneriidae (*Kneria* spp.) and (2) Cyprinidae (*'Barbus' cf. motebensis*) present in both regions; (3) Amphiliidae (*Amphilius* spp.) in the eastern region only; and (4) Clariidae (*Clarias/Clariallabes* sp. "kundelungu"), a possibly new species for science, very abundant in the western but absent in the eastern region. Because of the geographic isolation of the rivers of the Kundelungu plateau, we suspect the region to harbour a special fish fauna that upon further exploration, may be found to include more local endemics.

Theme 3

Aquatic conservation and management

Poster Presentations

Ichthyofauna diversity and reproductive strategies studies of *Clarias buettikofferi* (Pisces, Clariidae) in the Tanoé-Ehy forest (Côte d'Ivoire)

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A study of the ichthyofauna of Tanoé-Ehy forest carried out from March 2012 to February 2013 permitted to inventory 22 species of fish distributed in 15 genera belonging to 11 families where only six species are sedentary such as *Clarias buettikofferi*. Furthermore reproductive strategies of *Clarias buettikofferi* was studied by monthly sampling using gill nets and homemade traps to provide data on some biological aspects. A total of 623 specimens were examined (378 males and 245 females). The monthly evolution of the gonado-somatic index (GSI), hepato-somatic index (HSI) and the condition factor (K) indicated two periods of reproduction. The long period and the short period were respectively from May to August and from October to December. The hepatic reserves seem to be mobilized to ensure the energetic cost of the reproduction. The total sex-ratio (females: males) was in favour of males (1: 1,54; $\chi^2 = 19,03$; $p < 0,05$). The study of sex-ratio by size classes shows a dominance of males in the classes > 220 mm. The size at first maturity shows that 50% of females begin their sexual cycle from 176,72 mm in standard length, by males reach sexual maturity from 205,12 mm.

Catfish culture in nigeria: implication for conservation

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The culture of catfish in Nigeria has resulted in increased aquaculture production of more than 100% over the past 10 years. *Clarias gariepinus* and *Heterobranchus* species and their hybrids represent the most important contribution. *Heteroclarias* is the result of crosses between *Clarias* and *Heterobranchus*. The hybrid is characterized by faster growth rate compared to parent species. However several conservation issues are associated with fish culture and hybrids in particular including escapes from holding facilities and subsequent interaction with natural populations. This paper examines the roles of recent flood events on the catfish industry, using molecular techniques; hybrid must be identified and monitored through periodic assessment for introgression with natural populations. Research should be directed towards producing infertile hybrids to minimize their impact on extant natural populations.

The effects of riparian land use on water quality and fish species composition in the headwater streams of Tana, Athi and Ewaso ngiro rivers within central Kenya.

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Land use changes on riparian zones of streams have profound impacts on water quality and fish diversity. Sampling took place in 17 streams and in two dams along the streams in central Kenya and Nairobi which join up to form the three major rivers Tana, Athi and Ewaso ngiro. The physico-chemical parameters which contribute to the quality of water studied were temperature, dissolved oxygen, turbidity, flow rate, depth and width, conductivity and nutrients (Phosphates and Nitrates).

Land use patterns included National park, ranches, built-up areas, flower farms, vegetable gardening areas and natural vegetation. Temperatures ranged from 13.4 °C to 22.4 °C and dissolved oxygen concentration ranged between 4.47 mg/l to 1.76 mg/l. Turbidity varied according to soil types and activities in the areas surrounding the streams. Kinania stream on Athi river had the highest conductivity of 71 μ s and high nutrient concentrations, being in a vegetable gardening area. Most other streams had low nutrient concentrations. Fish species obtained were *Poecilia reticulata*, *Garra dembeensis*, *Chiloglanis brevibarbis*, *Barbus* sp., *Clarias gariepinus*, *Amphilius uranoscopus*, *Labeo cylindricus*, *Oreochromis* sp., *Neobola fluviatilis* and *Mormyrus* sp. The genus *Barbus* had more diversity than any other fish. *Clarias gariepinus* was the biggest fish and was found in lower parts of Athi river and in more turbid steam waters. Most of the fishes were small in total length (TL). The head water streams were dominated with species like *Garra*, *Amphilius*, and *Neobola* sp. At Hippo point dam on Ewaso ngiro, *Labeo cylindricus* was the largest fish obtained while at Karen on Athi river, *Micropterus salmoides* was the largest fish. The head water stream fishes were indicators of high water quality.

Impact of subsidy on fin fish production in Ondo state, south west, Nigeria.

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The effects of subsidies on the level of fish production in the coastal area of Ondo State were investigated in this study. Two hundred and five (205) respondents were randomly sampled to obtain information on socio – economic characteristics of the fishermen. The data was analyzed using descriptive statistics and production level of the fish farmers. The result from this study shows that when fishing inputs are subsidized this increases fishing activities, efforts and output of the fishermen. This study also shows that fisheries subsidies not only have their own peculiar production distortion effects but they have adverse effects on the environment and economic sustainability.

Impact of Dredging on the Water Quality and Fisheries of Igbedi Creek, Upper Nun River, Niger Delta, Nigeria

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The impact of dredging on water quality and fisheries of Igbedi Creek, upper Nun River, Niger Delta was investigated from June 2009 to May 2011. Two locations – Ogobiri (Dredged) and Agoro-Gbene (Un-dredged) were studied. The data revealed significant spatial differences ($P < 0.05$) between the locations in all the water quality parameters measured except for DO, Temp. and pH. There were significant temporal variations as well between the locations in the following parameters: Temperature, Turbidity, Conductivity, NO_3^- , NO_2^- , SO_4^{2-} , and BOD_5 . The results further showed high increase in values for Turbidity and NO_2^- in the station immediately downstream of the dredged area but steadily declined downstream. There was also a decrease in the number of fish species recovered in the undredged from 28 to only 22 in the dredged area. Fish from the dredged area exhibited negative allometric growth with length exponent (b) ranging from 0.911 ± 0.04 (*Brycinus macrolepidotus*). The only exception was *Schulbe uranoscopus*, which exhibited isometric growth with length exponent “b” = 3.027 ± 0.03 . In the undredged location, three species, exhibited isometric

growth (*Synodontis batensodath* ($b = 3.095 \pm 0.07$); *Schilbe uranoscopus* ($b = 3.097 \pm 0.03$) and *Distichodus faciatus* ($b = 3.021 \pm 0.11$). The other species exhibited negative allometric growth with length exponents ranging from 0.777 ± 0.004 to 2.560 ± 0.04 with the exception of *Hepsetus odoe* which exhibited positive allometric growth ($b = 3.412 \pm 0.07$). Correlation coefficients between length and weight “r” ranged from 0.739 (*Eleoties senegalensis*) to 0.978 (*Schulbe mystus*) in the dredged; and between 0.447 (*Polypterus ansorgi*) to 0.994 (*Synodontis membranoceus*) in the undredged locations. Student’s t-test values at 95% level showed significant differences in condition factor between the two areas. These results are clear indications that dredging significantly affected the fisheries and water quality of the creek.

Climate Change implications on the ecology and fishery communities of the Lake Chad Basin, Africa

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Climate change/global warming and the threat it poses to small-scale capture fisheries and aquaculture has been widely acknowledged. In the Lake Chad Basin (LCB), water shortage, caused by both climate induced and human factors, is impacting fisheries and other natural resources, through environmental and biodiversity changes. Located in the Central Sahel Region of Africa, the Lake and its basin, in its original form, is shared by eight African countries (Algeria, Central Africa Republic (CAR), Libya, Sudan, Cameroon, Chad, Niger and Nigeria), but presently, only the last four are in direct contact with the lake due to massive lake shrinkage. The fisheries of the region, exploited by both indigenous and migrant fishers, are huge, and significantly underpin livelihoods in terms food/nutrition security, income generation and employment. Over the years, hydrological and biophysical changes resulting from climate change factors and anthropogenic stream-flow modifications have combined to significantly alter the lake water area, leading to adverse implications for natural resources, sustainable livelihoods and community resilience in an environment that is generally impoverished. Surviving in such harsh and fluctuating environment, require communities to adopt and adapt different livelihoods coping strategies and portfolios in response to annual and inter-annual environmental changes. This report focuses significantly, on evaluating the climate and hydrology of the basin and the impact of climate and hydrological variability on the socio-ecological characteristics of the basin. The paper further identified a range of extant and potential coping strategies for overcoming household/regional vulnerabilities and build resilience in the face of drastic water shortage in the area. The report finishes with a set of concluding remarks and recommendations for saving the Lake Tchad.

Biodiversity of fishes in some major rivers traversing the CROSS River National Park, Nigeria.

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One of the primary functions of the Nigerian National Park Service is to record or establish all the resources found in each of its National Parks and also manage them, particularly the fisheries resources. The present study evaluated the species composition, diversity, abundance, distribution and some surface water physico-chemical parameters of some major rivers in the Cross River National Park, Nigeria (one of the most important National Parks situated in the tropical Rain forest belt of the country). Surface water and fish samples were collected over a period of six months covering parts of

the dry and rainy (wet) seasons. 10 sampling stations were designated, one on each of 10 major rivers sampled in the Park. Five (5) rivers each were sampled in the Oban and Okwango Divisions of the Park respectively. Analysis using standard methods showed that physico-chemical conditions at the various study stations were within the tolerable ranges (26-31 degrees Celsius for temperature, 6.5-9.0 mg/l for Dissolved Oxygen, and 6.8-7.5 for pH). A total of 2, 795 fish specimens (Oban, 1,684 and Okwango, 1,111) from 25 families, 48 genera and 114 species were recorded. The Abundance index showed that family Bagridae had 21.57%; Characidae, 19.59%; Cyprinidae, 19.54% and Cichlidae, 15.59% relative

Assessment of Heavy Metal concentration in *Parachannah obscura* and *Hepsetus odoe* from an abandoned Gold Mine reservoir, Igun, Nigeria using ICP-OES.

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This study was carried out to access the impact of Gold mining on the fish fauna as well as the resultant health impact on the people of Igun who depend mostly on the fishes in the reservoir as their main source of protein. Heavy metal concentration in the liver, gills and fillet of *Hepsetus odoe* and *Parachannah obscura* from an abandoned gold mine reservoir were examined between May 2008 and April 2009. Heavy metals (Cr, Ni, Cd, As, Cu, Zn, Pb, Se) were analysed using Inductively Coupled Plasma Optical Emission Spectrometer (ICP-OES) APL Model 3410. The mean concentration of heavy metals varied greatly in the two fish species with a high concentration of heavy metals being recorded in all organs and seasons throughout this study. The uptake of arsenic, copper, selenium and zinc in *H. odoe* were found to be statistically different with respect to the seasons at ($P < 0.05$) when compared with the uptake of chromium and nickel while in *P. obscura*, the difference in the heavy metal uptake in the dry and wet months were statistically insignificant at ($P > 0.05$). Irrespective of the time of collection, chromium was the most bioaccumulated element in the gills with a mean concentration ($664.947 \mu\text{g/g} \pm 41.673$) while nickel was the least bioaccumulated metal in the fillet with a mean concentration of ($4.393 \mu\text{g/g} \pm 0.364$) in *Hepsetus odoe*. In *Parachannah obscura*, chromium was found to have the highest mean concentration of $2644.04 \mu\text{g/g} \pm 1024$ in the liver while nickel was the least bioaccumulated heavy metal with a mean concentration of $4.57 \mu\text{g/g} \pm 0.243$ in the fillet. All metals assayed exceeded World Health Organisation (WHO) and Federal Environmental Protection Agency (FEPA) allowable limits in fish as food.

Assessment of extinction risks on a sub-continental level: lessons from Brazil

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The Brazilian government, through its federal agency for conservation of biodiversity (ICMBio), is assessing the conservation status of all the approximately 8600 known Brazilian species of vertebrates and of about 1400 invertebrates until 2014. The genesis of this ambitious project dates back to the first United Nations Conference on Environment and Development, also known as ECO-92, when Brazil became a signatory to the Convention on Biological Diversity (CBD). All parties of the CBD should develop national strategies aimed at the conservation of biological resources for present and future generations. In 2006 the Brazilian government established the National Biodiversity Goals and Targets, which includes the identification of all endangered species and the development of strategies for their conservation. We are following the methodology proposed by the International Union for Conservation of Nature (IUCN) for assessment of extinction risk categories, which is based on

quantitative and qualitative criteria. Categories are assessed in workshops that include a substantial portion of the Brazilian scientific community and IUCN experts. Those categories are subsequently validated in a second round of workshops, which includes only scientists more experienced with the IUCN methodology. The extinction risks of 5053 species were assessed until the end of 2012, including those of all Brazilian sharks, rays and chimaeras (169 species), all the currently described Brazilian species of hagfishes (5 species), and 1280 species of ray-finned fishes (Teleostei). All results of those workshops will be published. It is expected that about 2900 species will have their extinction risks assessed by the end of 2013, which in turn indicates that the goal of evaluating 10000 species will be achieved in 2014. Several African nations are also signatories of CBD, and the conservation status of their biota might be assessed following a strategy similar to that employed by the Brazilian government.

Theme 4

Fish and food security in the 21-st century in Africa

Oral Presentations

Suitability for cage culture in Africa's inland water bodies: A case of Northern Lake Victoria, Uganda.

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World over aquaculture has increasingly moved from land into water bodies and one of the commonest type of aquaculture in water bodies is cage aquaculture. Cage aquaculture involves culturing fish in nets cages suspended in the water column of a water body. The practice is common in South East Asia and parts of Europe, while in Africa Egypt and Zimbabwe are the only leading cage culture practicing countries. Uganda based farmers have also embraced cage culture which urgently calls for formulation of guidelines for site identification as prerequisite for sustainable fish production. Based on literature search and field measurements in 25 sampled bays in Lake Victoria during 2012 resulted into a criterion on suitability of cage culture for different scales that was broadly summarized into three areas namely environmental, bio-physical and socioeconomic. The specific multiple issues that must be considered included but were not limited to: suitable environment (e.g. temperature, pH, dissolved oxygen, water exchange, depth, shelter from wind, wave heights and water currents); other lake users (e.g. navigation, fishing grounds and cultural uses); disease effects either from cultured organism or from wild species; presence of breeding and nursery areas; presence of fish predators (e.g. birds and mammals); water quality and cumulative impacts; existing or creation of facilities and infrastructure (e.g. electricity, roads, landing sites) and genetic effects. The current study identified 18 bays out of the 25 sampled as suitable for different scales of cage culture while 7 bays were considered unsuitable.

Spatial and temporal patterns in Nile perch populations in southern Lake Victoria with possible indications of a recruitment peak

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In 2009-2011 the distribution and composition of the Nile perch (*Lates niloticus*) population of southern lake Victoria were sampled. A total of 16,874 Nile perch were caught during 153 gill net settings and 87 trawl hauls. At a spatial macro-scale (ca. 100 km), comparing different lake regions, the density of Nile perch in Mwanza Gulf was 10 to 40 times higher than in Speke Gulf to the east, or in Sengerema, to the west of Mwanza Gulf. Depth appeared to be the best predictor of abundance here. At a meso-scale (ca. 10 km), within Mwanza Gulf, the density of Nile perch was also negatively related with depth. Overall, the shallow parts of southern Lake Victoria appear to sustain a disproportionately large part of the Nile perch population. Moreover, in Mwanza Gulf the proportion of juveniles <10 cm was higher than in the other regions, especially in waters <8 m depth in the wet seasons from November to February. Taking known growth rates into account, this suggests a seasonal recruitment peak during the dry season from June to September.

***Impact of Agro-Industrial Activities on Water quality and Ichthyofauna in the Lower Reaches of Nyando and Sondu Miriu Rivers, Kenya**

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Rivers Nyando and Sondu upper catchments are characterized by industrial and agricultural activities respectively. This study investigated the impact of these anthropogenic activities on water quality and Ichthyofauna in the lower reaches of the rivers which are known breeding and spawning grounds for many indigenous fish species. Sampling was done monthly at five stations on each river. Fish samples were collected using an electrofisher (600V 8.0Hp) on a river reach 35 times the width of the river per station and identified to species level, counted, weighed and lengths measured. Rivers Nyando and Sondu differed significantly in terms of physico-chemical parameters and nutrients. The number of fish species increased downstream with the lakeshore having the highest number of species from three families (cyprinidae, cichlidae and schilbeidae). Fish abundance was upstream and at the lakeshore. Few fish were recorded at stations adjacent to Chemelil sugar factory. A stepwise selection model revealed that *Oreochromis* sp preferred high nutrient (PO₄.P & NH₃.N) waters and high DO levels. *Barbus* sp. was also associated with waters with high DO levels. The distribution of *Scilbe mystus* was significantly ($F=5.6359$, $p=0.04496$) influenced by conductivity. The species was abundant in waters with low conductivity. The study showed that some fish species are restricted to lower reaches of the two rivers. These areas are therefore important refugia hence the need for proper catchment management to conserve biodiversity

Determination of the specific inter-selectivity of fishing gears using Kohonen SOM

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Information on fishing gear selectivity do not often include the specific inter-selectivity of gears capturing the same species. In the few studies carried out on the subject, analyses are made using the Detrended Correspondence Analysis (DCA) which demonstrates neither the demarcation between the different groups of species caught and/or fishing gear nor the inter-selectivity of gears. The use of Kohonen Self Organizing Maps (SOM) helps to achieve that goal. In the Pendjari River, 5 types of fishing gear namely seine nets, gill nets, cast nets, multi-hook lines and the Malian trap, are regularly used. A total of 431 units of fishing, 42327 fish belonging to 86 species were examined. A matrix of 5 gears x 86 species allows us to bring together gears and species on a Self-Organizing Map made of 16 cells (4 rows x 4 columns). On this map, 2 groups of species (GI and GII) have been distinguished. GI contains species that are common to all gears and GII comprises species that are characteristic to each gear. GII has been subdivided into two groups (GIIa and GIIb): GIIa gathered species from seine nets and cast nets, and GIIb species from multi-hook lines and Malian trap while gill nets comprised all the species from all gears (GII).

Fisheries of the Lower Rufiji floodplain lakes, Tanzania: the influence of connectivity on catch composition and the potential impacts of Stiegler's Gorge dam

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In order to assess the potential impacts of the construction of the Stiegler's Gorge dam on the fisheries of the Lower Rufiji, fish catches were monitored by village-based recorders for 7 years in 7 floodplain-associated lakes with varying intensity. Two lakes in particular, large well connected Lake Zumbi and small infrequently connected Lake Mtanza were intensively followed from November 2005 to March 2009. Data from the landings of some 2500 canoes were collected on 8 randomly chosen dates per month. The lakes differ in the number of days and the volume of inflows from the river and thus provide a natural experiment to explore the links between catch composition and connectivity. In situations of low connectivity, during a series of drought years, the less well connected lakes quickly lose a number of species. Multivariate analysis shows that connectivity is a major determinant of catch composition and that species such as *Distichodus petersii* (vulnerable), *Citharinus congicus*, *Hydrocynus vittatus* and *Brycinus imberi* correlate inversely with an axis linked to the number of days since the last connection. Such species are likely to decline strongly in case the Stiegler's Gorge dam is built according to the current design with a managed flood release of only 2500 cubic meters per second. Many of the lakes will most likely dry out or become increasingly saline leading to a substantial loss in human well-being in the local communities as fisheries are a major component of their livelihoods and an important source of cash income.

