



SETAC Africa

10th Biennial Conference

20–22 September 2021 | virtual meeting

Stakeholder inclusion for climate change
and environmental sustainability

ABSTRACT BOOK

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2021

Society of Environmental Toxicology and Chemistry

ABSTRACT BOOK

SETAC AFRICA 10th BIENNIAL CONFERENCE

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This book compiles the abstracts from the platform and poster session presentations at the SETAC Africa 10th Biennial Conference conducted as a virtual conference from 20-22 September 2021. The abstracts are reproduced as submitted by the author and accepted by the Scientific Committee. They appear in order of abstract code and alphabetical order per presentation type. The presenting author of each abstract is underlined.

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Platform Abstracts

Adaptations in climate change for environmental sustainability (general)

1.01.01

Bioanalytical Tools to Determine Water Quality: The Answer South Africa Has Been Waiting for or Not?

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Water is an important resource and water of good quality is even more so. South Africa's Water Service Act (1997) and National Water Act (1998) are the sources for the regulations to monitor the water quality in the country. The South African National Standard (SANS) 241's guideline for drinking water was updated in 2015 but the environmental water quality guidelines have not been updated since its publication in 1996. The guidelines list a limited number of compounds known to have harmful effects to humans and wildlife and none of the emerging chemicals of concern have been added to this list. Due to mismanagement of funding and ageing infrastructure that is not maintained, water quality had been steadily declining in South Africa. As in many other developing countries, water quality is monitored using chemical analysis only. This approach provides the concentrations of the targeted compounds without giving information about their biological effects, let alone the synergistic effect of every compound in the aquatic environment on the biota. One possible solution to address these shortcomings is to apply *in vivo* and *in vitro* biological analyses. These can provide information on the cumulative effects of all compounds on the exposed organisms rather than to quantify a limited number of compounds within the sample. A wide variety of bioassays making use of test organisms representative of aquatic life have been established. Additionally, *in vivo* and *in vitro* bio-assays determining effects on different end-points such as endocrine activity, reproduction and photosynthesis are being used globally. Compared to chemical analysis, these assays are more cost-effective and easier to execute. The bioanalytical tools can be applied in tiers of increasing complexity (from cell assays to whole organisms) to screen water for suitability in its different uses: domestic, agricultural and industrial, to name a few. The challenge is to extrapolate the information obtained from the various bioassays to potential human and environmental health risks in a particular water source or system. Literature surveys showed that South Africa is using *Daphnia*, algae, fish, and some cell-based assays in research laboratories to study water quality, but none of the government water monitoring laboratories use assays as an important screen. This is because the current guidelines are limited to concentrations of a handful of compounds. This research aims to provide evidence for the effective application of bioassays in combination with chemical analysis to provide more useful information regarding the quality of the water.

1.01.02

Genetic Diversity of *Saccorhiza Polyschides* Along the Northwestern Atlantic Coast of Morocco

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Global climate conditions are known to strongly influence the genetic structure and evolutionary traits of many macroalgal species. Expansion and contraction of their distribution ranges over the time were found to be affected by the past climates and especially the Last Glacial Maximum, as they both contributed to shaping modern patterns of population genetic structure and diversity. *Saccorhiza polyschides* is one of the main kelp species known for its large distribution range from western Norway southward to Morocco where the main spots of the species are associated with upwelling. The ecology as well as the genetic structure of this species along the Atlantic coast of Morocco are still scant despite the importance of such a spatial scale, being the southernmost distribution range edge of the species. This study aims to explore patterns of connectivity and differentiation of *S. polyschides* along the Atlantic coast of Morocco using 8 microsatellite loci and hierarchical sampling in the 3 main spots of its southernmost populations. The obtained results revealed two main clusters showing genetically differentiated populations of *S. polyschides* with clear population boundaries, all with significant private alleles. Higher allelic diversity was found in the northern localities, but the southernmost population was the most differentiated, pinpointing its evolutionary and conservation importance. The southernmost population was also found to be the most isolated, leading to the conclusion that gene flow occurred preferentially among adjacent populations. Overall, this study improved the understanding of *S. polyschides* genetic diversity and structure in its southernmost distribution range edge. Findings revealed the southernmost population to be the most vulnerable

and isolated. Conservation plans should be applied to maintain the sustainability and genetic diversity of *S. polyschides* within the impact of global changes.

1.01.03

Multi-Biomarker Evaluation in Various Life Stages of *Clarias gariepinus* Exposed to Raw and Simulated Leachate From Solous Dumpsite in Lagos Nigeria

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Abstract Leachates are natural consequent of solid waste landfilling and dumpsites due to the decomposition of organic fractions of the waste. Leachates are known to contain many hazardous substances, some of which may threaten the environment, animals and human. In this study, we evaluated the behavioural responses and toxicity of raw and simulated municipal solid waste leachate from Solous Landfill in Lagos State on various life stages of *Clarias gariepinus* using different biomarkers. Behavioural responses, Genotoxic and histological indices in *Clarias gariepinus* exposed to sublethal concentrations of raw and simulated were evaluated for 28 days using a static-renewal bioassay procedure. Also, embryological studies were carried out to determine the hatching success, heart rate and abnormalities. pH, Chloride, Nitrate, Heavy metals (Pb, Mn, Zn, Cr) in the raw and simulated leachate were not within the National Environmental Standards and Regulations Enforcement Agency (NESREA) limits. The raw leachate was about 12x more toxic than the simulated leachate in *Clarias gariepinus* with a 96 hLC₅₀ of 0.23 ml/L and 3.04 ml/L respectively. The exposed fishes exhibited changes in swimming, opercular movement, body pigmentation, surfacing and air gulping on exposure to the toxicants. Mortality rate increased significantly at p< 0.05 as the concentration of the toxicant increased as well as the exposure period. Genotoxic and histological indices in fishes exposed to sublethal concentrations of the leachate as well as embryotoxicity studies are ongoing. On the basis of the preliminary results, we recommend that haphazard release of leachate should be prevented and measures put in place by the government to mitigate the harmful impacts of leachate in the environment by adopting efficient waste management strategies with leachate treatment plans. Also, leachate should be pre-treated on-site to remove all contaminants so as to meet required standards of discharge to wastewater treatment plants and safe release into environment. This will aid realization of the United Nation Sustainable Development Goal 6 (clean water and sanitation), 14 (life below water) and 15 (life on land). **Keywords:** Leachate, Aquatic ecosystems, Aquatic organisms, SDGs, Landfill