Lake Kariba revisited: an update on fish community developments from 1960 to 2012

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Lake Kariba is a reservoir in the Zambezi River, situated on the border of Zambia and Zimbabwe. Already soon after the closure of its dam in 1958, experimental gillnetting was started to monitor the developments of the fish community. Experimental fishing continued almost continuously until the present day, spanning a time period of more than 50 years. Therefore Lake Kariba is an excellent case to study long-term developments and succession in a tropical fish community. Experimental gillnetting was performed with a standardised fleet of nets, ranging from 38 to 178 mm stretched mesh on a nearly weekly basis from a permanent station close to the town of Kariba on the Zimbabwean side of the lake. Almost 2,000 surveys were performed in which ca. 270,000 fishes were caught. All specimens were identified, measured and weighed, and their sex and gonad development were recorded. In an earlier study, ranging until 2001, it was shown that the species richness and composition of the fish community, as well as the diversity, biomass and production measures took around 30 years to stabilise. Moreover, it was shown that inter-annual variations were strongly linked to lake level fluctuations and the abundance of the tigerfish (*Hydrocynus vittatus*), the top predator in the system. The current study extends the time series to 2012 and generally confirms the earlier conclusions about the developments in Lake Kariba's fish community. However, inter-annual variability appears to increase during the last decade, as well as the relative importance of the introduced Nile tilapia (*Oreochromis niloticus*). Although relatively stable, Lake Kariba is still in continuing development.

Promotion of consumer acceptance and marketability of catfish to enhance the productivity and profitability of aquaculture in Uganda

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As the fish supply from the traditional sources, capture fisheries, reaches maximum in Uganda, gap between supply and demand is widening as a result of population increase and the need to improve foreign exchange earnings from fish export. The only feasible alternative source of fish to bridge the gap is aquaculture. However, the development of aquaculture is too slow to have significant effect on the fish demand gap. The main reason for the slow pace is low aquaculture yields and profits earned from it. The current efforts are focusing on increasing aquaculture productivity and competitiveness through increased marketability and profits. The main aim of this paper is to highlight the potential in the culture of catfish to improve productivity, marketability and profits in aquaculture. On-farm research of the African catfish (*Clarias gariepinus*) on 35% protein diet made at the Aquaculture Research and Development Centre, Kajjansi, Uganda has shown that market size of 1.4 kg and pond productivity of 4.0kg/M³ of pond volume are attainable in six months. This allows farmers to get two crops totaling 8.0 kg/M³ in a year. These figures are much higher than the corresponding figure of market size of 0.5 kg and pond productivity of 1.2 kg /M³ in 7 months attainable with Nile tilapia (*Oreochromis niloticus*). On the other hand, market surveys to compare consumer preferences of the tilapia and catfish have been carried out in the districts of Mpigi, Wakiso and Kampala. These studies have shown higher preference of the tilapia over the catfish. The main reason advanced for the preference is that the tilapia has been longer on the market and consumers are more familiar with it even though some consumers cite cultural and religious inhibitions. Despite the current consumer preference for tilapia its market price of Ug. Shs 6,000 to 7,000 is not significantly higher than that of the catfish of Ug. Shs. 5,000 to 6,000 so as to make up for its lower pond yields. Therefore, the farmers earn much less money by growing tilapia than they would if they grew the catfish. A third study has compared consumer acceptance of different products, including dip fried whole and fish fillets, prepared and spiced fish balls and fish fingers, from the two fish species. The study has shown that there was no significant difference in the preference of the products from the two fish species and the consumers liked products of both fish. The conclusion drawn from the studies indicate that the promotion of consumer acceptance of the catfish through value addition will enhance its marketability and the earning and profits of fish farmers in Uganda. This will encourage more farmers to take up fish farming, improve availability of fish on the plates and improve food security situation.

Dynamics of fish stocks and fisheries in Lake Nabugabo, East Africa

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The Lake Victoria basin of East Africa is home to Africa's largest inland fisheries with tens of millions of people dependent on its resources. However, fisheries in the region have experienced intense fishing pressure with increases in both the number of fishers and ecologically-destructive practices, as well as a growing local and international demand for the non-native Nile perch (*Lates niloticus*), which has been introduced to lakes Victoria, Kyoga and Nabugabo. With increases in human population density and demand for fish, the introduced Nile perch is showing signs of decline. There is an urgent need for management strategies that integrate fishing capacity with distributional patterns of both the fish resource and the fishers. Here, we examine changes in fishing effort, fish stocks, and their associated implications in Lake Nabugabo, a satellite lake of the larger Victoria. Nile perch introduction in this Lake was followed by the development of a Nile perch fishery and intensive fishing, which coincided with reduced size and other phenotypic changes in this species. We use data collected through experimental fishing and fish catch assessments between 2006 and 2010, and comparisons with published data from 1962 and 1991 to explore dynamics of the fisheries in this system. We then evaluate the fisheries resources relative to the distributional patterns of fishing effort. In Lake Nabugabo, there was a notable decline in indigenous fishes with the establishment of Nile perch; currently, Nile perch, non-native Nile tilapia (*Oreochromis niloticus*) and mukene (*Rastrineobola argentea*) dominate the fishery. Fishing patterns between 2006 and 2010 corresponded closely with relative abundance in fish. Size frequencies of harvested *L. niloticus* and *O. niloticus* indicated that most harvested fish were below their sizes at maturity. This suggests a fishery at risk and calls for a sound, holistic approach that captures stakeholder involvement in sustainable management of the fishery, to mitigate future fluctuations.

Modeling and forward projections of Nile perch, *Lates niloticus*, stock in Lake Victoria using gadget framework

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A Globally applicable Area Disaggregated Ecosystem Toolbox (Gadget) was used to generate population and stock assessment models for Nile perch, *Lates niloticus* in Lake Victoria. Two model runs were conducted. Growth parameters generated from the first run $L_{\infty} = 255$ cm, $K = 0.069$, $t_0 = -0.25$ and $L_{\infty} = 198$ cm, $K = 0.1$, $t_0 = 0.8$ for the commercial and survey fleets respectively fitted well with data. These parameters were therefore fixed in the final model run. Sizes at 50% maturity (L_{m50}) were 61.34 and 70.37 cm while the adult sex ratio was 2:1 for males and females respectively. Model fit to length disaggregated, CPUE and acoustic survey indices showed strong positive correlation. Two selection patterns were evident in the commercial fleet in the periods prior and after 2002 with the latter exhibiting higher mean length. Population estimates show a biomass that decreased sharply in the late 1980s with rapid increase in fishing mortality. Catches on the other hand increased

exponentially from 1968 and then leveled off after 1990. The current fishing mortality of 0.53 gives a per recruit yield 1.38 kg, which is lower than it could have been at $F_{\max} = 0.33$ that results in 1.45 kg. The current fishing mortality is almost double the optimum. The estimated yield at $F_{0.1} = 0.21$ is 1.37 kg. Forward prediction based on different exploitation strategies show that the current fishing mortality or any increase in the same will lead to decline in biomass and catches in the long run. A fishing mortality F_{\max} that optimizes yield with significantly less effort is therefore recommended for the species in Lake Victoria.

Studies on Value Added Products from *Rastrineobola argentea* (Omena) for Food Security and Improved Livelihoods among Women Processors in Homabay County, Kenya.

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Despite the opportunities offered by the Lake Victoria, the region along the shores in Kenya has been described as a “Belt of poverty” by many researchers. Most households depend solely on fishing as their major source of income and food. Omena (*Rastrineobola argentea*) is one fish species that is largely depended on as source of income and food, especially by female fish traders. Besides sun-drying, these women have no other method of processing Omena to add value to the product for increased financial gain and improved livelihoods. The women in Lake Victoria fisheries play a crucial role, particularly, in the post-harvest and other ancillary activities such as fish processing, marketing, net-making and mending. However, women in the fisheries industry are often marginalized and their involvement is often limited to the small –scale processing of the native fish species especially *R. argentea* which is relatively less remunerative. In addition, post-harvest losses of fish in the domestic distribution chain especially of *R. argentea* are high in terms of recovery, quality and economic returns due to inadequate fish processing and storage technologies. When women are empowered, they will contribute effectively towards the achievement of the Millenium Development Goals and the Kenya Government Vision 2030. The objective of the project was to establish the processing strategies used by women around Lake Victoria and develop value added products from *R. argentea* to supplement the income of women processors for improved livelihoods. The project has analysed the hygiene conditions under which omena is processed, common processing techniques used by women and challenges they face. Preliminary results obtained so far indicate the absence of micro-organisms on a few selected stages of processing ($P < 0.005$). A number of modern drying techniques have been tried along the shores of Lake Victoria but the women still prefer using mosquito nets to dry omena on the ground. The women fish processors face a number of challenges during the course of duty ranging from lack of finances, lack of fish especially during closed seasons and high post-harvest losses during rainy seasons. This paper will present the preliminary results of the three year project that seeks to empower women fish processors around the lake region thus enhancing food security.

Trends in aquaculture production in Nigeria: implications for food security

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The fishery subsector is very important in the Nigerian economy. It provides direct and indirect employment opportunity as fish farmers, traders, and processors. It also provides income, foreign exchange, and offers a very cheap protein for human consumption. Fish is a healthy food, low in calories and cholesterol level. The fish industry in Nigeria is grouped into three; artisanal (meeting local demand), industrial and fish farming. Fish accounts for 35 -40% of animal protein consumption while supply per capita is just 9kg. In 2007, 600,000 metric tons of fish was produced while consumer demand was 2.66 million tons. This necessitated an import of 740,000 metric tons to bridge the gap. The production ability of captured fish is almost coming to a standstill due to overexploitation, uncertainties, obnoxious method of fishing, illiteracy, inadequate technical advice, and poverty among others. Despite the huge available aquatic resources such as rivers, creeks, natural and man-made dams, fish production is still very low. This paper examines the trends in aquaculture (fish farming) production and demand in Nigeria and its implications for food security. The study made use of secondary data obtained from relevant agencies. The trend shows an increasing pattern from 2001 to 2010, from 24,398mt in 2001 to 200,535mt in 2010. In spite of the increasing trend of production, the demand still outweighs the supply. This suggests that aquaculture is an alternative which will play an increasing role in food security. The study also reveals that about 80% aquaculture being produced in Nigeria is manned by the small scale farmers with a few exceptions. Constraints to aquaculture production include high cost of feed, technical knowhow, inadequate capital, and poor water quality management. The paper recommends that the government, the private sector, and non-governmental organizations should come to the aid of fish farmers by granting loans in cash and kinds particularly feeds and fingerlings in order to boost production.

La rizipisciculture au Mali : Pratiques et perspectives d'avenir de l'innovation piscicole.

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Le Mali est un pays de tradition halieutique dans ses eaux fluviales. Sa production halieutique, la plus élevée d'Afrique de l'Ouest, reste tributaire des régimes de crue du fleuve Niger. La pisciculture apparaît donc comme une alternative pour accroître la disponibilité de poissons en cas de sécheresse. Depuis 2006, une nouvelle activité de production de poissons s'implante peu à peu dans les paysages agricoles : la rizipisciculture. Cette activité émergente est un nouveau défi pour la recherche agricole malienne qui suscite plus d'interrogations que de solutions actuellement. C'est pour répondre à ces questions que des enquêtes individuelles ont été réalisées auprès des rizipisciculteurs de l'Office du Périmètre Irrigué de Baguieda (OPIB). 15 des 23 paysans, soit 65 %, pratiquant la rizipisciculture, ont été enquêtés et suivis en 2011. A la lumière de cette investigation, les pratiques rizipiscicoles et les résultats sont disparates. Le rendement piscicole des casiers varie entre 408 et 438 Kg ha⁻¹. Cette activité est confrontée à des contraintes d'ordres environnemental, socio-culturel, technique, institutionnel et financier. L'existence d'importants potentiels de riziculture irriguée au Mali est un espoir pour envisager le développement de cette innovation technique.

Light attraction optimum in the sardine fishery from Lake Kariba

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Capture of the freshwater sardines, *Limnothrissa miodon* in Lake Kariba relies on light for concentrating the fish hence, optimization of lighting is important for the fishery. The study objective was to determine the optimum light intensity for attracting sardines in the laboratory and field. In the laboratory, the sardines were exposed to varying light intensity and the number of fish under the light recorded. To investigate the relationship between catches, water quality and light intensity, samples of sardines were caught from the Sanyati basin of Lake Kariba, using three light bulbs of varying light intensity. At the same sampling sites water sampled were collected and the turbidity and suspended solids content measured. The experiments showed that medium levels of light attracted fish and higher light intensity could repel. Suspended particles in the water reduce light intensity affecting catches negatively. There was no relationship between suspended matter and catches made without light suggesting that abundance is not affected by suspended solids. Compared independently, the 80 Watts bulb alone had a significant relationship with catches whilst the 250 and 400Watts not. Results show that light used for fishing is less effective with increase in the suspended particles in water and that higher light intensity may counter increase in the amount suspended solids in the water. We can conclude that light intensity increase that we observed in the history of the fishery cannot go on indefinitely. In addition, it seems that the seasonal trends in CPUE may results from the seasonal changes in the amount of suspended particles in water as well as changes in fish abundance.

Small scale fishery dynamics along infringed Mpologoma River wetland Uganda

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Small scale wetland fisheries support livelihoods and protein sources for those communities with limited access to lake fisheries. In highly populated and climate variable areas where human demands are high, wetland fisheries such as those in eastern Uganda may be disturbed by agriculture practices. The study carried out between 2011 and 2012, investigated the impacts of land use change on wetland fish abundance and catch for Mpologoma river wetland. Four differently disturbed study sites were selected: intact, minimally disturbed, highly disturbed with small scale farmers and one with a large scale irrigation scheme. Water quality and fish data were collected from all sites. Fish data was collected from both experimental fish sampling and local fishermen catch. Conductivity and dissolved oxygen levels significantly differentiated the study sites and explained 72.03% of the variance. Nine fish taxa dominated the wetland fishery. *Clarias gariepinus* and *Protopterus aethiopicus* catch (range of 0.45 to 38kg/day and 0.25 to 20kg/day respectively), were higher at the less disturbed sites than at highly disturbed sites, accounting for over 90% of total wetland catch. *Tilapia zillii* and *Oreochromis leucostictus* abundance and catch were also higher at the less disturbed sites while the small fish species (*Haplochromis* sp, *Clarias liocephalus* and *C. alluaudi*) did not vary with site. Conductivity and dissolved oxygen correlated with the two large fish species' catch (spearman coefficient $\rho = 0.501$ at $p < 0.05$). Small fish did not significantly correlate with any water parameter. Differences in fish life strategies could have led to the variation in fish production in response to the disturbance levels along the wetland. Wetland fish species which are highly sensitive to water quality are likely to reduce drastically with increasing wetland disturbance by agricultural activities.

Macroinvertebrate Assemblages as Indicators of Water Quality and Ecological Integrity of Laikipia Rivers, Kenya

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Macroinvertebrate assemblages were sampled at various stations along Laikipia Rivers using 0.5 mm mesh size scoop net in the riffles, pools and runs from February 2010-January 2013. The overall objective of the study was to assess the structure and composition of macroinvertebrate assemblages as indicators of water quality and ecological integrity of the rivers. Sampled stations were chosen to correspond to different land-uses in the catchments. Sampled macroinvertebrates were identified, and taxon diversity, richness, evenness and dominance estimated for each station. Minitab for Windows version 14.0 and Microsoft Excel computer packages were used for statistical analyses. A total of 45 macroinvertebrate genera for River Nanyuki, Ewaso Nyiro and Ewaso Narok dominated by the Ephemeroptera, Plecoptera and Trichoptera (EPT). Other orders like Hemiptera, Coleoptera, Diptera, Pulmonata and Odonata besides EPT also registered a greater percentage in all the rivers sampled. Some orders such as Annelida, Amphipoda, Pelecypoda, Decapoda, Prosobranchiata and Lamellibranchiata did not dominate the rivers but their abundance were felt in some rivers like R. Ngare Narok, R. Gobit, R. Pesi, R. Burguret and R. Sirmon. Significant differences in the mean abundance ($F= 16.371$; $p = 0.000$) and diversity ($H=7$; $p=0.0032$) between the rivers were found that indicated differences in water quality. The results indicated that ecological integrity of Laikipia Rivers were experiencing intermediate levels of disturbance that influenced taxon composition, distribution, abundance and diversity. The study recommends that habitat quality should be maintained along the rivers. Macroinvertebrate assemblages in Rivers should also be used as indicators of ecological integrity to aid in management of the rivers.

Activity rhythms in piscicultural pond of *Heterobranchus longifilis* Valenciennes, 1840

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The activity rhythms of two adult catfishes *Heterobranchus longifilis* Valenciennes, 1840 (750g) were studied in piscicultural pond in Laboratory of Hydrobiology and Aquaculture of the Faculty of Agricultural Sciences of University of Abomey-Calavi (LHA/FSA/UAC) between January and March 2013. The fish were equipped with intraperitoneally implanted radio transmitters with activity circuits and were intensely followed during 15 24h cycles. The physicochemical parameters were measured every hour. Daily activity budgets were $31,75 \pm 8,96\%$ for female fish and $34,01 \pm 8,16 \%$ for male fish. Fish were always more active by day than by night. The regression between activity budgets variation and environmental parameters indicated that this variation was positively correlated with water temperature and was negatively correlated with dissolved oxygen. On the other hand, none information was contributed by activity budgets variation in this regression model. These results confirmed the use of this technical in piscicultural pond and studied the influence of some environmental factors on activity and behavior of fish.

The nutrient content of traditional sun-dried Nile fish in Sudan

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The chemical composition and fatty acid profiles were determined for sun dried flesh of: *Lates niloticus*, *Tetraodon lineatus*, *Heterotis niloticus*, *Mormyrus niloticus*, *Clarias lazera* and *Protopterus annectens*. Protein value of over 70g/100g was recorded for all the analyzed fish except *C. lazera* which contained (59.9±1.4g/100g). Lipid was (2±0.1-16.6±0.8g/100g), with the highest value recorded for *C. lazera* and *M. niloticus*. Ash was (3.9±0.1-13.6±0.9g/100g), high in *P. annectens* and *C. lazera* than in the remaining fish species. Energy value was (475-555 Kcal/100g) high in *C. lazera*. Minerals dominated by Ca, Na, K and P which form 99% of total minerals. The value of Mg was (1.4-2mg/100g). Other minerals had values <1mg/100g. SFA formed 16.4%-67%, highest in *P. annectens* and least in *C. lazera*, dominated by Palmitic and Stearic acids. MUFA formed 21.3%-34.4%, dominated by Oleic and Palmitoleic acids. PUFA formed 6.3%-56.8%, dominated by Linoleic acid. Linolenic, Lenolenic and Eicosatrienoic were the highest PUFA in *C. lazera*. Omega-6 was 6.3%-31.8%, with highest value in *C. lazera*. Omega-3 was 10.8%, 7.3% and 21.4% in *H. niloticus*, *M. niloticus* and *C. lazera*, respectively. Amount of EPA+DHA was 2.3%-3.2%. The results showed that the sun-dried product (Kajaik) of Nile fish has high nutritional value and is a good source of proteins, minerals as well as essential fatty acids for healthy diet. The data may benefit the fishing industry, nutritionists and researchers to improve the nutritive value, processing and marketing of selected fish.

Fish and Fisheries of Bangweulu Wetlands, Zambia

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Bangweulu Wetlands is a conservation area lying on the margins of the Bangweulu Swamps on the Congo River system. Customary fisher-farmers operate a seasonal artisanal floodplain fishery within the protected area. This study aimed to provide a baseline of the fishery using in-field observations, catch assessments and key-informant interviews. The fish community was typical of floodplain systems and contained a total of 43 species. Twenty-three species were sampled from the fishery but *Clarias gariepinus*, *Tilapia rendalli* and *Marcusenius macrolepidotus* were the most important, contributing 67% to the catch weight. Fishing was most intense during flood recession. The main fishing methods were basket traps and mosquito-mesh funnel nets set into earth fish weirs, gillnets, longlines and seine nets. Gear used depended on water levels and was adapted to maximising the catch from the fish and size classes available such that the average daily catch (7.8 ± 7.4 kg.fisher⁻¹) did not differ significantly between dry and wet season. Yield per fisher for a seven month season was 1.64 t based on catch assessment, similar to the 1.9 t estimated from a socio-economic survey. Yield per area estimate was 217 kg.ha⁻¹ over a three month shallow-floodplain fishing season. Sundried and smoked fish products were used for home consumption, local trade for staple starch meal and sale to urban merchant fish traders. The price for dried fish at source was 3.14 ± 1.34 \$US/kg and 6.14 ± 2.54 \$US/kg at urban markets. Returns on investment in fish trading were calculated as 68-77%. Overall the fishery was considered to be a biologically and socially sustainable contributor to local (fishers) and regional (traders) livelihoods. These findings are discussed in the context of developing appropriate management recommendations that seek to strengthen the traditional system of rights-allocation and enhance communication between fisheries and conservation stakeholders.

Networking for Co-Management of Zambezi-Okavango Fisheries

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Co-management has had varying degrees of success in southern and eastern African freshwater fisheries. In the Caprivi region of Namibia and bordering Zambia, communities along the Upper Zambezi River and associated floodplains are increasingly taking responsibility for their own resources in response to declines in catches and use of destructive fishing gears. Supported by NGO-led projects on both sides of the river, the communities set up fishing committees, established Fish Protection Areas, and are targeting removal of the most damaging methods. Recognising the apparent success of this approach, a networking project has been established to apply lessons learned in Caprivi to community-based management of river and floodplain fisheries throughout the Upper Zambezi and Okavango river systems. Entitled NNF/EU Community Conservation Fisheries in KAZA Project, the aim is to contribute to environmental conservation and to improve socio-economic benefits and food security, especially for women, children and the rural poor through capacity building and the development of regional and international networking platforms. The project aims to improve communications with other fisheries stakeholders in the Zambezi system as a whole. Collaborative programmes include: development of an Okavango-Cubango Transboundary Fisheries Management Plan; assistance to African Parks in managing the fishery in and around Liuwa Plain National Park in western Zambia; providing support to conservancies to manage Fish Protection Areas; support for post graduate research programmes including a PhD study on the development of fish populations and fisheries in the ephemeral but highly productive Lake Liambezi; and development of fish ranching in temporary water bodies such as pans and gravel pits.

Environmental and Nutritional Manipulation for Year-Round Spawning of the African catfish, *Clarias gariepinus*.

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A study was carried out to determine the efficacy of environmental and nutritional manipulation on gonadal development, and spawning of pond-bred *Clarias gariepinus* broodfish. This was aimed at proposing a substitute to chemical/hormonal and genetic stimulation methods for year-round spawning of the African catfish, and proffering a simple adaptive, cost effective and environmentally friendly method for year-round fingerling production for sustainable Catfish production. A total of 400 hundred adult catfish, weighing between 180 and 250 grams, and measuring between 17 cm and 20 cm were stocked in replicate experimental and control earthen ponds. In the treatment ponds, fishes were fed 40% Crude protein diet, the pond water continually renewed and the level maintained at 30 cm. In the control pond, water supply was dependent on nature (rainfall) and the fish were fed on natural food organisms from the ponds. Fish were sampled randomly for 12 months to assess gonadal development and spawning using standard qualitative and quantitative methods. Qualitative macro-morphologic assessment showed that, from June to November, both manipulated and non-manipulated fish groups achieved gonadal development from Immature Stage I to fully matured stage IV, and then to Running ripe Stage V. By November, all groups, control and experimental had Spent/Resting Stage VI gonads. This was supported by the quantitative assessment of Gonadosomatic index (GSI), which rose gradually from May and peaking twice before dropping in October/November. Subsequently, from November up to January, the non-manipulated fish groups

exhibited mainly Spent/Resting Stage VI gonads, followed by gradual gonadal development from Immature Stage I in February. In the environmentally manipulated groups, a steady supply of ready-to-spawn fully mature Stage IV, and Running ripe Stage V was achieved from November to May. This was supported by high GSI values of the environmentally manipulated fish groups as opposed to a drastic drop in GSI of non-manipulated fish groups. Subsequently, GSI values of both fish groups showed a gradual rise from February to May but the simulated groups exhibited higher GSI. The data demonstrated that environmentally and nutritionally manipulated fish showed superior gonadal development with concomitant spawning ability with a probability of 0.01% over non-manipulated fish. It is therefore concluded that year-round catfish fingerling production can be achieved without resorting to the use of chemical or genetic manipulation methods.

Aquaculture in Central Africa. Progress, Potential, Pitfalls and Problems with special reference to man-made Hydropower lakes.

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The object of this paper is to present a summary of the current state of aquaculture developments in central Africa and discuss the progress, potential and problems arising thereof. Planned developments of large scale Hydropower generating facilities have the potential of creating environments suitable for fish culture, but also the loss of biodiversity. This study focuses on past successes and mistakes, and suggests suitable mitigation measures encompassing anticipated trends that could be used.

This paper is mainly the product of personal observations accumulated over several years of consulting work conducted for NGOs and private companies on Aquaculture in Central Africa. As fish farming is conducted in many diverse systems, a comparison of the costs and benefits, both in economic and ecological terms that are available and suitable for use in the region has been made.

An analysis of the commercial pressures to produce more fish for a growing population in the region, and the current methodology of achieving this is presented. Various alternatives are suggested and specific threats to wild fish populations are enumerated with proposals for their mitigation.

Demand for fish is rising with increased human populations and more disposable income. With most traditional sources already overexploited, aquaculture will inevitably continue expanding. Debate on how this will be achieved sustainably, and with the least possible collateral damage to the environment is essential to plan a roadmap forward. This paper addresses some of those concerns.

The threatened freshwater fishes of Nigeria

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The assessment of the freshwater fish of West Africa, done by the International Union for the Conservation of Nature and published in 2010, has shown that three of the most species-rich areas of western Africa occur in Nigeria: the Niger River delta, the Ogun River and the Cross River. This makes the freshwater fish diversity in Nigeria the highest in western Africa. The Niger delta is also one of the two main regions of endemism in western Africa, and also the Ogun has a high number of endemic fish species.. This rich fish biodiversity is currently threatened by habitat degradation, agricultural activities, deforestation, mining and pollution, amongst others. Consequently, just over 30 freshwater species, or about 10% of the Nigerian freshwater ichthyofauna, have been categorized as threatened in the "IUCN Red List of Threatened Species". The families with the highest number of threatened species are the Nothobranchiidae (7 species), Cyprinidae (6 species) and Mochokidae (4 species). With 13 families having at least one threatened species, less than 25% of them thus contain over 50% of the threatened freshwater fish. On a regional scale, the Niger delta has the highest number

of threatened species in western Africa, and also the lower Ogun has an important number of threatened species. In order to highlight and create awareness to the plight of these fishes, a poster was developed illustrating a threatened species of every genus with at least a single species under threat. Other threatened species of the genus are mentioned, so that all threatened fish species of Nigeria are represented in the poster. In addition, the poster provides information on the threat status, major threats, distribution, economic importance and population trend in the wild of these species.

Nutrient utilization and growth responses of catfish hybrid (*Heterobranchus Bidorsalis X Clarias gariepinus*) fed dietary levels of *Ipomea Batatas* leaf meal.

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The growth and nutrient utilization responses of hybrid catfish post fingerlings of *H. bidorsalis x C. gariepinus* fed 35% isonitrogenous dietary levels of 0%(TI₁), 5%(TI₂), 10%(TI₃), 15%(TI₄) and 20%(TI₅) *Ipomea batatas* leaf meal were determined in a 3 replicate experiment that lasted for 8 weeks. 15 post harvest fingerlings, measuring 11.35 ±0.10g in mean weight were randomly assigned to each treatment. 15 plastic aquaria, 250 x 150cm in dimension were used for the trial. The fish were fed twice daily at 5% body weight and growth response monitored. The daily protein intake did not show significant differences among the treatments (p>0.05). The specific growth rate and protein efficiency ratio of the control were significantly (p<0.05) higher than the dietary treatments of *Ipomea batatas*. The feed conversion ratio of the control was significantly (p<0.05) superior to TI₃. Although higher levels of *Ipomea batatas* leaf meal up to 20% dietary inclusion showed improved responses, the overall performance of the experimental fish was significantly (p<0.05) higher for the control, than all the leaf meal dietary treatments.

Theme 4

Fish and food security in the 21-st century in Africa

Poster Presentations

Environmental considerations for selection of suitable cage aquaculture sites in Africa's inland water bodies; *Lake Victoria a case study.*

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Proper site selection for cage aquaculture inland water bodies is crucial if sustainable aquaculture development is to be achieved. Environmental degradation as a result of poor siting of aquaculture installations as well as interference with other activities has to be foreseen and avoided as much as possible. Equally important, harm to the cultured animals due to a contamination or inappropriate environment also has to be avoided. A careful study should be undertaken prior to any installation should be compulsory, in terms of mitigating any possible effects. Important aspects to be taken into account, during cage aquaculture site selection can be summarized as; Topography and general environment, bio-physical, chemical and socio-economic criteria. It is these that were used in this study to assess suitability of twenty-five (25) selected bays around Bugala, Dumba, and Kome islands on Lake Victoria. Four (4), six (6) and eight (8) of the twenty-five (25) sampled bays were identified as suitable as being suitable for big cages (10m maximum depth), medium cages (5m maximum depth) and small LVHD cages (2.5 - 3m maximum depth) respectively while seven (7) bays were considered unsuitable. The importance of each of the factors in the different selection criteria was considered.

Water for production the status of Valley dams for fish production in Swaz

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Water for production in Uganda became important before 1950s when over 50 valley dams were established in semi-arid areas most of which are within the cattle corridor. Though meant for domestic and livestock water, fish were also stocked being indicators for basic water quality. However, it has remained small in over 90% dams with potential for commercial fisheries unknown. To diversify fish culture systems to meet increasing demand, cage adoption was considered. The suitability of major valley dams and a few minor lakes in the zone were evaluated based on fish growth requirements specifically: (1) the physical-chemical water conditions; (2) the quantity and composition of plankton and macro-invertebrates as natural food to ascertain the basis of restocking programmes. It was found that reservoirs were threatened by siltation and over fertilization that made food webs unsuitable for aquatic life. Control of soil erosion and direct run off into the dams is the promising remedy to reduce further deterioration of these indispensable resources.

Growth Performance of Nile Tilapia (*Oreochromis niloticus L.*) Under Different Management Practices in Fertilized Earthen Ponds at Igare, Kisii County-Kenya.

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The impact of different feeding regimes and pond management practices on growth of *O. niloticus* were evaluated in earthen ponds at Igare, Kisii County. Ten ponds (30x10) m² were stocked at 3 fish/m² with sex reversed *O. niloticus*, averaging 2.0g. Five ponds were covered with predator control nets while 5 ponds were left uncovered. Fish were fed daily with formulated pellets (30% CP), at 3% body weight. Five ponds received 100% of the feed for the entire period and 5 ponds received 100% of feed in the first five months and the proportion reduced to 50% in the last two months of growth cycle. Fish were sampled bi-weekly to monitor growth and make feeding adjustments. At the same time water quality parameters were measured. The results obtained indicated the final lengths were significantly different (df=1; F=5.15; P =0.02) among the treatments. In addition, the final weights were significantly different (df=1; F=3.59; P=0.04) among the treatments. Highest percentage gain in length and weight was recorded in the ponds with net covers as compared to those without net. Mean daily length and weight gain, was significantly (P < 0.05) higher in covered ponds in comparison to uncovered ponds. Notably, Specific growth rate (SGR) of fish in covered ponds was significantly higher than fish stocked in uncovered ponds (P < 0.05). The food conversion ratio (FCR) was significantly higher in uncovered ponds compared to those covered (P<0.05). There were no significant differences (P> 0.05) in water quality parameters among treatments and therefore not a limiting factor for growth in the current study. Higher FCR in uncovered ponds could be as a result of feed competition and crowding with predators. Present results showed that properly managed ponds produced higher yield.

Growth performance and nutrient utilization of *Sarotherodon galilaeus* LINNAEUS, (1758) fingerlings fed various inclusion levels of activated Bamboo Charcoal

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The effect of different inclusion levels of bamboo charcoal powder (BCP) in fish diet on the growth, feed utilization, haematological and serum biochemical indices of *Sarotherodon galilaeus* fingerlings (mean weight, 11.48±0.04g) were investigated. The fish were separated into six experimental groups of 0% (control), 1%, 2%, 3%, 4% and 5% concentrations of BCP. Six iso-nitrogenous (35% CP) diets were formulated. A 12-week feeding trial was conducted. The diets were fed to triplicate groups of the experimental fish at 3% body weight twice daily in 40-litre glass aquaria kept outdoors. A stocking density of 10 fish per aquarium was adopted. Weight (g) and length (cm) of fish were taken on weekly basis; water temperature, pH, and dissolved oxygen concentrations were monitored daily. Results show that final fish weight was significantly (P>0.05) higher than the initial fish weight in all the different inclusion levels. Diets supplemented with BCP had significantly (p<0.05) higher weight gain ranging from 76.93-132.28g. The specific growth rates (SGR) for the fish fed BCP diets were significantly (p<0.05) higher and ranged from 2.43-3.02. The feed conversion ratio (FCR) of the fish fed BCP diets ranged from 1.50-1.68 and were significantly (p<0.05) lower than that of the control with 1.71. The results further revealed that fish fed diet with 3% BCP inclusion had significantly (p<0.05) better weight gain, SGR and FCR values when compared with fish fed other BCP diets. The haematological parameters investigated showed that the packed cell volume of fish fed test diets ranged from 22-36% and were significantly (p<0.05). The red blood cells (RBC) values of fish fed test diets ranged from 2.4-4.2mil/mm³ and were also significantly (p<0.05) lower than 6.60mil/mm³ for the control diet, although all the values are within the acceptable ranges. Diet with 3% inclusion of PCB is observed to be beneficial in the diet of *S. galilaeus* for aquacultural management

Analysis of Personnel Management of an Integrated fish Farm in Jimeta, Yola, Nigeria

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This work examined the personnel management involved in managing an integrated Fish Farm in Jimeta Yola with focus on the profitability of the firm based on the networking utilized by the management. Seventy (70) respondents comprising of staff and students on industrial training were randomly sampled and subjective questionnaires addressing likely Twelve questions in two sections to assess the quality of the networking, staff, facilities and operations of the firm were administered. Data were analyzed using simple percentages and economic indices to ascertain the profitability of each section. The findings reveal that 57% are males while 43% are females. 92.8% had formal education while 7.8% didn't. 65% of the staff had their training in agriculture and agricultural related courses. 71.4% of the respondents have their primary assignment on Fisheries and Fisheries related jobs (Hatchery, grow-out ponds, feedmill and fish processing), 5.1% focused on orchard development, 5.1% on security and while 21.4% are administrative and accounting personnel. The average input is ₦9.925Million, output is ₦35.11million while the annual net profit is ₦17.11. The most profitable unit is the hatchery followed by the grow-out ponds and the least by the orchard. All respondents agreed that the business is profitable and sustainable.

Haematological responses and Histopathology of *Heterobranchus longifilis* fed earthworm meal substituted diets

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Five experimental diets were isonitrogenous at 42.5% crude protein, isocaloric at calculated 1900kJ/100g with the same protein to gross energy ratio (P:GE) of 44.7mgprotein/kJ/100g animal proteins was used to replace fishmeal at various inclusion levels of 0% (control), 25%, 50%, 75% and 100%. The diets were coded Ewdm1 to Ewdm5 for dry earthworm meal diets. The fish were fed 5% body weight for twelve weeks in an indoor semi-flow through system and twelve weeks in out-door concrete tanks. At the end of the experiment, caudal fin of each of the live fish selected from each experimentl diet was cut using sharp surgical blade and blood was gently collected from the bled caudal peduncle using disposable heparinised sterile 10ml syringe and transported to the Medical Laboratory of Niger State General Hospital, New- Bussa, Nigeria. The data collected were treatment with ANOVA. The results of the experiment showed that highest Haematocrit, Hb, RBC, MCV, and WCT (Whole Clotting time) were from 100% earthworm meal compared to others but the control had highest MCH, Plasma volume and WBC. Plasma protein (30-42g/L), Blood glucose (2.10-1.60mmol/L) serum urea (2.30-1.80 µm/L). The highest visceral somatic index and gonadosomatic were from 100% earthworm meal diet. There was overlapping and degeneration (distortion) of the secondary lamella showing hypertrophy in fish fed 50% earthworm meal diet. From these results the substitution of fish meal by earthworm meal is possible to 50% inclusion without hampering the health status of the fish.