1.01.04

Prospects on Power Sector Transition to Renewable Energy in Cameroon

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Cameroon is facing rapid population growth in addition to high levels of economic growth. Simultaneously, the rising risk of global climate change threatens to cause a decline in food production, increase droughts and fires; and shatter development and poverty reduction efforts. Even though greenhouse gas emission levels in Cameroon are still small, it is still imperative that she joins global efforts to address climate change, including systematic strategies to avoid significant increase in emissions. Due to the anticipated increase in population, greenhouse emissions in the country are expected to grow rapidly through increased fossil fuel usage and power grid expansion. The electricity sector has prospects of utilizing the rich renewable energy potentials present in the country to replace some thermal power plants used to offset peak loads. The study suggests pathways in which the government could adopt to achieve a more sustainable power transition which provides realistic solutions for emission reduction, escaping high carbon pathways. The study recommended several opportunities which government could exploit in the electricity sector to sail across the challenging trade-offs needed in becoming a sustainable economy in a carbon-constrained world.

Global approaches for the bioremediation of petroleum hydrocarbon-impacted sites: green and nature-based solutions

1.02.01

Integrating Locally Formulated Agro-Wastes in Ecofriendly Microbial Remediation of Crude Oil-Impacted Soils

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Sustainable remediation involves the application of nature-based solution for eco-restoration of polluted soil. In this study, crude oil-polluted soils from two different communities in Rivers State, Nigeria were subjected to various treatment options for microbial remediation. Indigenous microbial populations were simulated with locally valorized agricultural wastes (agro-wastes) from spent husks of pulses and chemical fertilizer (liquid NPK 15:15:15) in a 90-day remediation treatment. Composite soil samples were collected from the sites using soil auger while baseline physicochemical parameters and microbial community counts were determined pre-, during and post- remediation period using standard methods. Initial total petroleum hydrocarbons (TPH) concentration decreased from 15,000mg/kg which is higher than the Department of Petroleum Resources (DPR) 5000mg/kg intervention value to the average of 13991mg/kg in the bioattenuation (natural attenuation) treatment, 1676mg/kg in NPK-amended soil and 882mg/kg in agro-waste-amended soil. The trend was similar in site B with initial TPH concentration of 19,327mg/kg, 14,047mg/kg in NPK treatment, 9376mg/kg in bioattenuation cell and 2083mg/kg residual extractable TPH in the agro-waste amendment at the endpoint. Microbial diversity and dynamics pre-treatment were higher when compared with trends during and post-treatment with the agro-waste amendment supporting microbial proliferation more than in NPK treatment. *Micrococcus*, *Pseudomonas*, *Bacillus*, and *Sphingobacterium* accounted for predominant oleophilic degraders identified during the active phases of crude oil degradation. The study demonstrated that the valorized agro-wastes are excellent nature-based stimulants for efficient microbial removal of crude oil from soil.

1.02.02 Elevational Gradient Effect on Microbial Distribution in a Crude Oil-Polluted Field

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Crude oil is a major environmental pollutant in the Niger Delta region of Nigeria owing to heightened operations of the petroleum industry in this location. This comparative study of 2 different petroleum hydrocarbon-polluted soils from Bodo and Tombia communities in Rivers State was carried out to determine microbial diversity and spread in relation to depth and soil texture of the polluted sites. Soil samples were collected at two different depths 15cm and 30cm from each site. Baseline physicochemical parameters and microbial counts were determined using standard methods. Hydrocarbon utilizing bacteria obtained were screened with 2,6-dichlorophenol indophenol (DCPIP) for crude oil degradation efficiency. The average total petroleum hydrocarbons (TPH) in each site were 18000mg/kg in the top soil and 12000mg/kg in the subsoil collected from Bodo community which is a sandy soil whereas the silt/clay polluted soil from Tombia had an average of 15,000mg/kg and 8,000mg/kg of TPH in the top and sub soils respectively. These values are higher than the intervention value of 5000mg/kg of soil as stipulated by the Department of Petroleum Resources (DPR) in the Environmental Guidelines and Standards for the Petroleum Industry in Nigeria (EGASPIN). Microbial distribution pattern was significantly different ($p=0.05$) between the top and subsoils in the sites investigated. Average viable culturable heterotrophic and hydrocarbon utilizing microbial counts for the two sites also varied considerably between 10^5 and 10^6 colony forming units per gram of soil (cfu/g) at both depths studied. A consortium of *Pseudomonas* sp., *Proteus* sp., *Sphingobacterium* sp. and *Bacillus* sp. isolated from the sites efficiently degraded crude oil by showing a 100% decolorization of DCPIP in Bushnell-Haas-crude oil broth. This study demonstrated that soil texture and depth affect microbial diversity and their function in crude oil-contaminated sites.