Aquaculture marine au Bénin : Perspectives de l'élevage de *Lutjanus agennes*, *Epinephelus aeneus* et *Mugil cephalus*.

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Des essais d'élevage de *Lutjanus agennes*, *Epinephelus aeneus* et *Mugil cephalus*) ont été réalisés pendant 12 mois. Une fertilisation naturelle des étangs et une complémentation alimentaire des sujets ont été utilisées. Les paramètres environnementaux (température, salinité de l'eau) et la croissance en poids et en longueur des poissons ont été mesurés. Les résultats montrent une croissance pondérale et en longueur significative chez les trois ($p < 0,05$) au cours de la période de l'essai. Ainsi, *E. aeneus* présente une masse corporelle variant entre $38,18 \pm 0,24$ g et $409,81 \pm 1,39$ g pour une longueur variant entre $10,48 \pm 0,01$ cm et $24,58 \pm 0,04$ cm. *L. agennes* présente une masse corporelle variant entre $35,16 \pm 0,57$ g et $452,12 \pm 2,03$ g et pour une longueur variant entre $10,01 \pm 0,02$ cm et $22,3 \pm 0,03$ cm. *M. cephalus* présente une masse corporelle variant entre $49,15 \pm 1,01$ g et $637,83 \pm 1,03$ g et pour une longueur variant entre $14,06 \pm 0,2$ cm et $28,32 \pm 0,32$ cm. Les trois espèces présentent donc de bonnes performances de croissance et peuvent être recommandées pour l'aquaculture béninoise.

Characteristics, constraints and perspectives of the fish farming in Burundi

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The fish farming was introduced in Burundi at about the 1950s. It is noticed that several fish ponds were abandoned and many others still unproductive and the fishing pressure on the Lake Tanganyika, the most important Lake in the sub-region still high. The objective of this study is to present the current state and perspectives of the fish farming for its real contribution to the socio-economic development. The results presented in this study are the compilation of the series of physico-chemical parameters measured fish ponds and inquiries led between 2010 and 2012 with the fish breeders in six provinces of the country (such as Bujumbura, Bubanza, Cibitoki, Muramvya, Rutana and Kirundo) which represent 30 % of the total surface areas of the country. The weak values of some physico-chemical parameters showed that the majority of ponds are badly maintained. For example, the dissolved oxygen values for the majority of ponds varied between 0.2 mg/l and 3.5 mg/l. The only widely brought up fish species is *Oreochromis niloticus*. The investigation results showed that the relinquishment rate of the fish farming varied between 40 and 67 % according to the provinces. Many constraints could explain this high relinquishment rate. There are no centers of fish farming breeding for various fish species. Another major constraint is that there is no center for production of complete foods with local products. Due to the lack training, the result of survey showed that the charge density in pond could reach about 4 kg of juveniles (with 10 g each) by 100 m², about that is the double of the recommended charge density. The majority (about 75 %) of the investigated fish breeders confirmed that they have never benefited any supervision regarding the fish farming. In spite of the diverse constraints, Burundi has a dense river system with favourable physico-chemical parameters and many appropriate morphological sites to the fish farming. We suggest to the Government and all development partners to invest in that sector for its real contribution in the food security and socio-economic development.

Drivers of small scale fish farming in Western Kenya.

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An assessment of factors affecting small scale fish farmers was conducted in Western Kenya. Structured questionnaires were administered to 135 households through direct interviews. The relationship between fish production and variables affecting it were modeled using a multiple linear regression in a statistical computing language and environment R 2.15.0. The results revealed that the level of pond management was the most significant ($p = 1.37e-07$) factor affecting fish production in the study area. Other significant factors of production include source of water for fish farms ($p = 0.0025$), access to road infrastructure ($p = 0.0039$), land ownership ($p = 0.041$) and occupation of fish farmers ($p = 0.03$). Therefore policy planning for aquaculture development should strongly consider these factors as an important aspect of fish farming.

Survival and growth of *Heterobranchus longifilis* (Valenciennes, 1840) larvae fed with Freshwater zooplankton

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The suitability of the freshwater zooplankton was investigated in one African catfish larvae, *Heterobranchus longifilis*, at the end of yolk sac resorption. This live food was compared to *Artemia nauplii*, another live food. With those two regimens, two lots of larvae were constituted with two replicates: H1 zoo: larvae of *H. longifilis* fed with freshwater zooplankton and H1 art: larvae of *H. longifilis* fed with *artemia*. After a 10 day-experiment, survival rates ranged from 78.5% to 81.5% were obtained in H1 zoo and H1 art, respectively. Final mean weight were 67 ± 0.001 and 89 ± 0.005 mg for H1 zoo and H1 art, respectively with Specific growth rate which respectively were 14.29 ± 0.22 and $17.2 \pm 0.5\%$ per day. Those results show that freshwater zooplankton proved suitable for first feeding of *H. longifilis* larvae and could constitute a valuable alternative for larval rearing.

Evaluation of soaked ripe plantain (*Musa paradisiaca*) peel meal as a replacement for maize in the diet of Nile tilapia, *Oreochromis niloticus* fingerlings

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A feeding trial was conducted to investigate the effect of soaked ripe plantain peel meal (SRPM) on and blood parameters of Nile tilapia, *Oreochromis niloticus* fingerlings. One hundred and fifty (150) fingerlings of Nile tilapia (1.61 ± 0.06 g) were stocked in plastic tanks in three replicates per treatment. Five iso-nitrogenous diets containing 35% crude protein in which corn meal was replaced by SRPM at 0% (SRPM 0), 25% (SRPM 25), 50% (SRP 50), 75% (SRPM 75) and 100% (SRPM 100) were

formulated, prepared and fed at 5% body weight per day for 56 days. There was no significant difference ($p>0.05$) in growth, nutrient utilization, survival and protein digestibility in all the treatments. The highest weight gain of $5.77\pm 0.70\text{g}$ in fish fed dirt SRP0 was not significantly different ($p>0.05$) from $4.46\pm 0.30\text{g}$ of fish fed diet SRP75. Also, feed conversion ratio (FCR) of $1.82\pm$ in fish fed diet SRP0 was not significantly different ($p>0.05$) from 1.95 ± 0.17 of fish fed diet SRP100. Furthermore, net protein utilization of $59.05\pm 5.29\%$ in fish fed diet SRP75 was not significantly different ($p>0.05$) from $51.92\pm 5.11\%$ of fish fed diet SRP0. Likewise, the pack cell volume of $28.67\pm 3.08\%$ was not significantly different ($p>0.05$) from $25.67\pm 0.58\%$ in fish fed diet SRP100. Therefore, it is evident from the results obtained from this trial that soaked ripe plantain, (*Musa paradisiaca*) meal can replace maize meal at 100% level without any negative effect in the growth, nutrient utilization, protein digestibility and blood profile the Nile tilapia, *Oreochromis niloticus* fingerlings

Preliminary Evaluation of Kwalkwalawa (Sokoto) and Bakolori (T/Mafara) Soils for Rice cum Fish Culture

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Kwalkwalawa is an area noted for extensive rice production as well as fishing activities, while T/Mafara is an area mainly for rice production. Soils of the two areas were collected and evaluated for potentialities of rice cum fish culture. Soil samples were collected from three sampling sites from 0 – 15 cm and 15 – 30 cm at each location in October 2004 and 2005. Analysis of soil samples in October 2004 indicated that at Kwalkwalawa the soil pH was 7.35 and 7.28 for 0 – 15 cm and 15 – 30 cm of the soil depth, and 6.75 and 6.67 for T/ Mafara respectively. During 2005 the pH at Kwalkwalawa was 6.75 and 7.18, while at T/ Mafara it was 5.63 and 5.14. Organic carbon at Kwalkwalawa during 2004 was 1.12 g/Kg and 0.81 g/Kg for 0 – 15 cm and 15 – 30 cm, at T/ Mafara it was 0.93 g/Kg and 0.11 g/Kg. During 2005 organic carbon at Kwalkwalawa was 0.45 g/Kg and 0.28 g/Kg and at T/ Mafara it was 0.38 g/Kg and 0.06 g/Kg. Total N at Kwalkwalawa during 2004 was 0.04 g/Kg and 0.03 g/Kg for 0 – 15 cm and 15 – 30 cm, at T/ Mafara it was 0.04 g/Kg and 0.04 g/Kg. During 2005 at Kwalkwalawa, total N was 0.04 g/Kg and 0.03 g/Kg and at T/ Mafara it was 0.05 g/Kg for both depths. Available P at Kwalkwalawa during 2004 was 1.93 mg/Kg and 2.03 mg/Kg for 0 – 15 cm and 15 – 30 cm, at T/ Mafara it was 1.59 mg/Kg and 1.63 mg/Kg. During 2005 available P was 5.82 mg/Kg and 6.13 mg/Kg for Kwalkwalawa and 1.67 mg/Kg and 1.91 mg/Kg for T/ Mafara. Analysis of clay content indicated that at Kwalkwalawa the clay content was 11 g/Kg for both depths during 2004 and 16.5 g/Kg during 2005, and the soil texture was classified as sandy loam during both seasons. At T/ Mafara during 2004 the clay content was 73 g/Kg and 93 g/Kg for 0 – 15 cm and 15 – 30 cm. During 2005 it was 84 g/Kg and 103 g/Kg. The soil was classified as loamy sand. Results indicated stability of clay content at Kwalkwalawa over two seasons, at T/ Mafara it differed, even though the soil texture was same for both seasons and depths. The results show that with some textural improvements rice cum fish culture project can be undertaken in the study areas.

The continental fishing in a deserted Environment: The Case of Mauritania

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Although Mauritania is a deserted country with an increasingly important rainfall deficit, continental and river fishing, has a relatively high potential, which can be highlighted. The good management of this resource will contribute to food security of rural communities practicing this activity on the one

hand and on the other hand, the fight against poverty suffered by these people while keeping them in their natural environment and thus limits the rural exodus to big cities. This activity provides a livelihood for hundreds of families; it is practiced seasonally with traditional tools made locally.

Based on estimates, the annual production could reach 2000 tons. The production generated from the dam of FOUM GLEITA in 2012, reached 260 tons of which 67% were sold, 21% consumed locally and 12% processed as (dry production). Only WILAYA (regions) in the south and south east of the country are home to water bodies with more or less important fish resources, we consider here the wilaya of TRARZA, GORGOL, ASSABA and GUIDIMAGHA. In the last three WILAYA, water bodies have identified a total area of 117000 ha with a permanent water volume of 113 million cubic meters and more than one billion in the rainy season. However, this potential remains largely under exploited except in rare places that are subject to scientific monitoring as to, the dam of FOUM GLEITA. In this communication, we present the main scientific results obtained in this site in terms of environmental, biological and socio economic monitoring.

Eco-morphological Features and Sex Distribution Pattern of Palaemonid Prawns In Ilaje Estuary, South-Western Nigeria.

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Species composition, length-weight relationships (LWR), condition factor (cf) and sex distribution pattern of prawns in Ilaje Estuary (southwest Nigeria) were investigated for 18 months. The study revealed that three prawn species (*Macrobrachium macrobrachion*, *Nematopalaemon hastatus* and *Palaemon maculatus*) are important to the benthic community in this estuary. A total of 891 shrimps were collected comprising of; *M. macrobrachion* (M, 68, 48 – 90mm; F 312, 32- 58mm); *P. maculatus* (M 88; 37-66mm; F 161, 35-56mm) and *N. hastatus* (M 89, 40 – 76mm; F 173, 40 – 57mm). LWR of *M. macrobrachion* showed isometric growth ($b = 3$), as female population reflected an allometric growth ($b < 3$). Male and female populations of *P. maculatus* exhibited positive and negative allometric growth pattern, with value of $b > 3$ for males, and $b < 3$ for females. Both sexes of *N. hastatus* maintained isometric growth ($b = 3$). William's equation showed that the condition factor(s) for the prawn species is sex dependent. Condition factor values were higher in *M. macrobrachion* and *P. maculatus* male than in females except in the case of *N. hastatus*. *M. macrobrachion* population showed significant difference ($P < 0.05$) in sex distribution pattern, as against the conventional ratio of 1male:2 female, while *N. hastatus* and *P. maculatus* showed no significant difference ($P > 0.05$). The study revealed that palaemonid prawns grow well in the estuary, thus the shrimp culture can be feasible and can be sustained.

Enfin un réseau de Recherche-développement sur les systèmes piscicoles extensifs familiaux en Afrique de l'Ouest et Centrale (Ré-SyPiEx) !

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⁵Coordonnateur National-Cameroun de Ré-SyPiEx (LabiHA/FASA-UDs)

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Le projet de Réseau intitulé : « **Réseau de Recherche-développement sur les systèmes piscicoles extensifs familiaux en Afrique de l'Ouest et Centrale (Ré-SyPiEx)** » est financé par le Ministère des Affaires Etrangères (MAE - France) à travers le Programme d'Appui à la Recherche en Réseau en Afrique (PARRAF) piloté par l'Agence Inter-établissement de Recherche Développement (AIRD). Il est un consortium au niveau régional ouest et centre africain réunissant des équipes de recherche du Bénin, du Cameroun et de la Côte d'Ivoire, en liaison avec des partenaires français, dans le domaine de la gestion durable des systèmes piscicoles extensifs. Il vise à renforcer et pérenniser les partenariats initiés depuis 2011 entre les différentes équipes impliquées. La pisciculture paysanne, qui est la thématique principale du réseau, correspond actuellement à un enjeu majeur pour la sécurité alimentaire et la lutte contre la pauvreté dans nos pays. Nécessitant peu de trésorerie, elle permet de valoriser les facteurs de production et les sous-produits agricoles, diminue les dépenses liées à l'alimentation, crée une activité génératrice de revenus et améliore l'équilibre de la ration alimentaire. Dans les campagnes, la place du poisson dans les achats quotidiens des ménagères témoigne d'un marché important de proximité sur lequel le poisson de ces piscicultures se compare très favorablement en prix et en qualité aux autres produits offerts, dont le poisson congelé importé. L'impact économique de ces systèmes de production utilisés dans le monde rural tend à être minimisé et insuffisamment pris en compte dans les programmes nationaux de développement, dont les moyens sont de manière prépondérante axés sur l'aquaculture entrepreneuriale. Sans pour autant remettre en question ces choix, un rééquilibrage argumenté semble indispensable. C'est ce qui justifie les objectifs du présent réseau dont les résultats apporteront certainement aux décideurs publics cet éclairage, montrant notamment que la dimension commerciale est aussi une composante des systèmes « traditionnels » souvent qualifiés d'extensifs. Ce projet officiellement démarré lancé en juillet 2013, durera trois (03) ans. Les équipes impliquées sont : l'URAEaq/FA-UP (Bénin), l'UR ESR/FA-UP (Bénin), le LHA/FSA-UAC (Bénin), l'ISH-UD (Cameroun), le LabIHA/FASA-Uds (Cameroun), le URBioNuAq-CRO (Côte d'Ivoire), l'UR SPGA-UPGC (Côte d'Ivoire), le REDAQ/ESA-UL (Togo), l'UMR Intrepid-CIRAD (France), et le Pôle Halieutique de Agrocampus Ouest de Rennes (France).

Intensification écologique des systèmes piscicoles extensifs familiaux en Afrique de l'Ouest et Centrale à partir d'une analyse des processus d'innovation endogène ; *Systèmes Piscicoles Extensifs (SyPiEx)*

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¹Faculté d'Agronomie, Université de Parakou (FA/UP-Bénin) ;

²ONG Aquaculture et Développement Durable (AquaDeD ONG-Bénin) ;

³Centre de Recherche Océanologique d'Abidjan (CRO-Côte d'Ivoire) ;

⁴Institut des Sciences Halieutiques de Yabassi (ISH-Cameroun) ;

⁵Centre International pour la Recherche Appliquée au Développement (CIRAD- France)

⁶Conseil Ouest et Centre Africain pour la Recherche et le Développement Agricoles, WECARD-Sénégal)

La pisciculture extensive se développe de façon très discrète avec pourtant des contributions particulièrement intéressantes au développement durable et à la sécurité alimentaire dans certains pays. C'est dans ce contexte que des institutions de recherche et de développement de l'Afrique de l'Ouest et Centrale se sont associées à des partenaires français pour élaborer le projet de recherche-développement intitulé : « *Intensification écologique des systèmes piscicoles extensifs familiaux en Afrique de l'Ouest et Centrale à partir d'une analyse des processus d'innovation endogène ; Systèmes Piscicoles Extensifs (SyPiEx)* ». Ce projet (N° 03/PA/05) est financé par le CORAF/WECARD suite à son appel à projet N° «CW/CGS/04/PCN/LFA /01/2010» sous le Programme *Elevage, Pêche et Aquaculture*. Il vise principalement à appuyer cette dynamique locale et régionale de développement de la pisciculture familiale en intégrant la logique des innovations récentes et de celles en cours d'élaboration, afin de participer à la levée des principales contraintes (notamment, faible performance des systèmes techniques et accès limité aux informations sensibles) pressenties à son évolution. Les résultats attendus sont relatifs à l'identification des innovations et contraintes piscicoles, la co-

construction des innovations techniques et organisationnelles, et au partage et la diffusion des connaissances acquises. Le réseau mobilisé regroupant des pisciculteurs et des chercheurs se chargera également de renforcer les capacités des différents acteurs, notamment à travers l'établissement de plateformes d'innovation multi-acteurs. Ce projet officiellement démarré depuis juillet 2012, durera trois (03) ans. Les institutions impliquées sont : l'ISH (Cameroun), la FA/UP (Bénin), le CRO (Côte d'Ivoire), et le CIRAD (France). Par ailleurs, des ONGs ou OP de chaque pays sont également associées au projet ; il s'agit de l'ONG SEAPB (Cameroun), ONG AquaDeD (Bénin), de l'APCI (Côte d'Ivoire), et de l'APDRA (France).

Tanganyika session
Oral presentations

Lake Tanganyika biodiversity, threats on it, and current management & conservation strategies

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1-University of Burundi

2-FAO Consultant, Lake Tanganyika Authority

Lake Tanganyika is a global hotspot of spectacular biodiversity, an invaluable source of freshwater, and provider of countless ecosystem services to more than 10 millions of people living in its basin. This biodiversity and resources are increasingly under threat from environmental changes caused by i) excessive fishing pressure both in the littoral and pelagic zones, ii) growing urban, industrial, agricultural and harbour pollution but also risk from mining activities, marine accidents and projects of petroleum exploration and production, iii) excessive rate of sedimentation in the lake caused by erosion on the watershed and due to poor agriculture practices, deforestation and unsustainable land use, iv) degradation of important habitats for biodiversity, mostly in sensitive coastal zones and protected area, v) plant and animal invasive species which reduce ecosystem productivity, biodiversity and natural resources, vi) climate change impacts, including increasing temperatures and changes in precipitations pattern. At least five of the above threats are linked with growing human populations in the lake watershed. To address these issues, the riparian countries have signed a Convention on the Sustainable Management of Lake Tanganyika coordinated by a permanent Lake Tanganyika Authority (LTA). They also agreed on a Strategic Action Program (SAP), which include a plan for the most urgent interventions. Some activities are currently being implemented in the four riparian countries within national policies and action plans, other at regionally funded projects, but there is still a lot to be done.

Shaping development through mechanical strain: the transcriptional basis of diet-induced phenotypic plasticity in a cichlid fish

H. M. Gunter, S. Fan, F. Xiong, P. Franchini, C. Fruciano & A. Meyer

Adaptive phenotypic plasticity, the ability of an organism to change its phenotype to match local environments, is increasingly recognized for its contribution to evolution. However, few empirical studies have explored the molecular basis of plastic traits. The East African cichlid fish *Astatoreochromis alluaudi* displays adaptive phenotypic plasticity in its pharyngeal jaw apparatus, a structure that is widely seen as an evolutionary key innovation that has contributed to the remarkable diversity of cichlid fishes. It has previously been shown that in response to different diets, the pharyngeal jaws change their size, shape and dentition: hard diets induce an adaptive robust molariform tooth phenotype with short jaws and strong internal bone structures, while soft diets induce a gracile papilliform tooth phenotype with elongated jaws and slender internal bone structures. To gain insight into the molecular underpinnings of these adaptations and enable future investigations of the role that phenotypic plasticity plays during the formation of adaptive radiations, the transcriptomes of the two divergent jaw phenotypes were examined. Our study identified a total of 187 genes whose expression differs in response to hard and soft diets, including immediate early genes, extracellular matrix genes and inflammatory factors. Transcriptome results are interpreted in light of expression of candidate genes—markers for tooth size and shape, bone cells and mechanically sensitive pathways. This study opens up new avenues of research at new levels of biological organization into the roles of phenotypic plasticity during speciation and radiation of cichlid fishes.

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Genetic and environmental bases of morphological asymmetry in the scale-eating cichlid fish, *Perissodus microlepis*

Axel Meyer and H. Je Lee

Left-right asymmetry, where morphological features of left or right individuals differ asymmetrically, has received particular attention from evolutionary biologists as it may represent an extreme case of adaptive phenotypic evolution. The scale-eating cichlid fish, *Perissodus microlepis*, from Lake Tanganyika are a well-known example of an asymmetrical mouth/head that is either left-bending or right-bending. However, whether this notable morphological laterality is determined by gene(s) and/or environment still remains unclear. With quantitative assessments of mouth asymmetry, we investigated its origin by estimating narrow-sense heritability (h^2_{34}) using midparent-offspring regression. The heritability estimates [field-estimate: $h^2 = 0.22; 0.06, P = 0.013$; laboratory-estimate: $h^2_{35} = 0.18; 0.05, P = 0.004$] suggest that although variation in laterality has a significant additive genetic component, it is strongly environmentally influenced. Family-level association analyses of putative microsatellite marker that was claimed to be linked to gene(s) for laterality revealed no association of this locus with laterality. Moreover, the observed phenotype frequencies in offspring from parents of different phenotype combinations were not consistent with a suggested single-locus two-allele model. These results reconcile the disputed mechanisms for this textbook case of mouth asymmetry in that not only genetic, but also environmental factors contribute to this remarkable case of morphological asymmetry.

Evolution of body shape in sympatric versus non-sympatric *Tropheus* populations of Lake Tanganyika

C. Sturmbauer¹, P. Mitteröcker², & M. Kerschbaumer¹

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² Department of Theoretical Biology, University of Vienna, Vienna, Austria

Allopatric speciation often yields ecologically equivalent sister species, so that their secondary admixis enforces competition. The rocky shores of Lake Tanganyika harbor more than 100 distinct populations of the cichlid genus *Tropheus*, but only some are sympatric. When alone *Tropheus* occupies a relatively broad depth zone, but in sympatry fish segregate by depth. To assess the effects of competition we studied the partial co-occurrence of *Tropheus moorii* “Kaiser” and “Kirschfleck” with *Tropheus polli* along a section of the central eastern shores of the lake. A previous study demonstrated via standardized breeding experiments that some observed differences between *Tropheus* “Kaiser” living alone and in sympatry to *T. polli* have a genetic basis despite large-scale phenotypic plasticity. Using geometric morphometrics and neutral genetic markers, we now investigated whether sympatric populations differ consistently in body shape from populations living alone and if the differences are adaptive. We found significant differences in mean shape between non-sympatric and sympatric populations, whereas all sympatric populations of both color morphs clustered together in shape space. Sympatric populations had a relatively smaller head, smaller eyes, and a more anterior insertion of the pectoral fin than non-sympatric populations. Genetically, however, non-sympatric and sympatric “Kaiser” populations clustered together to the exclusion of “Kirschfleck”. Genetic distances, but not morphological distances, were correlated with geographic distances. Within- and between-population covariance matrices for *T. moorii* populations deviated from proportionality. We conclude that natural selection acts on both phenotypic plasticity and heritable traits, and that both factors contribute to the observed shape differences. The consistency of the pattern in five populations suggests ecological character displacement.

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Allopatric speciation often yields ecologically equivalent sister species, so that their secondary admixis enforces competition. The rocky shores of Lake Tanganyika harbor more than 100 distinct populations of the cichlid genus *Tropheus*, but only some are sympatric. When alone *Tropheus* occupies a relatively broad depth zone, but in sympatry fish segregate by depth. To assess the effects of competition we studied the partial co-occurrence of *Tropheus moorii* “Kaiser” and “Kirschfleck” with *Tropheus polli* along a section of the central eastern shores of the lake. A previous study demonstrated via standardized breeding experiments that some observed differences between *Tropheus* “Kaiser” living alone and in sympatry to *T. polli* have a genetic basis despite large-scale phenotypic plasticity. Using geometric morphometrics and neutral genetic markers, we now investigated whether sympatric populations differ consistently in body shape from populations living alone and if the differences are adaptive. We found significant differences in mean shape between non-sympatric and sympatric populations, whereas all sympatric populations of both color morphs clustered together in shape space. Sympatric populations had a relatively smaller head, smaller eyes, and a more anterior insertion of the pectoral fin than non-sympatric populations. Genetically, however, non-sympatric and sympatric “Kaiser” populations clustered together to the exclusion of “Kirschfleck”. Genetic distances, but not morphological distances, were correlated with geographic distances. Within- and between-population covariance matrices for *T. moorii* populations deviated from proportionality. We conclude that natural selection acts on both phenotypic plasticity and heritable traits, and that both factors contribute to the observed shape differences. The consistency of the pattern in five populations suggests ecological character displacement.

The adaptive radiation of cichlid fishes in Lake Tanganyika

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More than one and a half centuries after the publication of Charles R. Darwin's *The Origin of Species*, the identification of the processes governing the emergence of novel species remains a fundamental question to biology. Why is it that some groups have diversified in a seemingly explosive manner, while other lineages have remained unvaried over millions of years? What are the external factors and environmental conditions that promote diversification? And what is the molecular basis of adaptation, evolutionary innovation and diversification? A key to these and related questions is the comparative study of exceptionally diverse yet relatively young species assemblages that have radiated in geographically well-defined areas, such as the Darwin's finches on the Galapagos archipelago, the Caribbean *Anoles* lizards or the cichlid fishes in the Great Lakes of East Africa. Lakes Tanganyika, Malawi, and Victoria are each teeming with a unique set of hundreds of endemic cichlid species, which are likely to have evolved in the last few millions to several thousands of years only. East Africa's cichlid species differ greatly in ecologically relevant, hence naturally selected, characters such as mouth morphology and body shape, but also in sexually selected traits such as coloration. Lake Tanganyika is the oldest of the Great Lakes and contains the ecologically, morphologically and behaviorally most complex species flock of cichlid fishes. Here, I review the current knowledge on the evolutionary history of the species flock and focus on the triggers of the adaptive radiation. I will also introduce a newly discovered phenomenon in the Tanganyikan cichlid radiation, convergent evolution within an adaptive radiation.

Patterns of hybridization in Lake Tanganyika's cichlid species flock

S. Koblmüller

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The assumption of a strictly bifurcating speciation process, which underlies most phylogenetic tree-building algorithms, is increasingly found to be violated in empirical studies. Incidental gene flow among species turns out to be relatively frequent in plants and, as more recently recognized, also in animals. The occurrence of hybridization can be triggered by several factors, including the environmental conditions under which reproductive isolation evolves, divergence time, mate recognition mechanisms, the extent of ecological segregation, and the duration and geographical scope of barrier breakdown. Recent studies have shown that hybridization has played a major role in the evolution of the species-rich East African lacustrine cichlid radiations. However not all cichlid lineages are equally impacted by (ancient) hybridization. Here, I review the current knowledge on large scale patterns of hybridization in Lake Tanganyika's cichlid species assemblage: i) hybridization appears to occur more frequently in substrate breeders than in mouth brooding lineages, ii) ecomorphological characteristics of cichlid tribes appear to be good predictors for the extent of (ancient) hybridization, and iii) outgroup choice might have a significant impact on tree-based inference of hybridization from multi-locus data.

Does morphological variation trouble species delineation? A revision of the Lake Tanganyika cichlid *Tropheus*

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The endemic Lake Tanganyika cichlid genus *Tropheus* Boulenger 1898 consists of highly stenotypic rock dwellers, whose limited capacity for dispersal gave rise to over a hundred colour morphs. This made *Tropheus* an important model for evolutionary research. Yet, the genus' taxonomy is confusing with most species being ill-defined and with many populations that cannot be unambiguously assigned to a valid species. As such, a revision of the genus is needed. Notwithstanding its high chromatic and genetic differentiation, the general morphology of *Tropheus* was, until recently, reported to have remained static. This hypothesis of morphological stasis was investigated in *Tropheus duboisi* Marlier 1959, an early diverged *Tropheus* that displays only minor intra-specific differences in colour pattern and is less stenotypic than its congeners. The results, however, revealed significant morphological differentiation between geographically isolated populations. This indicates that problems for a morphological revision of the genus not only result from the low degree of morphological differentiation between species, but also from the presence of intra-specific differentiation. One of the long-standing problems in *Tropheus* is the similarity between *T. annectens* Boulenger 1900 and *T. polli* Axelrod 1977, which are sometimes regarded as synonyms. Using museum specimens and recently collected material and a multidisciplinary approach, this problem could be resolved. Surprisingly, the morphological differences found between different populations of these two highly resembling species are mirrored by the differences encountered between populations of another, sympatric, *Tropheus* species. This finding suggests a strong environmental effect on morphology.

Molecular phylogenetics of the Claroteinae (Claroteidae: Siluriformes) and affinities of the Tanganyikan clarotein species flock

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Lake Tanganyika is known for the endemism of its fishes and species flocks of cichlids, *Lates*, mochokid catfishes and mastacembelid spiny eels. While the term “species flock” is sometimes applied to Tanganyika's clarotein catfishes, knowledge of how many lineages are represented and their extra-lacustrine affinities has been lacking. Tanganyikan claroteins include three genera endemic to the Lake—*Phyllonemus* (3 spp.), *Bathybagrus* (1 sp.) and *Lophiobagrus* (4 spp.)—as well as seven endemic species referred to *Chrysichthys*, a genus with more than 40 valid species widespread across Africa. We conducted a phylogenetic study of 58 specimens representing 42 clarotein species using nuclear (*rag2*) and mitochondrial (cytochrome *b*) DNA sequences. We included one species of *Phyllonemus*, two species of *Lophiobagrus*, *Bathybagrus tetranema*, and six of the seven Tanganyikan endemic species of *Chrysichthys* (all but *C. stappersii*) along with 24 nominal species of *Chrysichthys* from central, western and eastern Africa drainages as well as *Clarotes laticeps*, *Amarginops platus*, *Gephyroglanis congicus*, *Rheoglanis dendrophorus* and undescribed taxa from the Congo basin. We find that the three Tanganyikan genera—*Phyllonemus*, *Bathybagrus* & *Lophiobagrus*—belong to a monophyletic group that includes five of the six Tanganyikan *Chrysichthys* sampled (*C. grandis*, *C. graueri*, *C. platycephalus*, *C. sianenna*, and *C. acsiorum*). This clade is most closely related to *Clarotes laticeps*, a widespread species in East Africa, the Nile, and West Africa. However, *C. brachynema*, the only clarotein in Lake Tanganyika with a well developed postcleithral process, belongs to a large clade of Congo basin species. Using fossils and the inferred age of Lake Tanganyika as a temporal calibrations, we conducted a Bayesian relaxed clock analysis in the software BEAST to estimate the age of the impressive clarotein radiation in the Congo basin. We discuss implications of our results for future taxonomic revision of this important group of African catfishes.

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A first phylogenetic network hypothesis for the Lake Tanganyika cichlid species flocks

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The phylogenetic origin of the ancient endemic fauna of Lake Tanganyika has remained debated with respect to one of most diverse endemic groups, the cichlids (Perciformes: Cichlidae). Lakes, even the oldest ones, are ephemeral and molecular-clock based evidence supports the view that the origin of the African riverine cichlid fauna predates the geomorphological origin of Lake Tanganyika. Based on this logic we aimed to evaluate phylogenetic hypotheses for Lake Tanganyika cichlids. The approach took into account that (1) published molecular phylogenetic evidence has placed the majority of endemic Tanganyika cichlids within an extant African cichlid group referred to as “austrotilapiines”, i.e. members of the genera *Tilapia* s.str., *Congolopia*, *Chilochromis* and *Steatocranus*, (2) that published phylogenetic hypotheses have been unsatisfactory with regard to taxon sampling, and (3) that the number of genomic loci investigated has not yet allowed for the reconstruction of reticulate phylogenetic hypotheses. We based our assessment on a dataset with 3312 polymorphic AFLP loci and 1010 bp of mitochondrial (ND2) DNA. These loci were genotyped for a representative sample of East African cichlid riverine and lacustrine cichlids including members of all Tanganyika cichlid tribes (n=81), of all austrotilapiine genera (n=9), and of distant outgroups (n=3). Inferred from discrepancies of mtDNA and AFLP based hypotheses (alternative dichotomous tree hypotheses), from analyses of homoplasy excess potentially caused by ancient hybridization events, and from multivariate analyses of the AFLP data, we provide a novel reticulate phylogenetic network hypothesis that includes evidence that (1) riverine austrotilapiines have contributed to genomic diversity of “basal” Tanganyika lineages (Boulengerochromini, Bathybatini, Lamprologini), (2) Eretmodini share genetic components with Lamprologini, ancient mouthbrooding Lake Tanganyika tribes and rheophilic “*Orthochromis*”, and (3) that the “Out of Tanganyika hypothesis”, i.e. that “Lake Tanganyika is the geographic and genetic cradle of all haplochromine lineages” (Salzburger et al. 2005), is compromised.

Parasite speciation as an overlooked cause of species richness in ancient lakes: the case of monogenean cichlid parasites of Lake Tanganyika

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The enormous diversity of Lake Tanganyika with its cichlid and non-cichlid fish species flocks and its importance as cradle and reservoir of ancient fish lineages seeding other radiations, has resulted in a significant body of literature in the fields of biodiversity and evolution. The lake also contains several invertebrate taxa that underwent radiation *in situ*. Remarkably, virtually no research was carried out into the Tanganyika parasite fauna. Parasitism is the most common lifestyle on Earth in terms of species diversity, and it is established in speciation biology that parasites are prone to radiate. Hence, parasitic organisms seem a high-potential subject for speciation studies in ancient lakes. We introduce the diversity and speciation of monogenean flatworms infecting Tanganyika cichlids. Monogenea was chosen because of the species richness and host-specificity of its representatives. Their simple (one-host) life cycle ensures a tight association with the respective host species. Therefore, these parasites constitute prime “markers” for coevolutionary processes and host taxonomy and evolution. We set off focusing on the radiation of the endemic tropheine cichlid tribe. Combining molecular sequence data (nuclear ITS rDNA, mitochondrial *cox1*) and morphological identification (using hard parts of attachment and copulatory organs), we discovered high host-specificity in monogeneans belonging to *Cichlidogyrus* (Ancyrocephalidae) parasitizing tropheines. Co-speciation and within-host speciation caused this genus to surpass the species richness of its host radiation. Conversely, speciation in the monogenean *Gyrodactylus* (Gyrodactylidae), owing to its unique life history and colonization strategy,

is more influenced by host-switching. Investigating other host lineages demonstrated that monogeneans followed different speciation pathways in other cichlid tribes, e.g. lacking the host-specificity found for tropheine *Cichlidogyrus* parasites. We hypothesize that the relatively low mobility of rock-dwelling cichlids, and the particular host and parasite biology jointly mediate parasite biodiversity, a hitherto disregarded component of the famed species richness of the African Great Lakes. MPMV, AS, IP, MM and MG are funded by the Czech Science Foundation P505/12/G112 (ECIP), and SK and CS by the Austrian Science Fund (FWF). MPMV and MVS were PhD fellows, and TH a post-doctoral fellow, respectively, of the Research Foundation – Flanders (FWO-Vlaanderen). Fieldwork was supported by FWO-Vlaanderen and the King Leopold III Fund for Nature Exploration and Conservation.

***A new genus of Monogenea of the family Ancyrocephalidae, a gill parasite from the endemic *Lepidiolamprologus cunningtoni* (Teleostei, Cichlidae) of Lake Tanganyika.**

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Actually only three genera of Monogenea belonging to the family Ancyrocephalidae, are known to parasitize gills of African cichlids: *Cichlidogyrus* Paperna, 1960; *Onchobdella* Paperna, 1968 and *Scutogyrus* Pariselle & Euzet, 1995. We recently found on gills of *Lepidiolamprologus cunningtoni* (Boulenger, 1906), an endemic cichlid of Lake Tanganyika, an Ancyrocephalidae with peculiar characters represent with no doubt the morphology of a new genus. After description of numerous new species of parasite in this Lake, such as *Cichlidogyrus centesimus* Vanhove, Volckaert & Pariselle, 2011; *C. vandekerkhovei* Vanhove, Volckaert & Pariselle, 2011 or *C. nshomboi* Fidel Muterezi Bukinga, Vanhove, Van Steenberghe & Pariselle, 2012, which present, even though being ranged in to *Cichlidogyrus* genus already described elsewhere in Africa, extraordinary morphological specificities; this discovery demonstrate once more, the singularity of Lake Tanganyika comparing to other African Lakes of the East and to the West and the Central African Rivers.