1.02.03 Microbial Consortium for the Degradation of Polycyclic Aromatic Hydrocarbons (PAHs) From Petroleum Hydrocarbon-Polluted Sites

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This study investigated the distribution of polycyclic aromatic hydrocarbons (PAHs) degraders in two different petroleum hydrocarbons-polluted sites in Niger Delta, Nigeria, and the ability of the reconstituted indigenous consortium to utilize PAHs. Physicochemical parameters of the soil samples including PAH concentrations, pH, and conductivity were determined for the spill sites. Microbial isolation was done using selective enrichment with naphthalene and anthracene while biosurfactant production was determined using the emulsification index method. PAH concentrations of approximately 6000mg/kg and 9000mg/kg in Tombia and Bodo were higher than the Department of Petroleum Resources (DPR), intervention limit of 40mg/kg. The pH, soil texture and high conductivity affected microbial distribution considerably. A total of 12 bacteria from the genera

Bacillus, *Pseudomonas*, *Micrococcus* and 3 fungal isolates (*Fusarium*, *Aspergillus* and *Penicillium*) from the 2 sites were able to utilize naphthalene and/or anthracene as sole carbon source. While the Tombia site had more microorganisms capable of PAH degradation (10 bacterial and 3 fungal species), 2 bacterial species from Bodo were able to produce biosurfactant. A combination of all isolated microorganisms worked efficiently to degrade naphthalene at a faster rate than each individual isolate when verified with a modified technique using the redox indicator 2, 6-dichlorophenol indophenol (DCPIP). The findings of this study show that indigenous microbes in the polluted sites are catabolically active and could be further stimulated for eco-friendly and green removal of PAHs from the polluted soils.

1.02.04 Effect of Exposure of Male Albino Rats to Kerosene, Diesel and Petrol on Kidney Function

C. Imo, federal University Wukari / Biochemistry

The effect of exposure of male albino rats to inhalation of Kerosene, Diesel, Petrol and a mixture of kerosene, diesel and petrol on kidney function was examined in this research. Creatinine, serum urea and serum electrolytes (sodium, potassium and chloride) increased in all groups exposed to the petroleum products compared with the control. Creatinine and serum urea increased significantly ($p < 0.05$) in all groups exposed to the petroleum products. Creatinine increased highest in the rats exposed to kerosene (from 0.73 ± 0.11 to 1.50 ± 0.19 mg/dl), while serum urea increased highest in the group exposed to petrol (from 27.20 ± 2.05 to 52.80 ± 3.49 mg/dl). Sodium increased significantly ($p < 0.05$) only in the group exposed to kerosene (from 124.80 ± 11.88 to 165.20 ± 14.17 mEq/L), but increased non-significantly ($p < 0.05$) in all other groups exposed to the petroleum products compared with the control. Potassium increased significantly ($p < 0.05$) in all the groups exposed to the petroleum products. Potassium increased highest in the rats exposed to petrol (from 3.70 ± 0.03 to 6.15 ± 0.34 mEq/L). Chloride increased significantly ($p < 0.05$) in the rats exposed to kerosene and petrol, but increased non-significantly in the rats exposed to diesel and mixture of kerosene, diesel and petrol. Chloride increased highest in the rats exposed to kerosene (from 36.63 ± 3.68 to 44.13 ± 1.66 mEq/L). Histological analysis of kidney section from rat in group one (control) showed essentially normal histoarchitecture of the kidney tissue, but exposure of the animals to inhalation of kerosene, diesel and petrol showed necrosis, distorted glomeruli and Bowman's capsule of the kidney tissue when compared with the control. The results of this study show that exposure of the male albino rats to inhalation of kerosene, diesel and petrol can cause alterations in kidney function parameters and distortion in normal histoarchitecture of the kidney tissue. This means that exposure to inhalation of kerosene, diesel and petrol can cause kidney damage.

1.02.06 Spatial Effect on Total Petroleum Hydrocarbons and Microbial Communities in Crude Oil-Polluted Soil

N.N. Obaretin, F.P. Udofia, C.P. Okafor, University of Port Harcourt; C.B. Chikere, University of Port Harcourt / Microbiology

Crude oil pollution is a major threat to soil microbial diversity and continuous dependence on crude oil for energy increases the incidence of soil pollution. Microbial remediation which depends on robust indigenous microbial community capable of crude oil catabolism remains a sustainable clean-up technique. The role of distance on pollutant distribution and its effect on microbial diversity within a crude oil-polluted site (18m x 36m) was determined in this study. Four different points equidistant from each other along the pollution gradient were sampled (CH5, CH6, CH7, and CH8) from a crude oil-polluted site in Bodo (2.76NW, 90E). Soil physicochemical parameters were determined and correlated to microbial counts at each sampling point. The total petroleum hydrocarbons (TPH) and polycyclic aromatic hydrocarbons (PAHs) were determined using gas chromatography (GC-MS) while culture-based methods were used for microbial isolation. Both TPH and PAHs concentrations increased along the gradient. TPH concentrations were 13567.6398mg/kg at point CH5; 21679.8550mg/kg at point CH8 and PAHs were 6763mg/kg at CH5 and 11492mg/kg for CH8. These values were higher than regulatory standards of >5000mg/kg and 40mg/kg intervention limits for TPH and PAHs respectively. However, hydrocarbon utilizing bacterial counts differed with point CH7 having the most counts at 10.8×10^7 . Bacterial species such as *Pseudomonas*, *Enterobacter*, *Bacillus* and *Staphylococcus* and fungal species such as *Neosortonya fisheri*, *Penicillium* sp. and *Candida krusei* were identified. Conclusively, the bacterial and fungal counts at the different locations varied differentially as a result of the dynamics of petroleum hydrocarbons at the different sampling points. Keywords: Spatial distribution, microbial communities, TPH and PAHs

1.02.07 Microbial Consortium for Biodegradation of Petroleum Hydrocarbons From Artisanal Oil-Polluted Site

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Bioremediation is a nature-based and eco-friendly method for removal of crude oil pollutants through microbial biodegradation. This study aimed at screening for

hydrocarbonoclastic extremophiles from petroleum-inundated site that can degrade long-chain alkanes and developing an efficient consortium from them. Crude oil-polluted soil samples were collected from Tombia Town in Rivers State using soil auger in sterile containers and transported to the laboratory for microbiological analyses. Hydrocarbon utilizing bacterial (HUB) isolation was by enrichment on Bushnell Haas-paraffin oil broth. The average HUB count after 72 hours incubation was 6.5×10^6 cfu/g with a total of 13 isolates recovered. Colorimetric method with the redox dye, dichlorophenol indole phenol (DCPIP) was employed for degradation screening. Efficiency of individual isolates to degrade paraffin oil was compared with their collective potentials as part of a consortium. Four different consortia were developed as follows: isolates with more than 50% individual degradation efficiency, Gram-positive isolates, Gram-negative isolates, and combination of all isolates. Following 96-hours biodegradation assay, the rates of degradation of paraffin oil by the different consortia were 56%, 60%, 65%, and 85% respectively with the consortium containing all the isolates as the most efficient. *Bacillus* sp., *Klebsiella* sp., *Staphylococcus* sp., *Micrococcus* sp., *Corynebacterium* sp. and *Pseudomonas* sp. were HUB identified. The findings of this study confirm that the polluted site has metabolically active long-chain alkane degrading HUB and the significance of microbial synergy over individual biodegradation capability. Keywords: Artisanal oil refining, microbial consortium, DCPIP, Paraffin oil

Aquatic and terrestrial ecology and toxicology (general)

2.01.02

Acute Exposure to Diclofenac Alters Haematological Profile of the Hybrid Catfish, *Heteroclaris*

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Studies have shown that emerging contaminants such as diclofenac, a nonsteroidal anti-inflammatory drug, may be toxic to fish but research on its acute effects on fish haematology is scarce. Despite its relative abundance in Nigerian waters, data on its toxicity in fish relevant to the Nigerian context is limited and no studies have examined its toxicity in the hybrid catfish *Heteroclaris*. This study examined the acute effects of diclofenac on the haematology of *Heteroclaris*. Fish were exposed to diclofenac concentrations ranging from 4 to 20 mg/L in a static bioassay. The 96 hour LC_{50} of diclofenac was 10.8 mg/L. Exposed fish exhibited abnormal behavioural and morphological changes at all concentrations. The mean corpuscular haemoglobin concentration (MCHC), mean corpuscular haemoglobin (MCH), mean corpuscular volume (MCV), packed cell volume (PCV), platelet (PLT), red blood cell (RBC), and white blood cell (WBC) were significantly lower ($p < 0.05$) in exposed fish compared with the control. RBC, WBC, and Hb only decreased significantly at high concentrations (16 mg/L) while lymphocytes showed an unsustainable increase compared to the control. The results suggest that diclofenac affects the haematology of *Heteroclaris* and may be immunosuppressive at high concentrations. However, further studies with environmentally relevant concentrations are needed to fully appreciate the impact of this pharmaceutical.

2.01.05

Assessment of Red Sea Branching Coral *Stylophora Pistillata*'s Resilience to Acute Copper Contamination Under Thermal Stress

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Decreased seawater quality, associated with rapid coastal urbanization, is a major driver of increased coral reef vulnerability to climate change. The Gulf of Aqaba (GoA), located in the northern Red Sea, is considered a coral refuge despite alarming rates of warming. Although being extremely heat tolerant, GoA corals are increasingly exposed to land and sea-based pollutants, with heavy metals constituting a major threat. Among these, copper (Cu) plays a crucial role at low concentrations in the coral tissue and becomes highly toxic when in excess. To date, no study focused on the impact of thermal stress on the recovery of corals from such pollution, which constitutes a significant knowledge gap when planning efficient conservation strategies of reefs. The present study assessed the resilience (resistance and ability to recover) of the heat-tolerant branching coral *Stylophora pistillata* to combined Cu contamination and thermal stress. Coral nubbins were incubated under two thermal conditions (ambient seawater (23°C) and maximum summer (29°C) temperatures), exposed to four environmentally relevant concentrations of $CuCl_2$ (0 - 2.5 - 5 - 10 $\mu g L^{-1}$) for three weeks, and let to recover for a depuration period of one week at their respective temperatures. Throughout the experiment, the coral photo-physiology was monitored, together with the oxidative stress status, the antioxidant response, and the accumulation of Cu in the coral tissue. Results show an additive effect of thermal stress and Cu enrichment on most parameters, indicative of a reduced thermal tolerance upon Cu contamination. In ambient conditions, recovery during depuration was mediated by a boost of antioxidant levels, leading to a reduction in reactive oxygen species, and a return to baseline levels of all photo-physiology parameters. We hypothesize Cu contamination impairs the antioxidant defense mechanisms, leading to a decline of the overall metabolism. Conversely, elevated temperatures impaired the recovery, with limited antioxidant response. The present study is the first to give insights into the effects of elevated temperature on the recovery capacity of a

scleractinian coral exposed to a common marine pollutant. Our findings suggest that ocean warming may alter the resilience of corals exposed to local pollution, an impact that might have long-term consequences on the chances of survival of coral reefs in increasingly populated and warming coastal environments.

2.01.06

Bioaccumulation and Trophic Transfer of Total Mercury Through the Aquatic Food Webs of the Phongolo Floodplain