Tanganyika session

Poster presentations

Back to Tanganyika – migration between “closed” systems

A. Indermaur

The cichlid species flocks of the East African Great Lakes are thought to each have evolved independently and to date no species is known to be shared between the different lake faunas (apart from the otherwise widely distributed *Coptodon rendalli*), thus leaving these systems to appear somewhat closed and limited in their genetic diversity. Genetic and morphological analysis of a haplochromine species (*Astatotilapia* cf. *stappersi*) recently recorded from the southernmost affluents of Lake Tanganyika suggests an origin from within the Lake Victoria/Kivu super flock. *Astatotilapia stappersi* (Poll, 1943) described from the Malagarasi in Tanzania, is indistinguishable from the present species suggesting an ancient spread of riverine species out of the Lake Victoria/Kivu drainage in to river and lake systems such as Lake Tanganyika and the Malagarasi and Rukwa systems. Several different migration scenarios are discussed with respect to geology and phylogenetic relations to other haplochromines of the region. I suggest a never before reported migration of cichlid species originating from one of the three large species flocks, to another. Such migrations might be very rare events facilitated by special environmental conditions only and might not be likely or even possible in other lake systems. Nevertheless, they could represent a novel mechanism for the input of new genetic diversity in ancient lake systems such as Lake Tanganyika.

Population parameters of some fish species of Lake Tanganyika in the north of coastal zone.

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Population parameters of main fish species from the coastal zone of the north of Lake Tanganyika were investigated using length-frequency samples from the artisanal fisheries and analysed with FiSAT (FAO ICLARM Stock Assessment Tool, www.fao.org/Fisat) Software. Extreme values estimated are $L_{\infty} = 37$ cm and $K = 0.37$ year⁻¹ for *Boulengerochromis microlepis* (Boulenger, 1899) and $L_{\infty} = 16.5$ cm and $K = 0.85$ year⁻¹ for *Xenotilapia sima* Boulenger, 1899. The growth parameters are comparable with same species for others localities available in Fishabase. Recruitment was noted bimodal for some species and unimodal for others. Preliminary estimates of mortalities and exploitation rates are also presented. Fishing mortality and exploitation rate ($E = F/Z$) were found to be high for some species such as *Boulengerochromis microlepis*, *Limnochromis auratus* and *Limnotilapia dardenni* with respectively $E = 0.8$; $E = 0.63$ and $E = 0.54$. Small fish species such as *Cardiopharynx shoultereri*, *Tremotacara variable* and *Xenotilapia sima* showed natural mortality values very high than the fishing mortality. This situation could be attributed to the fishing practices in the zone.

Fish biodiversity in the north of coastal zone of Lake Tanganyika (Uvira/R-D Congo and Bujumbura/Burundi): Evaluation of the anthropological pressures.

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In the aim to study the influence of human activities on spatial variation of fish biodiversity, fish sampling were collected between February and December 2011 on the coastal zone of the north of Lake Tanganyika from Uvira (RD-Congo) to Nyamugari (in the South of the Mayor of Bujumbura, the Capital of Burundi) in six stations (three by each coastal zone) where fish species are victims of both the strong fishing pressure and the negative effects of a high anthropological pressure (which is responsible for the general degradation of the limnological conditions of the Lake). These databases were analyzed using the method of ABC (Abundance Biomass Comparison) and gave rise to calculations of biodiversity Indexes (Diversity Index of Shannon, (H') (Shannon & Weaver, 1963) and Piérou Equitability (E) (Piérou, 1963)) which allow spatial and/or seasonal comparisons of the biodiversity. Results showed that the most disrupted sites, either Bujumbura Port (on the coast of Bujumbura Mayor) or Maendeleo (on the coast of Uvira town / RDC), presented the weakest values of Shannon Index, respectively $H'=2.31$ and $H'=2.14$. The highest values of the specific richness, H' , E, ABC and DAP, respectively 41; 3.1; 0.83; 6.3 and 6.8, were recorded in the least disrupted site (the site of Nyamugari situated on side Bujumbura) considered as witness because undergoing less influence of the polluting human activities with regard to two other previous sites. The close hillside is uninhabited and there is no stream throwing itself into the lake at that level.

Spatial variations of zooplanktonics and macro-invertebrates communities in the north of coastal zone of Lake Tanganyika (Uvira/R-D Congo and Bujumbura/Burundi): Evaluation of the anthropological pressures.

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In the aim to study the influence of human activities on spatial variation of zooplanktonics and macro-invertebrates communities, zooplanktonics and macro-invertebrates sampling were collected between February and December 2011 on the coastal zone of the north of Lake Tanganyika from Uvira (RD-Congo) to Nyamugari (in the South of the Mayor of Bujumbura, the Capital of Burundi) in six stations (with three stations by each coastal zone). The spatial distribution analysis of zooplankton showed that some taxa are exclusive in specific sites. It is in particular about Cladocera and Jellyfishes (Limnochnida tanganyicae) which were identified only in Bujumbura coastal zone, respectively in sites Bujumbura Port for Cladocera and in the Mouth of Ruzizi for Jellyfishes. On the other hand, some species such as *Tropodiptomus simplex* and the larvas nauplii of *Tropodiptomus simplex* were collected in all the sampled sites. Similar observations were done about macro-invertebrates spatial distribution. Some families were exclusive in specific sites. Those are such Hydrophilidae, Mesovelidae, Gomphidae and Capanidae exclusive in the Mouth of Rusizi River; Viviparidae around the Bujumbura Port and Cordulegasteridae around Maendeleo (Uvira). It was noticed that it is in both

sites less disrupted such as Kilomoni (Uvira) and Nyamugari (Bujumbura) where families' abundances seemed to be better distributed. In the mouth of Ruzizi and Kalimabenge Rivers, there were dominance of Shellfish: Caridea and Potamonidae represent about 99.7 % and 100 % of total abundance of Shellfish respectively in the mouths of Ruzizi and an Kalimabenge

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Contribution à l'étude du peuplement des poissons et macro-invertébrés des affluents du lac Tanganyika : Cas de l'embouchure de la rivière Dama

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Afin d'étudier l'impact des activités anthropiques sur les peuplements des poissons et des macro-invertébrés des rivières affluentes du Lac Tanganyika, une étude sur les peuplements des poissons et des macro-invertébrés a été menée à l'embouchure de la rivière Dama, une des rivières affluentes du Lac Tanganyika et recevant les effluents des unités de transformations de l'huile de palme et des pesticides utilisés pour pulvériser les champs. L'étude a été menée entre mars et mai 2012. Les poissons ont été pêchés à l'aide du filet maillant et les macro-invertébrés aquatiques ont été capturés à l'aide du filet troubleau. Les résultats de l'étude ont montré les valeurs de la physico-chimie des eaux sont voisines de celles du lac Tanganyika. Les valeurs de l'O₂ dissous (6,43 mg/l et 7,5 mg/l, celles du pH sont 8,08 et 8,8 et celles de la conductivité moyenne sont 615,83 µS/cm) et 636 µS/cm

respectivement dans l'embouchure de la rivière Dama et dans le Lac Tanganyika. L'ichtyofaune de la zone d'étude révèle une prédominance des poissons-cichlidés. En effet, sur un total de 35 espèces recensées, 27 espèces (soit 71,14%) appartiennent à la famille des cichlidés. Trois genres sont plus représentés. Il s'agit de *Trematocara* (31,44 %), *Triglachromis* (14,38 %) et *Limnochromis* (13,71 %). Parmi les macro-invertébrés, dix familles appartenant à trois embranchements (Annélides, Arthropodes et les Mollusques) ont été représentés. Il s'agit des *Glossiphoniidae*, *Lumbricidae*, *Aphelocheiridae*, *Nepidae*, *Libellulidae*, *Dreissenidae*, *Sphaeriidae*, *Lymnaeidae*, *Physidae* et *Potamonautidae*. Les Lumbricidae, avec 37 % de l'abondance numérique totale, sont les plus largement représentés suivis des gastéropodes représentés par *Physa sp* (17 %) et *Lymnaea sp* (9 %).

Appendix 1. Listes of Titles and contacts

Theme 1: Fish systematic, biodiversity research and data management

Theme 1 / Oral Presentations

A morphological revision of the <i>Brycinus macrolepidotus</i> (Valenciennes, 1850) group (Characiformes: Alestidae) reveals unexpected species diversity . <u>T. Koné</u> & E. Vreven	Ktidiani@yahoo.fr
Genetic variability of some Tilapia species from three different reservoirs in Southwestern Nigeria. <u>R.N Onyeabor</u> and O.A Bello-Olusoji	amy.onyeabor@gmail.com
Molecular phylogeny of the Distichodontidae (Ostariophysi: Characiformes) and the timing of citharinoid diversification: Implications for Characiform biogeography. <u>J. Arroyave</u> , J.S.S. Denton, M.L.J. Stiassny	jarroyave@amnh.org
Towards a checklist of the fishes of Kahuzi-Biega National Park and its surroundings, Eastern Congo River basin (DRC). <u>T. Kisekelwa</u> , J. Snoeks, M. Nshombo, M. Isumbisho & E. Vreven	kisengoja@yahoo.fr ; kissengoja@gmail.com
A geographic study of <i>Pollimyrus isidori</i> (Osteoglossiformes, Mormyridae). <u>K. F. Konan</u> , G. Boden, J. Snoeks	universite_jlog@yahoo.fr
<i>Steatocranus</i> : towards an integrative view on the systematics and taxonomy of a complex miniature species flock of rheophilic cichlids . <u>Ulrich Schliewen</u> , Julia Scharzer, Juliane Wedekind, Paul Alibert, Andreas Dunz, Emmanuel Vreven, Seraphin Ifuta	Schliewen@zsm.mwn.de
Generic and species-level diversity of Auchenoglanidinae (Siluriformes: Claroteidae). <u>T. Geerinckx</u> , A. Ibala Zamba, V. Mamonekene, M. Dierick, L. Van Hoorebeke, D. Adriaens, E. Vreven	tom.geerinckx@ugent.be
The geographic distributions of the paedomorphic freshwater clupeoids <i>Sierrathrissa leonensis</i> (Pellonulinae) and <i>Amazonsprattus scintilla</i> (Engraulinae): different continents, same strategy? <u>F. Di Dario</u> , M. R. Britto, M. C. C. de Pinna	didario@gmail.com
Phylogeny and adaptation in subterranean catfishes in South America, Africa and Asia: phylogenetic homologies and convergences in <i>Phreatobius</i> , <i>Uegitglanis</i> and <i>Horaglanis</i> (Siluriformes: Phreatobiidae and Clariidae). <u>Mario. C. C. de Pinna</u> & J. Muriel-Cunha, Seção de Peixes	pinna@ib.usp.br
Morphological, genetic and parasitological differentiations between four species of <i>Hemichromis</i> “five spots”: evidence on the existence of the new species from Central Africa. <u>A.R. Bitja Nyom</u> , A. Gilles, A. Pariselle, C.F. Bilong Bilong, J.F. Agnèse & J. Snoeks	bitja.nyom_arnold@ymail.com
Diversity, distribution and conservation status of freshwater fishes of Ethiopia: Revisited. <u>A. Getahun</u>	abebe12002@yahoo.com
First DNA Barcoding Assessment of Madagascan freshwater fishes. <u>Roger Daniel Randrianiaina</u> , Miguel Vences, Walter Salzburger	roda.randrianiaina@googlemail.com
Morphometric revision of <i>Barbus kerstenii</i> Peters, 1868. <u>C. S. Nyamweya</u> , M. Hanssens, J. Snoeks, W. O.Ojwang	sanychris@yahoo.com
Unexpected species richness in the African pike <i>Hepsetus odoe</i> (Bloch, 1794); (Characiformes: Hepsetidae) . E. Decru , E. Vreven, K. De Gelas, E. Verheyen & J.Snoeks	eva.decru@africamuseum.be
Distribution patterns of catfishes in the Congo River basin. <u>T. Musschoot</u> , G. Boden, E. Vreven and J. Snoeks	tobias.musschoot@africamuseum.be

<i>Xenocharax crassus</i> Pellegrin, 1900 (Characiformes: Distichodontidae) from the Congo River basin, central Africa: in need of revalidation. <u>Armel Ibala Zamba</u> , Victor Mamonekene, Emmanuel Vreven & Melanie L.J. Stiassny	armelzamba@yahoo.fr
Towards a better knowledge of ichthyofauna of the Shiloanggo basin, (Lower Guinea). <u>Wamuini Lunkayikakio Soleil</u> , Snoeks Jos & Vreven Emmanuel	wamuini_lunkay@yahoo.fr ; wamuini@alumni.ulg.ac.be
What to know about FishBase and how to use it. <u>G. Boden</u> , T. Musschoot, D. Geelhand and J. Snoeks	gert.boden@africamuseum.be
Two case studies on <i>Synodontis</i> Cuvier, 1816 (Siluriformes: Mochokidae) from the Congo Basin (DRC). <u>M.C. Danadu</u> , E. Vreven, T. Moelants, A.-P. Ulyel & J. Snoeks	danaducele@yahoo.fr;
Some osteological features of the anchovies <i>Encrasicholina heteroloba</i> and <i>Anchoviella lepidentostole</i> (Engraulidae) in relation to <i>Denticeps clupeoides</i> , the most basal clupeiform and sole Recent member of the Denticipitoidei. <u>M. V. Loeb</u> , F. Di Dario, M. C. C. de Pinna	loebmv@gmail.com
Towards a reevaluation of <i>Labeobarbus</i> and <i>Varicorhinus</i> (Cypriniformes: Cyprinidae) species diversity of the Epulu River in D.R.Congo. <u>A. Walanga</u> , E. Decru, J. Snoeks & E. Vreven	albertwalanga@yahoo.fr
FishBase and Fish Taxonomy training sessions at the Royal Museum for Central Africa . D. Geelhand, T. Musschoot, G. Boden & J. Snoeks	dimitri.geelhand@africamuseum.be
Extensive intergeneric hybridisation in the large cyprinids from the Inkisi River basin (Lower Congo, DRC): a unique case or a possible widespread pan-African phenomenon? <u>Emmanuel Vreven</u> , Soleil Wamuini Lunkayilakio, Tobias Musschoot, Kevin Obiero, Eva Decru, Jos Snoeks, Ulrich K. Schliewen	emmanuel.vreven@africamuseum.be
Multiple origins of <i>Varicorhinus</i> -like scraping feeders among the African hexaploid barbins inferred from mtDNA sequences: a search for the second true <i>Varicorhinus</i> . <u>B.A. Levin</u> , N.S. Mugue, and A.S. Golubtsov	borislyovin@mail.ru
<i>Brycinus leuciscus</i> (Günther, 1867) and <i>B. luteus</i> (Roman, 1966) (Characiformes: Alestiidae) in West Africa: similar species or synonyms? <u>Djiman Lederoun</u> , Jos Snoeks and Emmanuel Vreven	ldjiman@yahoo.fr; djiman.lederoun@student.ulg.ac.be
Georeferencing Fish Collections: a Community-Based Model to Georeferencing Natural History Collections. <u>N. Rios</u> & H.L. Bart	nrios@tulane.edu
Diversity and phylogeography of African suckermouth catfishes (<i>Chiloglanis</i> : Mochokidae) from Guinea, West Africa. <u>RC Schmidt</u> and HL Bart Jr.	rschmidt@tulane.edu
Headwater captures effect on phylogenetic freshwater fish structure. <u>P. P. U. Aquino</u> & G. R. Colli	pedropua@gmail.com
Upper Congo Fishes Project: ichthyological study and collection building at the University of Kisangani, Orientale, D.R. Congo. <u>J.P. Sullivan</u> , J.P. Frie, A. Kankonda Busanga, E. Tambwe Lukosha, J.-P. Thumitho Unencan, A. Bulimwengu Walanga	jpsullivan@cornell.edu
Molecular phylogenetic and phylogeographic evidence of unrecognized diversity within nominal species of <i>Labeobarbus</i> from Indian Ocean drainages and Endorheic Rivers of the Great Rift Valley of Kenya. <u>Gilbert Kosgei</u> , Wanja Dorothy Nyingi, Henry L. Bart Jr, Nathan Gichuki, Dorcas Sigana, Ray C. Schmidt, and Maya Patterson	2kipscham@gmail.com

Hyperdiverse freshwater ichthyofaunas in Africa and the Neotropics; overview and comparisons. <u>RP Vari</u>	VARIR@si.edu
Molecular phylogenetic evidence of unrecognized diversity within <i>Barbus kerstenii</i> and a broad zone of introgression with <i>Barbus neumayeri</i> in Kenya. <u>Henry L. Bart Jr</u> , Wanja Dorothy Nyingi, Nathan Gichuki, Dorcas Sigana, Ray C. Schmidt, David Lach	hbartjr@tulane.edu
Genetic Variability in Cultured and Wild Populations of <i>C. gariepinus</i> using Random Amplified Polymorphic DNA (RAPD) Marker. <u>O.M Popoola</u> , E. A Fasakin and J. I Awopetu	hestillguides@yahoo.com ; omoniyipopoola@gmail.com
The rise of the modern freshwater fish fauna of Africa. <u>Olga Otero</u> , Aurélie Pinton	olga.otero@univ-poitiers.fr
The riverine fishes of Burundi (East Central Africa). <u>G. Banyankimbona</u> , E. Vreven, G. Ntakimazi, J. Snoeks	gaspard.banyankimbona@ub.edu.bi;
Fish Divedrsity of trhe Bagoé River in Mali. <u>Y. Sanogo</u> , F. Samaké, A. Koné, D. Traoré	yfsanogo@yahoo.fr
Genetic and environmental bases of morphological asymmetry in the scale-eating cichlid fish, <i>Perissodus microlepis</i> ; <u>Axel Meyer</u> and Hyuk Je Lee	axel.meyer@uni-konstanz.de
Parsing parallel evolution: ecological divergence and differential gene expression in the adaptive radiations of thick-lipped Midas cichlid fishes from Nicaragua; T. Manousaki, P.M. Hull, H.Kusche, G.Machado-Schiaffino, P. Franchini, C. Harrod, K. R. Elmer & <u>A.Meyer</u>	axel.meyer@uni-konstanz.de
Homology of segments of the mandibular and hyoid arches within Gnathostomata: a first glance from the perspective of the comparative developmental anatomy; <u>Flávio A. Bockmann</u> , Murilo Carvalho & Marcelo R. de Carvalho	fabockmann@ffclrp.usp.br
A Preliminary Phylogenetic Studies of Populations of <i>Tilapia zillii</i> Gervais, <i>Oreochromis niloticus</i> Linn. and <i>Sarotherodon galilaeus</i> Linn. in Three Selected Reservoirs in Osun State, Nigeria; <u>*M.O. Popoola</u> and J.I. Awopetu	popoolam@oauife.edu.ng hestillguides@yahoo.com,
African ichthyology: lessons learned, challenges accepted. <u>Jos Snoeks</u> & Emmanuel Vreven	jos.snoeks@africamuseum.be
Identification and morphological characterization of African catfish (<i>Clarias sp.</i>) populations in Burkina Faso. I. Compaoré and <u>A. Toguyeni</u>	toguyenia@yahoo.fr
Fishes of the streams flowing from the Mulanje Massif, Malawi	D.Tweddle@saiab.ac.za