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Coal-fired power plants in South Africa generates more than 90% of its electricity and associated to these power plants are the emissions of mercury (Hg). These power stations are the largest anthropogenic source of Hg which is released into the atmosphere and are found in the catchment of both the Usuthu and Phongolo rivers. Mercury impacts not only aquatic ecosystems but human health as well. As such, Hg poses a threat to the ecology and socio-economic value of the lower Phongolo floodplain as communities are reliant on these aquatic ecosystems for drinking water and fish as a protein source. The study aimed to determine the level of Hg contamination, accumulation and biomagnification in two freshwater lakes and rivers in the lower Phongolo floodplain. Sediment and biota were sampled from the selected aquatic ecosystems in the Ndumo Game Reserve (NGR) and were analysed for total Hg (THg) using a Flow Injection Mercury System (FIMS) - FIAS 400. Sediment THg concentrations ranged from 0.007 - 0.068 $\mu g/g$ dry weight (dw). These are similar to what was found in the Olifants River Basin and based on international literature are typical of unpolluted areas. Total Hg concentrations in fish from the NGR varied across the different aquatic ecosystems. Mercury concentrations in both rivers were very similar, as well as the associated floodplain lakes. However, when comparing the rivers to their associated floodplain lakes, differences in THg concentrations were observed. Significant differences were found between the same species of the different systems as the apex predator (*H. vittatus*) in the Usuthu River were significantly higher in THg concentrations than in its associated floodplain lake, Shokwe. Conversely, no significant differences were found in the apex predator between both rivers. While the same trend was observed with the Mozambique tilapia (*O. mossambicus*). A significant positive relationship was found between THg concentrations and trophic position (TP) of the Usuthu River and its associated floodplain lake (Lake Shokwe) while an insignificant positive relationship was recorded for the Phongolo River and Lake Nyamithi. Trophic magnification factors (TMF) showed that THg biomagnification occurred in all aquatic food webs. While THg concentrations in fish of the present study were comparable to other studies in Africa, concentrations were however considerably lower than studies in Europe, North and South America.

2.01.07

Biological Effects of Face Mask Leachates: An Emerging Source of Chemicals in the Aquatic Environment

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To fight, the use of disposable face masks increased drastically in the fight to curb the spread of Covid-19 as most countries made it compulsory to wear a mask in public. The face masks are made from polymeric materials, mainly polypropylene, but also polystyrene, polyethylene, polycarbonate and polyester. Due to disposable face masks not being discarded as medical waste only anymore they frequently end up in the water bodies of South Africa transported there by wind and heavy rainfall. The face masks should be considered as a source of plastic pollution and their leachates can have the same negative effects on the environment. Some well-known leachates for example phthalates, bisphenol A (BPA) and nonylphenol are known to cause endocrine disruption. This study aimed to determine if leachates from face masks have the potential to activate or inhibit the oestrogen receptor using the T47D-KBluc reporter-gene assay. Face masks were leached in ethanol to mimic the polar aqueous environment and target water-soluble compounds. The masks were leached for 24 and 48 hours at 4°C and for 24 and 48 hours at 30°C. The T47D-KBluc cells were exposed to the leachates and because these cells are genetically modified with an transposed luciferase enzyme, activation or inhibition of the ER could be determined by measuring the luminescence produced. The MTT (3-[4,5-dimethylthiazole-2-yl]-2,5-diphenyltetrazolium bromide) viability assay was also performed to prevent false negative results. The leachates were cytotoxic at concentrations of 0.333, 1 and 3 $\mu g/mL$. An influence on the ER is expected due to previous reports that indicated that additives such as phthalates and BPA bind to the oestrogen receptor. The influence of the Covid-19 pandemic might be even more far reaching when the contribution of polluting face-masks is considered.

2.01.08

Biological Effects of Water Soluble Agrochemical Mixtures on the H4IIE-luc Rat Hepatoma Cell Line

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It is projected that by the year 2050 the global human population will exceed the 9 billion mark putting increased pressure on global food security. In crop-producing countries where poverty, hunger and health are important social issues, such as South Africa, the burden is even greater. Agrochemicals, such as pesticides, are widely used in the agricultural sector to reduce crop losses. Currently, South Africa is the largest pesticide user in sub-Saharan Africa, with more than 3 000 pesticide products registered for use. It is estimated that 10% of the overall applied pesticides reach non-target areas through runoff, leaching or spray drift. As a result, aquatic ecosystems and vulnerable human communities are exposed to these chemicals. One of the toxicological effects associated with pesticide exposure is endocrine disruption—whereby the chemicals act as agonists or antagonists of endogenous hormone receptors (such as the aryl hydrocarbon receptor, AhR). The aim of this study was to investigate the potential biological effects caused by water-soluble agrochemical residues extracted from soil that was sampled in maize growing regions of South Africa. An *in vitro* bioassay, using the H4IIE-luc rat hepatoma cell line, was performed to determine if the water-soluble agrochemical mixtures applied to crops can activate the mammalian AhR which is responsible for gene regulation in xenobiotic metabolism. The MTT [(3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide) viability assay was also conducted to evaluate whether the water-soluble extracts from the soil are cytotoxic. Results indicated that compounds present in the water-soluble extracts of the soil samples did not activate the AhR. However, soil extracts from seven of the nineteen sample sites caused statistically significant ($p < 0.05$) cytotoxicity in the H4IIE-luc cells in a dose-dependent manner. In addition, the water-soluble extracts from two of the sites promoted cell proliferation ($p < 0.05$). The approaches followed in this study will aid in assessing the ecotoxicological risks posed by water-soluble agrochemicals which migrate to non-target areas and become bioavailable for aquatic biota.

2.01.12 Endocrine-Disrupting Pollutants in Water Bodies in Sub-Saharan Africa - Sources, Impacts and Knowledge Gaps

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Developing countries are facing unique socio-economic challenges, including the world's highest rates of urbanisation, rapid human population growth, and the proliferation of informal settlements. These factors, and others, are worsening the pollution of water bodies in developing country towns and cities, mainly due to the discharge of untreated wastewater in urban areas. While some of the effects of this pollution are generally well documented, there is a dearth of literature on the sources and impacts of emerging contaminants of concern, such as endocrine-disrupting chemicals (EDCs). We reviewed the literature to assess the environmental levels, effects, and significant sources of EDCs in sub-Saharan Africa. Sources of concern included urban wastewater and continued use of legacy organochlorine pesticides. The levels and environmental impacts of EDCs were either comparable to or exceeded those reported in developed countries. Except for South Africa, there are still many knowledge gaps on sources and effects of EDCs in Sub-Saharan Africa. Studies that assessed impacts of EDCs using native animal species are limited, making it difficult to understand ecological implications.