Theme 1 / Posters

Fish Biodiversity of the Kwilu River, under southern affluent of the river Kasai (ichthyogeographic province of Congo). <u>José Justin Mbimbi Mayi Munene</u>	jjmbimbi@yahoo.fr
Fish Diversity of the Mayi-Ndombe River (Congo River, DR Congo). <u>Tobit Liyandja</u>	tobitliyandja@yahoo.fr
Fishes of the Nsele river (Affluent of the Congo River, Pool Malebo, Ichthyogeographic region of the Congo). <u>Raoul J.C. Monsembula Iyaba</u> , <u>Tobit Liyandya</u> and <u>Melanie L.J. Stiassny</u>	raoulmonsembula@yahoo.fr
The ichthyofauna of the Upemba National Park (DR Congo): diversity, ecology, conservation and sustainable management. <u>B.M. Katemo</u> ; A.M. Chocha; J. Snoeks; E. Vreven	bauchetmanda@gmail.com

Phylogeographical patterns in the Congo Basin: understanding the Pan-African evolution of the catfish <i>Clarias gariepinus</i> (Burchell, 1822) . <u>Auguste Chocha Manda</u> , Maarten Vanhove, Maarten Larmuseau, Karine Van Doninck, Jean- Claude Micha, Filip A.M. Volckaert	augustemanda@hotmail.com
Morphometric and meristic variation between two endangered tilapiine fishes <i>O. esculentus</i> and <i>O. variabilis</i> and the exotic tilapias <i>O. niloticus</i> and <i>O. leucostictus</i> in Lake Kanyaboli, Kenya. <u>A. Arrumm</u> and K. M. Mavuti	aarrumm@uonbi.ac.ke
The <i>Petrocephalus catostoma</i> (Pisces, Osteoglossomorpha, Mormyridae) subspecies: clarifying the status. is it one species? <u>J. M. Njiru</u> , G. Boden, J. Snoeks	rmnjiru2002@yahoo.com; jamnji@gmail.com
Problématique de <i>Synodontis</i> (Siluriformes: Mochokidae) du bassin du Congo (DRC). <u>Danadu, M.C.</u> , Vreven, E., Ulyel, A-P, Snoeks, J.	danaducele@yahoo.fr;
Barcoding fish along the West African Coastline. <u>Reinold Hanel</u>	reinold.hanel@vti.bund.de ; reinold.hanel@ti.bund.de
The Marine Mangrove Park (DR Congo, Bas-Congo): towards a better knowledge of a largely neglected ichthyofauna. <u>Paul N’Lemvo Budiongo</u> , Soleil Wamuini Lunkayilakio, Jos Snoeks & Emmanuel Vreven	pnlemvo@yahoo.fr; pnlemvo@gmail.com
<i>Clarias/Clariallabes</i> sp. « kundelungu" (Siluriformes: Clariidae), a new species from the Kundelungu National Park (DR Congo)? <u>K.M. Kasongo Ilunga</u> , E. Abwe, A. Chocha Manda, T. Musschoot, J. Snoeks & E. Vreven	micheline.kasongo@yahoo.com; michelinekasongo.k@gmail.com
Molecular phylogenetics of the Claroteinae (Claroteidae: Siluriformes) and affinities of the Tanganyikan clarotein species flock. <u>J.P. Sullivan</u> , J.P. Friel, M. Hardman, R.J.C. Monsembula Iyaba and M.L.J. Stiassny	jpsullivan@cornell.edu; john.friel@cornell.edu;
A Preliminary Phylogeny of West African ‘Barbus’ (Cyprinidae). <u>M.M. Hayes</u> and J.W. Armbruster	malorie.hayes@auburn.edu
Comparative phylogeography of annual Nothobranchius fishes from southern Mozambique. <u>V Bartáková</u> , J Bryja, M. Polačik, R. Blažek, M. Reichard	324243@mail.muni.cz
A re-evaluation of species diversity within the Labeo (Cypriniformes: Cyprinidae) with papillary lips from the Congo basin. L. Gajdzik, <u>M. Van Steenberge</u> , A. Chilala, J. Snoeks & E. Vreven	Maarten.VanSteenberge@bio.kuleuven.be
Towards a revision of the large-sized <i>Distichodus</i> Müller & Troschel, 1844 (Characiformes: Distichodontidae) species from the Congo basin. <u>T. Moelants</u> , V. Mbadu Zebe, J. Snoeks and E. Vreven	tuur.moelants@africamuseum.be
Upper Congo Fishes Project: ichthyological study and collection building at the University of Kisangani, Orientale, D.R. Congo. <u>J.P. Sullivan</u> , J.P. Friel, A. Kankonda Busanga, E. Tambwe Lukosha, J.-P. Thumitho Unencan, A. Bulimwengu Walanga	jpsullivan@cornell.edu; john.friel@cornell.edu;
Africhthy.org: a virtual research environment and web portal for African fishes. <u>J. P. Friel</u> and J. P. Sullivan	john.friel@cornell.edu; jpsullivan@cornell.edu
Aquatic biodiversity in Kenya: Discoveries from the 2010-2012 International Research Experiences for Students (IRES) expeditions. <u>N. Gichuki</u> , W. D. Nyingi, M. Ogada D. Sigana, H. L. Bart Jr., G. Talarchek, S. Abade, J. Abong’o, R. Anderson, A. Ewing, J. Gathua, G. Kosgei , D. Lach, L. Losili, A. Lydiah, L. Mathews, C. Mburu, N. Moses, T. Ndiwa, P. Nganga, M. Odhiambo, W. Owako, M. Oyier, M. Patterson, R. C. Schmidt, L. Spivey, H. Strobbel, P. Tanui, T. Woods	nathangichuki@gmail.com

An update overview of freshwater and brackish fish diversity in Gabon. <u>Y. Fermon</u> , J.-D. Mbega, J-H. M. Beh, J-F-F Liwouwou	tropi91@mac.com;
A field survey on Lake Albert in DRC in 2007; Y. Fermon, P. Alema	tropi91@mac.com
The statement on fisheries and diversity in the Congolese northern part of Lake Tanganyika in 2007; Y. Fermon, M. Nshombo	tropi91@mac.com
The biodiversity of fishes in the part of the St John and St Paul rivers in Liberia. <u>Y. Fermon</u> , C. Gsegner	tropi91@mac.com
Characteristics, constraints and perspectives of the fish farming in Burundi. <u>C. Niyonkuru</u> & G. Ntakimazi	cniyon@yahoo.fr
Population parameters of some fish species of Lake Tanganyika in the north of coastal zone. <u>C. Niyonkuru</u> , P. Isumbisho & J. Moreau	cniyon@yahoo.fr;
The genus <i>Pollimyrus</i> in the Nile system: a species plus, a species minus. <u>B.A. Levin</u> , A.S. Golubtsov, A.A. Orlov, N.S. Mugue, and V.D. Baron	borislyovin@mail.ru
Hypertrophied lips in species of <i>Crenicichla</i> (Cichlidae: Cichlinae: Geophagini) from the Rio Iguaçú, upper Paraná basin, Brazil: convergence with big-lipped cichlids from Central America and Africa; <u>H.R. Varella</u>	hrvarella@hotmail.com

Theme 2: Biology, ecology and behavior

Theme 2 / Oral Presentations

Reproductive activities of two clupeid zooplanktivores in relation to the seasonal abundance of copepod prey in the northern end of Lake Tanganyika; <u>Mulimbwa</u>	ltfmp_drc_uv@yahoo.fr
Secondary sexual characters of the small alestids <i>Micralestes acutidens</i> (Peters) and <i>Rhabdalestes septentrionalis</i> Boulenger: a comparative anatomy, with comments on these characters in American characids; <u>T. F. Teixeira</u> , A. M. Zanata and C. R. Moreira	fratute@hotmail.com
Extraordinary life history in African annual fishes; <u>Radim Blazek</u> Matěj Polačik, Martin Reichard	demon@sci.muni.cz
Evolutionary ecology of annual <i>Nothobranchius</i> fishes: the model taxon for ageing studies; <u>Martin Reichard</u> , Matej Polačik, Radim Blazek, Alessandro Cellerino, Milan Vrtilék	Reichard@ivb.cz
Spatial and temporal patterns in Nile perch populations in southern Lake Victoria with possible indications of a recruitment peak; I.J.M. Cornelissen, P.A.M. van Zwieten, H. Peter, <u>L.A.J. Nagelkerke</u>	leo.nagelkerke@wur.nl
Fish assemblage and resource partitioning in self-stocked ponds in lower Rufiji floodplain, Tanzania; <u>H.A. Lamtane</u> , Y.D. Mgaya and R.G. Bailey	hlamtan@suanet.ac.tz; hlamtan@yahoo.co.uk
Nile perch is an opportunistic feeder with a greater taste for fish than for shrimp; I.J.M. Cornelissen, P.A.M. van Zwieten, H. Peter, <u>L.A.J. Nagelkerke</u>	leo.nagelkerke@wur.nl
Some osteological features of the anchovies <i>Encrasicholina heteroloba</i> and <i>Anchoviella lepidentostole</i> (Engraulidae) in relation to <i>Denticiceps clupeoides</i> , the most basal clupeiform and sole Recent member of the Denticipitoidei; <u>M. V. Loeb</u> , F. Di Dario, M. C. C. de Pinna	loebmv@gmail.com
The parasite, <i>Henneguya ghaffari</i> (Myxozoa: Myxosporidia), infecting the Nile perch <i>Lates niloticus</i> in Lake Victoria Kenya; <u>Ogwai, C.O.</u> , Aloo, P. A, Lester, R.J.G., Oyugi, D.O., Oyoo, E, and Semo, C.	ogwaic@yahoo.ca

Comparative study of the effect of the diet ration on the oxygen consumption of juvenile cichlid fish <i>Oreochromis niloticus</i> , <i>Sarotherodon melanotheron</i> and <i>Tilapia guineensis</i> reared in concrete tanks; <u>A. Chikou</u> , H. Agadjihouèdé, L. C. Hinvi, N. L. Y. Amoussou, S. M. Fagnon & P. Lalèyè.	chikoua@yahoo.fr
Revisiting Roberts (1972): an updated view of the fish fauna of the Congo and Amazon rivers, with a discussion of the Madeira River ichthyofauna; <u>J. Zuanon</u> , G. Torrente Vilara, W. M. Ohara	jzuanon3@gmail.com
Ecologie alimentaire de <i>Schilbe multitaeniatus</i> (Pellegrin, 1913) (Siluriforme, Schilbeidae) de la rivière Rembo Bongo au Gabon (Afrique Centrale); <u>J.F Liwouwou</u> , S. Ahouansou Montcho, D. Adandédjan, A. Chikou, J.D Mbega, P. Lalèyè.	jean_feli@yahoo.fr
Biologie de reproduction de <i>Schilbe multitaeniatus</i> (Siluriforme, Schilbeidae) de la rivière Rembo Bongo au Gabon; <u>J.F Liwouwou</u> , S. Ahouansou Montcho, A. Chikou, J.D Mbega, P. Lalèyè	jean_feli@yahoo.fr
Local variation in functional morphology of the feeding system of two haplochromines cichlids from Lake Kivu (Rwanda): <i>Haplochromis kamiranzovu</i> Snoeks 1984 and <i>H. insidiae</i> Snoeks 1994 (Teleostei: Cichlidae). <u>Philippe Munyandamutsa</u> , Tim tkint and Dominique Adriaens	sanziraphilippe@yahoo.fr
Novel nasal anatomy suggests enhanced olfactory acuity in a subfamily of African catfishes: oddly lost in large male <i>Parauchenoglanis</i> cf. <i>balayi</i> ; <u>M.L.J. Stiassny</u> and V. Mamonekene	mljs@amnh.org
Morphological differentiation of <i>Oreochromis niloticus</i> (Linnaeus, 1958) populations found in extreme conditions of temperature and alkalinity in Kenya; <u>T. C. Ndiwa</u> , D. Nyingi, J. Agnese, P. Alibert	ndiwatitus@yahoo.com
Diet composition and food selectivity of edible oyster <i>Crassostrea gasar</i> in Lake Nokoue, Benin (West Africa); <u>D. G. Akele</u> , H. Agadjihouede, U.A. Gougbedji, G. Mensah and P. Laleye	akeldav@yahoo.fr
A new genus of Monogenea of the family Ancyrocephalidae, a gill parasite from the endemic <i>Lepidiolamprologus cunningtoni</i> (Teleostei, Cichlidae) of Lake Tanganyika. <u>Fidel Muterezi Bukinga</u> , Maarten P.M. Vanhove, Antoine Pariselle	fidelmuterezi@yahoo.fr
Microbial assessment of selected smoked fishes in Akokoland, Ondo State, Nigeria; <u>Adeyemo M. Adewole</u> , Adebayo. S. Balogun and Modupe. O. Monebi	adewoleyemo68@yahoo.com
Size-specific dietary habits, trophic level and foraging preference of the reticulate knife fish, <i>Papyrocranus afer</i> , (Gunther, 1868) from a tropical lagoon in south western Nigeria; F.V. Oluwale and <u>A.A.A. Ugwumba</u>	adiaha4me@yahoo.co.nz
Impacts des coccidioses digestives sur les performances zootechniques des poissons-chats : cas de <i>Clarias gariepinus</i> Burchell, 1822; M. N. Assogba, N. G. Sakiti ; I. Imorou Toko ; E. J. E. Siko.	sikojoel@gmail.com
Habitat use and downstream migration of 0+ juveniles of the migratory riverine spawning <i>Labeobarbus</i> species (Cypriniformes: Cyprinidae) of Lake Tana (Ethiopia); <u>W. Anteneh</u> , A. Getahun, E. Dejen & E. Vreven	wassie74@gmail.com
Ecological niche modeling of the invasive potential of Nile tilapia <i>Oreochromis niloticus</i> in African river systems: concerns and implications for the conservation of indigenous congeners; <u>T. A. Zengeya</u> , M. P. Robertson , A. J. Booth, C. T. Chimimba	tzengeya@csir.co.za
Comparative study of helminth parasites of <i>Chrysichthys nigrodigitatus</i> and <i>Bagrus filamentosus</i> from lower River Benué. <u>R.A. Obande</u> , S. Omeji and O.S. Oholi	obanderose@yahoo.com

Shaping development through mechanical strain: the transcriptional basis of diet-induced phenotypic plasticity in a cichlid fish; H. M. Gunter, S. Fan, F. Xiong, P. Franchini, C. Fruciano & <u>A. Meyer</u>	axel.meyer@uni-konstanz.de
Parasite speciation as an overlooked cause of species richness in ancient lakes: the case of monogenean cichlid parasites of Lake Tanganyika; <u>M.P.M. Vanhove</u> , A. Šimková, A. Pariselle, M. Van Steenberge, I. Příkrylová, M. Mendlová, M. Gelnar, S. Koblmüller, C. Sturmbauer, F.A.M. Volckaert, J. Snoeks & T. Huysse	Maarten.Vanhove@bio.kuleuven.be
Diverse world of African gyrodactylid parasites (Monogenea: Gyrodactylidae) under molecular and morphological magnifying glass; <u>I. Příkrylova</u> , M. P. M. Vanhove, M. Barson, M. Gelnar	ivaprik@sci.muni.cz

Theme 2 / Posters

Plankton communities of Ikpa River, South East Nigeria, exposed to sand dredging activities; <u>Ekwu, A.O.</u> , and Udo, N.D.	ekwualice@yahoo.com
Habitudes alimentaires de <i>Bryconaethiops boulengeri</i> dans le cours inférieur de la rivière Djiri (affluent de la rive droite du fleuve Congo); <u>Mikia M.</u> , I. Mady-Goma Dirat, A. Tsoumou & J. Vouidibio	mmmikia@yahoo.fr
Histological description of cyclic changes in the gonads of <i>Bagrus docmak</i> , Forsskal 1775, (Pisces: Bagridae); <u>Aruho Cassius</u> , Rose Basiita, David Kahwa, Gladys Bwanika and Justus Rutaisire	caruho@yahoo.com; aruhoc@gmail.com
Canals and pores of the cephalic laterosensory system of Characiformes (Ostariophysi): anatomy and its phylogenetic information. <u>M. N. L. Pastana</u>	murilopastana@gmail.com
Evaluation de l'exploitation des ressources halieutiques des lacs peu profonds du Bénin au moyens d'indicateurs biologiques : cas des lacs Azili et Hlan. <u>E. Montchowui</u> , H. Agadjihouédé, R. Yaovi, C.A. Bonou & P. Lalèyè	e.montchowui@yahoo.fr

Theme 3: Aquatic conservation and management

Theme 3 / Oral Presentations

Toxicity of sub-lethal concentrations of Monocrotophos (MCP) on the haematological, biochemical and growth responses of hybrid catfish, <i>Heteroclaris</i> and contaminated <i>Heteroclaris</i> -fed rats were investigated. <u>S. I. Abdulkareem</u> and O. D. Owolabi	iyabodesaratu@yahoo.com
Coastal Resource Management through Enhanced Stewardship: A Nested and Integrated Approach. R. Chuenpagdee, D. Sikawa, <u>J. Kazembe</u> , C. Nyasa, B. Chilora, M. Chirwa, M. Pippy, C. Walsh, T. Cole, D. Kassam, E. Chirwa and W. Jere	jkazembe@yahoo.co.uk
The Great Lakes in East Africa – a novel biological conservation strategy for species flocks. <u>C. Sturmbauer</u>	christian.sturmbauer@uni-graz.at
Nile perch and the transformation of Lake Victoria: fifty years on. <u>A. Taabu-Munyaho</u> and B. Marshall	ataabum@yahoo.com taabu@firi.go.ug
Ecological quality assessment of the Porto-Novo Lagoon through the biodiversity of macroinvertebrates. <u>D. Adandedjan</u> , S. Ahouansou Montcho, A. Chikou, P. Laleye, G. Gourene	adandedjandelph@yahoo.fr,
The role of multi-disciplinary aquatic research in enhancing conservation and co-management of aquatic ecosystems in East Africa. <u>Wanja Dorothy Nyingi</u> , Stephanie Duvail, Olivier Hammerlynck, Quentin Luke, Nathan Gichuki, Judith Nyunja, Mordecai Ogada,	dorothyningi@yahoo.com