2.01.14 Genotoxic Potential of Cypermethrin-Based Pesticide BEST on African Catfish *Clarias gariepinus*

a. priscila, FUTO

Due to industrialization and agricultural developments, various chemical substances have been released into the environment causing pollution. The accumulation and persistence of these pollutants in the aquatic environment constitute a serious threat to biological life and to human beings indirectly through the food chain. Two hundred and fifty specimens of *Clarias gariepinus* having a mean weight of 0.2 kg and length of 2.50 cm were exposed to synthetic pyrethroid pesticide, cypermethrin in concrete tanks. Acute toxicity testing was carried out to determine the 96 hours lethal concentration. Genotoxicity was evaluated using the micronucleus assay method. Behavioral abnormalities such as hyperactivity, faster opercula activity, and erratic swimming movements were observed following the exposure of the test fish to pesticide during the acute toxicity test. The median lethal concentration value (LC50) of cypermethrin was determined to be 7.23 µg/l. There was a significant decrease ($P < 0.05$) in the frequency of induction of micronuclei as the concentration of the pesticide and period of exposure increased. Formation of micronuclei in the erythrocyte of *Clarias gariepinus* in this study is an indication of genetic damage.

2.01.24 The Effects of Platinum Mining and Associated Metal Pollution on Fish and Human Health Risks Associated With the Consumption of Fish

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The use of fish as bioindicators to assess the ecological state of aquatic ecosystems, has effectively been applied in the past and is still a preferred monitoring tool to date. Pollutants such as metals can be incorporated into aquatic food webs that can potentially biomagnify in the food web posing risks to organisms that consume them (e.g. predatory fish, piscivore birds and mammals, as well as humans). In South Africa, numerous rural communities and low-income groups depend on fish that are harvested by subsistence fishers from local rivers and its impoundments as a source of protein. Furthermore, communities that consume contaminated fish on a regular basis are potentially chronically exposed to toxic pollutants, especially metals, which may cause increasing genotoxic, non-carcinogenic and carcinogenic health risks. The aim of the present study was to determine the metal bioaccumulation (As, Cd, Cr, Cu, Ni, Pb, Pt, Zn) in three fish species (*Clarias gariepinus*, *Cyprinus carpio*, *Oreochromis mossambicus*) from two impoundments in the Hex River system (Pt mining hotspot, South Africa), as well as the health risk it poses to human consumers. Metal concentrations in the fish associated with platinum mining activities (As – *C. gariepinus*, *C. carpio*, *O. mossambicus*, Cr – *C. gariepinus*, *C. carpio*, Ni – *O. mossambicus*, Pt – *C. gariepinus*, *C. carpio*) increased significantly from the unimpacted impoundment towards the impoundment downstream of the mining activities. The Mozambique tilapia (*O. mossambicus*) accumulated the highest concentrations of As, Cr, Cu and Ni, while the sharptooth catfish (*C. gariepinus*) accumulated the highest concentrations of Cd. From the human health risk assessment, only As exceeded the recommended hazard quotient (HQ > 1) for all three species from both impoundments, indicating a high probability of adverse human health effects. However, no HQs were calculated for Pb and Pt as there are no reference dose values available for these metals. Although only As exceeded the HQ, it is important to keep in mind that a mixture of these metals or other pollutants (organic compounds) occurs within these fish species, potentially enhancing the toxicity and posing an even greater risk to people who consume these fish. **Key words:** Bioaccumulation, mining activities, adverse human health risk

2.01.25 Using Artificial Mussels in Laboratory and Field Studies As a Monitoring Tool of Platinum Exposure in the Freshwater Environment

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The artificial mussel (AM) is a passive sampling device that was originally developed for monitoring metal concentrations in the marine environment, but is also increasingly used in freshwater environments. The AM allows the determination of the dissolved, bioaccessible metal fraction in water bodies without killing organisms, as well as environments with unfavourable conditions for living bioindicators. The AM consists of a non-permeable Perspex tube, which is closed on both sides with a semi-permeable membrane. In the present study, the aims were to determine the concentration dependent Pt uptake kinetics of the AM in freshwater over a wide exposure concentration range under laboratory conditions; to validate the AM under field conditions as a reliable tool for monitoring bioavailable Pt concentrations by comparing the Pt uptake of the AM with that of living organisms, and to comment on the appropriateness of the AM as an alternative to living organisms as biological indicators of metal exposure. The uptake kinetics of the AM were determined under laboratory conditions over a wide exposure concentration range (0.1–1000 µg/L) showing highly correlated Pt accumulation in the AMs with the aqueous exposure concentration. To validate the AM in the field, the Pt accumulation of the AM was assessed together with that of freshwater clams (*Corbicula fluminalis africana*), muscle and liver tissue of three fish species sharptooth catfish (*Clarias gariepinus*), common carp (*Cyprinus carpio*) and Mozambique tilapia (*Oreochromis mossambicus*), as well as water hyacinths (*Eichhornia crassipes*) at two sampling sites in the Pt mining area of South Africa. Results from the field exposures demonstrated that the AM is a promising tool for monitoring Pt in the freshwater environment and the laboratory study demonstrated that it accumulates Pt in a concentration-dependent manner. The AM only represents the dissolved bioavailable metal fraction and does not consider, e.g., particle bound metals, which can be taken up by living organisms via the food. Thus, it is recommended to combine active monitoring using living bioindicators with AMs to obtain insight into the role of dissolved bioavailable metal fractions and particulate bound metals in metal exposure in aquatic ecosystems.

2.01.27 Metal and Metalloid Concentrations in the Southern African Endemic Inter- and Infratidal Super Klipfish, *Clinus Supercilius*, From the West and

South Coasts of South Africa

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Clinus superciliosus was collected from six localities along the South African west and south coasts, where muscle and liver tissue were sampled for metal and metalloid analysis. Concentrations of As, Cd, Cu, Fe, Mn, Pb, Sb, Sn, and Zn were determined considering size and sex of the fish. There was no significant positive correlation between size and elemental concentrations, except for Mn and Sn in liver tissue from Simons Town marina on the west coast just south of Cape Town, while no significant differences were detected between concentrations of males and females. For the majority of the elements, significantly higher concentrations occurred in fish collected from Tsitsikamma in the Garden Route National Park and the small coastal town Chintsa, both on the south coast, while only some concentrations were significantly higher in muscle tissue at Simons Town marina (Sb and Sn). Land-use activities played a limited role in metal and metalloid bioaccumulation in *C. superciliosus*. Element concentrations were rather influenced by large scale oceanographic processes (i.e., currents and upwelling events) and localised seasonal geogenic derived run-off. The limited data on element accumulation patterns of inter- and infratidal fish species in South Africa, highlights the need for long-term monitoring, as well as further studies on different resident as well as transient inter- and infratidal fish species.

Aquatic risk assessment and validation of the risk assessment using data from lakes and rivers in Africa

2.02.02

Daphnia magna Responses to Efavirenz and Tenofovir Antiretroviral Drugs Exposure in River Water

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Human immunodeficiency virus (HIV) is a major global public health concern where by 2018 some 37.9 million people were reported to be living with HIV worldwide. The prescription of lifelong antiretroviral therapy (ART) to combat high morbidity and mortality has increased dramatically after 2017, with over 30 antiretroviral drugs (ARVs) widely used to treat HIV. At present, ARVs are classified among environmental contaminants of concern and are widely detected in high concentrations in aquatic environments, but with unknown ecotoxicological effects. However, studies on ARVs' effects on aquatic biota, especially at lower trophic levels e.g. crustaceans are limited. Herein, *Daphnia magna* acute toxicity and biochemical responses were evaluated. The endpoints included immobilization, catalase (CAT) and glutathione S-transferase (GST) activities, and malondialdehyde (MDA) content levels following exposure to efavirenz (EFV) and tenofovir (TFV). Exposure concentrations were 62.5–1000 µg/L over 48 h in Elands river (South Africa) water samples. Findings indicated that EFV and TFV induced concentration-dependent immobility after 48 h, with the former exhibiting higher effects. Both ARVs induced significant changes in CAT and GST activities, and MDA levels relative to the controls. Notably, the biochemical responses of *D. magna* were higher due to EFV relative to TFV. Although no observable immobility at lower exposure concentrations (62.5 and 125 µg/L), changes in the antioxidant enzyme activities were apparent, indicative of ARVs induced oxidative stress. These results show that immobilization was observable at the test concentrations (250–1 000 µg/L), and significant effects on the oxidative stress biomarkers (125–1 000 µg/L). Importantly, both acute and biomarker effects were observed at concentrations similar to measured environmental concentrations. This suggests likely negative effects to sensitive aquatic species e.g., *D. magna*. This, in turn, may result in altered ecosystem function as *D. magna* forms a link between primary producers (e.g., algae) and organisms at higher trophic levels (e.g., fish). Overall, biochemical responses can be valuable endpoints to elucidate the effects of ARVs even at lower concentrations compared to acute toxicity.

Advances in the assessment of chiral pollutants in the environment: Challenges and opportunities

3.01.02

Quality Criteria for Enantioselective Analysis in Chemodynamics and Ecotoxicology Studies

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It is often assumed that the biotic processes in the environment favor the enrichment of one enantiomer over the other while abiotic processes are not enantioselective. Based on this assumption, enantioselective analysis is a widely used to assess the source, fate and transport of chiral pollutants in the environment. However, previous studies demonstrated that some abiotic processes such as adsorption have been shown to be enantioselective. In addition, some

stages in the analytical process can result in enantioselective transformations such as chiral inversion during storage in solvent. A framework for improving the quality of data in enantioselective analysis is proposed. Since instrument and matrix effects can result in false positives in enantioselectivity, stable isotope internal standards are recommended for quantitative calibration while determination of solvent stability of the chiral analyte could aid in establishing whether storage of standards result in enantioselective transformation. This study, will help in improving the utility and accuracy of enantioselective analysis in source apportionment, wastewater epidemiology, natural attenuation assessment, and enantioselective toxicity studies.

Environmental and Analytical Chemistry (general)

3.02.02

Hospital Wastewater As a Source of Priority Substances to the Wastewaters

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A wide range of activities taking place in hospitals cause the consumption of a large variety of medical substances. As a result, hospital wastewaters may create risks to the aquatic environment. This study traces the priority substances (PSs) that originate from the hospital wastewater (HWW) of one of Istanbul's largest medical faculty hospitals up to the discharge point into the Sea of Marmara. For this purpose, physicochemical parameters and 45 PSs were analyzed in the HWW samples taken from the hospital's sewer line and, after the preliminary treatment facility's (WWTP) screening and grit removal. Samples were taken in four seasons, during one-year period. Measured concentrations of chemical oxygen demand (COD), suspended solids (SS), total Kjeldahl nitrogen (TKN), and pH of the HWW were 474 ± 106 mg/L, 198 ± 81 mg/L, 61 ± 15 mg/L, and 7.87 ± 0.24 , respectively. Analyses showed that among the organic PSs, DEHP, fluoranthene, dioxin, and dioxin-like compounds were present in all samples in the HWW. Total concentration of PAHs measured in HWW were in the range 25.0 – 46.1 ng/L. HWW was investigated to control if it contributed to the presence of PSs in the urban wastewaters. Most of the PSs in HWW were absent, or detected at very low concentrations. Since WWTP effluents are considered to be a point source of pollution to the receiving water environments, considering the loads, the contribution of the HWW under consideration was limited as a source of PSs to the WWTP, hence to the Sea of Marmara.