Indigenous species paradigm for African aquaculture development: Prospects of African lungfish. <u>J. Walakira</u> , J. Molnar, J. Terhune, R. Phelp, N. Isyagi and J. Curtis	johnwalakira2003@yahoo.co.uk
Impacts of human activities on fish communities in Lake Nokoué and Porto-Novo Lagoon, Benin. <u>Philippe A. Laleye</u>	laleyeph@yahoo.fr
Studies on the toxicity of dispersed PAHs petrogenic origin on <i>Oreochromis niloticus</i> (Linnaeus, 1757). <u>Sikoki, F.D.</u> and Lelei, K.E.	sikokifrancis@yahoo.com
Ichthyological diversity of Tai National Park and conservation status of aquatic ecosystems. <u>M. Bamba</u> , E. P. Koumelan, O. Grell, J. Schwahn & H. Thiessen	bambamamadouz@yahoo.fr
Nile perch and the transformation of Lake Victoria: fifty years on. <u>A. Taabu-Munyaho</u> and B. Marshall	ataabum@yahoo.com / taabu@firi.go.ug
The effects of riparian land use on water quality and fish species composition in the headwater streams of Tana, Athi and Ewaso Ngiro rivers within central Kenya. <u>D. O. Sigana</u> , N. N. Gichuki, H. Bart and D. Nyingi	dsigana@uonbi.ac.ke
Effects of climate change and fishing practices on fish yield of Lake Kivu. <u>D. Akonkwa</u> , M. Nshombo, B. Muhigwa, P. Laleye	akonkwabalagizi@yahoo.fr
Assessing conservation priorities for endemic species with narrow distributions: the case of two imperilled South African fishes. <u>BR Ellender</u> , OLF Weyl, LAJ Nagelkerke, ER Swartz	bru.ellender@gmail.com
Macroinvertebrate Assemblages as Indicators of Water Quality and Ecological Integrity of Laikipia Rivers, Kenya. Ngodhe O. S, Nyingi D. W and Gichuki N	mcomaristev26@yahoo.com
Temporal trends in life history traits of Nile perch <i>Lates niloticus</i> in Lake Victoria, Uganda. <u>W.N. Nkalubo</u> , L.J. Chapman, J.S. Balirwa	wnkalubo@yahoo.co.uk
Rehabilitation of a Freshwater Ecosystem Priority River in South Africa using a piscicide to kill alien smallmouth bass. N.D. Impson, <u>O.L.F. Weyl</u> and D.J. Woodford	dimpson@capenature.co.za, o.weyl@saiab.ac.za
Variations spatio-temporelles des macroinvertébrés du lac Nokoué. Pierre Gnohossou, Magali Gerino, et Jacques Moreau, Philippe Lalèyè	gnonhossou@yahoo.com
The role of beach management units on fish catch in the Nyando river wetland, Lake Victoria Basin. M. Wayumba, S. Mwakubo, P.O. Raburu, S.A. Adede	praburu2002@yahoo.com praburu2002@yahoo.com
Assessing ecological impacts and socio-economic benefits of alien fish introductions: a case study of the Amatola trout?. <u>O.L.F. Weyl</u> , L.A.J. Nagelkerke, B. Ellender, J. Kinghorn, J. Snowball, P. Britz, C. Evans, J. Gambiza, K. McHugh, N. Smit	o.weyl@saiab.ac.za
Conservation and sustainable use of the riverine fishes of Burundi: challenges and opportunities. <u>G.Banyankimbona</u> , E. Vreven, G. Ntakimazi, J. Snoeks	gaspard.banyankimbona@ub.edu.bi
The fish fauna of the Kundelungu National Park (DR Congo): diversity, ecology, conservation and sustainable management; <u>E. Abwe</u> , A.M.Chocha, K.M. Kasongoilunga, J. Snoeks & E. Vreven	emmanuelabwe@gmail.com

Theme 3 / Posters

Ichthyofauna diversity and reproductives strategies studies of <i>Clarias buettikofferi</i> (Pisces, Clariidae) in the Tanoé-Ehy forest (Côte d'Ivoire); <u>Konan Yao Aristide</u> , Koné Tidiani & Bamba Mamadou	ariskoya@yahoo.fr
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The culture of catfish in Nigeria has resulted in increased aquaculture production of more than 100% over the past 10 years. <u>S.A. Nwafili</u> and N. A. Jamabo	nwafili4@gmail.com
The effects of riparian land use on water quality and fish species composition in the headwater streams of Tana, Athi and Ewaso ngiro rivers within central Kenya. <u>D. O. Sigana</u> , N. N. Gichuki, H. Bart and, D. Nyingi	dsigana@uonbi.ac.ke nathangichuki@gmail.com
The effects of subsidies on the level of fish production in the coastal area of Ondo State were investigated in this study. <u>Adetuyi, O.O.</u> , A.O Oladapo. J.M Aremu	odunayoadetuyi@yahoo.com
The impact of dredging on water quality and fisheries of Igbedi Creek, upper Nun River, Niger Delta was investigated from June 2009 to May 2011. Seiyaboh, E.I. and <u>Sikoki, F.D.</u>	psttimi2003@yahoo.com; Sikokifrancis@yahoo.com
Climate Change implications on the ecology and fishery communities of the Lake Chad Basin, Africa. <u>Solomon Ovie</u>	soloovie@yahoo.com
Biodiversity of fishes in some major rivers traversing the cross River National park, Nigeria. <u>C. B. Ndome</u> , G. S. Olorunpomi, and A. P. Ekanem.	cmdome@yahoo.com
Assessment of Heavy Metal concentration in <i>Parachanna obscura</i> and <i>Hepsetus odoe</i> from an abandoned Gold Mine reservoir, Igun, Nigeria using ICP-OES. O.A Lawal and <u>O.O Komolafe</u>	rocksept01@yahoo.com komolafe@oauife.edu.ng
Assessment of extinction risks on a sub-continental level: lessons from Brazil. <u>F. Di Dario</u> , M. M. Mincarone, R. J. Subirá, E. C. F. Souza, C. E. Guidorizzi, M. P. Almeida, D. S. Martins, R. A. dos Santos, C. N. M. Polaz	didario@gmail.com

Theme 4: Fish and food security in the 21-st century in Africa

Theme 4 : Oral Presentations

Suitability for cage culture in A case of Northern Lake Victoria, Uganda. Africa's inland water bodies: <u>M. Nkambo</u> , D. Mbabazi, M. Aanyu, J.S Balirwa and R. Tumwebaze	mnkambo@yahoo.co.uk
Spatial and temporal patterns in Nile perch populations in southern Lake Victoria with possible indications of a recruitment peak. I.J.M. Cornelissen, P.A.M. van Zwieten, H. Peter, <u>L.A.J. Nagelkerke</u>	leo.nagelkerke@wur.nl
Impact of Agro-Industrial Activities on Water quality and Ichthyofauna in the Lower Reaches of Nyando and Sondu Miriu Rivers, Kenya. <u>Raburu P.O.</u> , Anyango J.O., Nyamwaya C. and Achieng A.O.	praburu2002@yahoo.com
Determination of the specific inter-selectivity of fishing gears using Kohonen SOM; <u>S. Ahouansou Montcho</u> , D. Adandedjan, A. Chikou, P. Laleye.	s.ahouansou@yahoo.fr,
Fisheries of the Lower Rufiji floodplain lakes, Tanzania: the influence of connectivity on catch composition and the potential impacts of Stiegler's Gorge dam. <u>O. Hamerlynck</u> , D.W. Nyingi, S. Duvail, L.Vandepitte, K. Kindinda, J. Snoeks	olivier.hamerlynck@gmail.com
Lake Kariba revisited: an update on fish community developments from 1960 to 2012. J. Kolding, N. Songore, <u>L.A.J. Nagelkerke</u> , N. Ndhlovu, P.A.M van Zwieten	leo.nagelkerke@wur.nl
Promotion of consumer acceptance and marketability of catfish to enhance the productivity and profitability of aquaculture in Uganda.	owori_aw@yahoo.co.uk

Owori-Wadunde, A; V. Namulawa; G. Atukunda	
Dynamics of fish stocks and fisheries in Lake Nabugabo, East Africa. <u>D. Mbabazi</u> , E. Nyboer, C. Morgan, M. Luk, H. Nakiyende, A. Byekwaso, E. Muhumuza, I. Vaccaro,, J.S. Balirwa and L.J. Chapman	mbabazidismas@yahoo.com
Modeling and forward projections of Nile perch, Lates niloticus, stock in Lake Victoria using gadget framework. <u>C. S. Nyamweya</u> , G. Thordarson, A. T. Munyaho, J. M. Njiru	sanychris@yahoo.com
Studies on Value Added Products from Rastrineobola argentea (Omena) for Food Security and Improved Livelihoods among Women Processors in Homabay County, Kenya. <u>Aloo,P.A</u> , Jumbe JJ, MungutiJ and Mokuu M	alooopenina@yahoo.com
Trends in aquaculture production in Nigeria: implications for food security.. <u>E. F Adebayo</u> and S.O Anyanwu	eadebayo86@gmail.com;
La rizipisciculture au Mali : Pratiques et perspectives d'avenir de l'innovation piscicole. <u>T. Niaré</u> , M. Kalossi	tiemaniare@sfr.fr
Light attraction optimum in the sardine fishery from Lake Kariba.;P C Chifamba	pcchifamba@science.uz.ac.zw
Small scale fishery dynamics along infringed Mpologoma River wetland Uganda; <u>G.A. Ssanyu</u> , J. Kipkemboi , J.M. Mathooko and J. Balirwa	ssangrace@mail.com
Macroinvertebrate Assemblages as Indicators of Water Quality and Ecological Integrity of Laikipia Rivers, Kenya; <u>Ngodhe O. S</u> , Nyingi D. W and Gichuki N	mcomaristev26@yahoo.com
Activity rhythms in piscicultural pond of Heterobranchus longifilis Valenciennes, 1840; <u>S. M. Fagnon</u> , A. Chikou, H. Agadjihouede and P. Lalèyè	simeonfagnon@yahoo.fr,
Effect of ecological factors and harvesting activity on spatial distribution of freshwater oyster Etheria elliptica in Pendjari River, Porga, Benin (West Africa). <u>D. G. Akele</u> , <u>A. Chikou</u> and P. Laleye.	chikou@yahoo.fr
The nutrient contentt of traditionnal sun-dried Nile Fish in Sudan; <u>Elagba H. A. Mohamed</u> and Jamal N. AL-Sabahi	elagba2000@yahoo.com
Fish and Fisheries of Bangweulu Wetlands, Zambia; <u>CF Huchzermeyer</u> , OLF Weyl, R. Bills, J. Kolding	c.huchzermeyer@gmail.com
Networking for Co-Management of Zambezi-Okavango Fisheries; <u>D. Tweddle</u> & C.J. Hay	D.Tweddle@saiab.ac.za
Environmental and Nutritional Manipulation for Year- Round Spawning of the African catfish, Clarias gariepinus; <u>Sikoki, F.D.</u> and Ibim A. T	francis.sikoki@uniport.edu.ng
Aquaculture in Central Africa. Progress, Potential, Pitfalls and Problems with special reference to man-made Hydropower lakes; <u>ALR Piers</u>	tilapia@zambia.co.zm
The threatened freshwater fishes of Nigeria; <u>B.D. Olaosebikan</u> and T. Musschoot	badolax@yahoo.com
Nutrient utilisation and growth responses of catfish hybrid (Heterobranchus bidorsalis S X Clarias gariepinus) fed dietary levels of Ipomea batatas leaf meal. Anyanwu, D.C., Udedibie, A.B.I. and Osuigwe, D.I	ahamefula-dan@yahoo.com

Environmental considerations for selection of suitable cage aquaculture sites in Africa's inland water bodies; <i>Lake Victoria a case study</i> . <u>M. Nkambo</u> , D. Mbabazi, A. Margaret and J.S Balirwa; and R. Tumwebaze	mnkambo@yahoo.co.uk
Growth Performance of Nile Tilapia (<i>Oreochromis niloticus</i> L.) Under Different Management Practices in Fertilized Earthen Ponds at Igare, Kisii County-Kenya. <u>J.K. Okechi</u> , S. Musa, E. Kembenya, S. Machera and H. Charo-Karisa	jokechi_1263@yahoo.co.uk
Growth performance and nutrient utilization of <i>Sarotherodon galilaeus</i> L. (1758) Fingerlings fed various levels of activated bamboo charcoal. <u>Y.Akegbejo-Samsons</u> , O Y Alli and W O Abdul	samsons56@yahoo.co.uk
Analysis of Personnel Management of an Integrated fish Farm in Jimeta, Yola, Nigeria. <u>Sogbesan, O.A.</u> , Ekundayo, T.M., Matta, Z. and Abolude, D, Adewole M.A.	sokayfish@gmail.com
Haematological responses and Histopathology of <i>Heterobranchus longifilis</i> fed earthworm meal substituted diets. <u>Sogbesan, O.A.</u> , and <u>Ugwumba,A.A.A.</u>	sokayfish@gmail.com
Aquaculture marine au Bénin : Perspectives de l'élevage de <i>Lutjanusagennes</i> , <i>Epinephelus aeneus</i> et <i>Mugil cephalus</i> . <u>Lambert Cloud Hinv</u> , Antoine Chikou, Zacharie Sohoun, Philippe, Laleye	coprapp@yahoo.fr
Drivers of small scale fish farming in Western Kenya. <u>R. Kundu</u> , M. Njiru, M. Muchiri, C. S. Nyamweya, C. A. Etiegni	rodkundu@yahoo.com
Survival and growth of <i>Heterobranchus longifilis</i> (Valenciennes, 1840) larvae fed with Freshwater zooplankton. <u>Hyppolite Agadjihouede</u> , Antoine Chikou, Clément Agossou Bonou, & Philippe Laleye	agadjihouede@gmail.com
Evaluation of soaked ripe plantain (<i>Musa paradisiaca</i>) peel meal as a replacement for maize in the diet of Nile tilapia, <i>Oreochromis niloticus</i> fingerlings; <u>S. O. Obasa</u> , F. O. A. George., A. A. Idowu, A. A. Akinkunmi, O. O. Akinwehinmi and O. E. Babalola	samoluobasa@yahoo.com
Preliminary Evaluation of Kwalkwalawa (Sokoto) and Bakolori (T/Mafara) Soils for Rice cum Fish Culture; By <u>A. B. Misau</u> , L. Abubakar and L.A Argungu	abubakarbabamisau@yahoo.com
The continental fishing in a deserted Environment: The Case of Mauritania <u>Meilouid Ould Ehmed Salem</u>	meilou54@yahoo.fr
Eco-morphological Features and Sex Distribution Pattern of Palaemonid Prawns In Ilaje Estuary, South-Western Nigeria; Abiodun Eniade and <u>Oluayo Bello-Olusoji</u>	olusojioluayo@yahoo.com
Water for production : The status of valley dams for fish production in the South Western Argo-ecological zone; Howard Kasigwa	kasigwane12012@gmail.com

Tanganyika session

Tanganyika session / Oral presentations

Evolution of body shape in sympatric versus non-sympatric <i>Tropheus</i> populations of Lake Tanganyika; <u>C. Sturmbauer</u> , P. Mitteröcker, & M. Kerschbaumer	christian.sturmbauer@uni-graz.at
Does morphological variation trouble species delineation? A revision of the Lake Tanganyika cichlid <i>Tropheus</i> ; <u>M. Van Steenberge</u> , M.P.M. Vanhove, L. Maerten & J. Snoeks	Maarten.VanSteenberge@bio.kuleuven.be

Molecular phylogenetics of the Claroteinae (Claroteidae: Siluriformes) and affinities of the Tanganyikan clarotein species flock; <u>J.P. Sullivan</u> , J.P. Friel, M. Hardman, R.J.C. Monsembula Iyaba and M.L.J. Stiassny	js151@cornell.edu; john.friel@cornell.edu
The adaptive radiation of cichlid fishes in Lake Tanganyika; <u>W. Salzburger</u>	walter.salzburger@unibas.ch
Patterns of hybridization in Lake Tanganyika's cichlid species flock; <u>S. Koblmüller</u>	stephan.koblmueLLer@uni-graz.at
A first phylogenetic network hypothesis for the Lake Tanganyika cichlid species flocks; <u>J. Wedekind</u> , U. Schliewen	jwedekind@gmail.com; Schliewen@zsm.mwn.de
Genetic and environmental bases of morphological asymmetry in the scale-eating cichlid fish, <i>Perissodus microlepis</i> ; <u>Axel Meyer</u> and Hyuk Je Lee	axel.meyer@uni-konstanz.de

Tanganyika session / Posters

Back to Tanganyika – migration between “closed” systems. <u>Indermaur</u>	a.indermaur@unibas.ch
Molecular phylogenetics of the Claroteinae (Claroteidae: Siluriformes) and affinities of the Tanganyikan clarotein species flock. <u>J.P. Sullivan</u> , J.P. Friel, M. Hardman, R.J.C. Monsembula Iyaba and M.L.J. Stiassny	jpsullivan@cornell.edu; john.friel@cornell.edu
Fish biodiversity in the north of coastal zone of Lake Tanganyika (Uvira/R-D Congo and Bujumbura/Burundi): Evaluation of the anthropological pressures. <u>C. Niyonkuru</u> , J. M. Nkezabahizi, P. Isumbisho, J. Moreau	cniyon@yahoo.fr; isumbisho@yahoo. Jacques.Moreau@ensat.fr
Spatial variations of zooplanktonics and macro-invertebrates communities in the north of coastal zone of Lake Tanganyika (Uvira/R-D Congo and Bujumbura/Burundi): Evaluation of the anthropological pressures. B. Hyangya Lwikitcha ¹ , P.Isumbisho ¹ , <u>C. Niyonkuru</u> ² & J. Moreau ³	cniyon@yahoo.fr; isumbisho@yahoo. Jacques.Moreau@ensat.fr
Population parameters of some fish species of Lake Tanganyika in the north of coastal zone. <u>C. Niyonkuru</u> ¹ , P. Isumbisho ² & J. Moreau ³	cniyon@yahoo.fr; isumbisho@yahoo. Jacques.Moreau@ensat.fr
Molecular phylogenetics of the Claroteinae (Claroteidae: Siluriformes) and affinities of the Tanganyikan clarotein species flock. J.P. Sullivan ¹ , J.P. Friel ¹ , M. Hardman ² , R.J.C. Monsembula Iyaba ^{3,4} and M.L.J. Stiassny ⁴	jpsullivan@cornell.edu
Contribution à l'étude du peuplement des poissons et macro-invertébrés des affluents du lac Tanganyika : Cas de l'embouchure de la rivière Dama. <u>E. Nibona</u> ¹ , G. Ntakimazi ² , J.-C.Micha ³ .	gaspard.ntakimazi@ub.edu.bi