3.02.05

Assessment of Crude Biosurfactant Production in Cellulolytic Actinomycetes Species and Comparison With Standard Surfactants

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Preference for biosurfactants is on the rise because of their biodegradability and the green biotechnology involved in their production. This work comparatively evaluated the effectiveness of biosurfactants from cellulolytic actinomycetes and standard surfactants using emulsifying activity (E_{24}), oil displacement, and drop collapse methods. Ten actinomycetes initially screened for cellulose and xylan biodegradability, demonstrated strong emulsifying activities (E_{24} -values 44–50 %) and remarkable cell surface hydrophobicity (37–57%) in five petroleum hydrocarbons (aviation fuel, kerosene, petrol, diesel and crude oil). Crude biosurfactants produced by three of these actinomycetes (*Trueperella bernardiae* UIL-M, *Lentzea albidocapillata* UIL-K and *Actinomyces slackii* UIL-E) had significantly greater emulsifying activities in petrol than the nonionic synthetic surfactants Tween 20, Tween 80 and Triton X-100 as well as hydroxylpropyl-beta-cyclodextrin (HP-β-CD). However, the biosurfactants displaced oil on water surface less than these surfactants but better than HP-β-CD. The E_{24} -values of the actinomycetes compared well with those of the surfactants, sodium lauryl sulphate (SDS) and *N*-cetyl-*N,N,N*-trimethyl ammonium bromide (CTAB), though these surfactants were better in term of oil displacement. Rapid positive drop-collapse results were obtained for the biosurfactants and standard surfactants. Crude biosurfactants produced by these novel cellulolytic actinomycetes are superior to the nonionic synthetic surfactants and the expensive biosurfactant HP-β-CD.

Innovative sample preparation and detection techniques for legacy and emerging pollutants in different environmental matrices

3.03.04

Occurrence of Organic Micropollutants in Biota and Sediments From Western Kenya Freshwater Systems

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Recently, global concerns have been raised on the environmental occurrence of organic micropollutants (OMPs) due to the adverse risks posed by these compounds to organisms. Several studies have shown that OMPs including pesticides, biocides, pharmaceuticals and other industrial compounds pose adverse effects to the environment. However, similar studies carried out in developing countries are limited. Therefore, our study aimed to narrow this knowledge gap by investigating the occurrence of OMPs in snail tissues and sediments in surface water systems within rural western Kenya. Snail and sediment samples were collected from 48 sites distributed among Homabay, Kisumu, Kisii, Kericho, Migori, Nyamira and Narok counties. Extraction of chemicals in snail tissues was done using QuEChERS (quick, easy, cheap, effective, rugged and safe) method while pressurized liquid extraction was applied to sediment samples. Gas Chromatography-High Resolution Mass Spectrometry (GC-HRMS) was performed for chemical analysis. Out of the 109 target compounds, 32 were detected in snails and 39 in sediments with pesticides being the most commonly detected chemical class. Detection frequencies in snails and sediments ranged from 2% to 98%. In snails, highest detection frequencies were reported for cypermethrin and esfenvalerate. Cypermethrin is a synthetic pyrethroid which is used as an insecticide against aphids, thrips and whiteflies while esfenvalerate is a broad-spectrum non-selective insecticide. For sediments, the industrial compounds *cis*-stilben and fluorene were most frequently detected. Individual compound concentrations were found up to 945 ng g⁻¹ wet weight with alpha-tocopherol acetate and acenaphthene predominantly detected at high concentrations in snails. For sediments, compound concentrations were up to 72 ng g⁻¹ organic carbon with this maximum concentration reported for benzo[b]fluoranthene. Benzo[b]fluoranthene is a product of incomplete combustion and primarily found in gasoline exhaust. This study builds on the previous research on multi-compartment analysis of organic micropollutants in surface water systems within rural western Kenya. It provides comprehensive data on GC amenable compounds in a rather data limited region. Results from this study show that snails and sediments are contaminated with OMPs which might pose a risk to other organisms when exposed. Further research will focus on ecological risk assessment.

3.03.07

Extraction Efficiencies of Conventional Organic Solvents Vs GREEN Deep Eutectic Solvents in the Extraction of Organophosphorus Flame Retardants From Landfill Leachate and Sediment

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In the present study organic solvents and deep eutectic solvents (DESs), were employed in optimizing LLE and SLE for the extraction of OPFRs from landfill leachate and sediment in Gauteng Province, South Africa. Leachate and sediment samples were collected from selected landfill sites which are in the centre of two metropolitan municipalities, namely, Tshwane and Johannesburg, in Gauteng Province, South Africa. The development of the extraction efficiency using LLE and SLE for organic solvents involved using solvents like Hexane (Hex), Ethyl acetate (EtAc), Hex: Acetone (Ace), Hex: EtAc and Hex: Dichloromethane (DCM); for deep eutectic solvents it involved the four main families of DES namely: choline chloride: urea (CU), Lewis acidic (CZ), Bronsted acidic (CO) and carbohydrate-derived (CD) DES, which were synthesised before being used to extract OPFRs. In addition to solvents parameters, sample volume and mass, sonication time, vortex time and centrifuge speed and time were optimized for the extraction of OPFRs in landfill leachates and sediments. The best organic extraction solvent was Hexane, and for green DES it was Choline chloride: oxalic acid dihydrate (CO (1:1)) and choline chloride/urea (CU (1:2)) for extracting OPFRs in landfill leachate and sediment respectively. After the application of optimum extraction conditions on landfill leachate and sediment using organic solvents, the samples were injected on the LC-MS/MS for quantification. Results for method validation using sediment CRM showed 3 to 24 % improvement in terms of recoveries with green solvents (85.2 % - 118 %) compared to organic solvents (84.7 % - 109 %). The ΣOPFRs in leachate ranged from 5.90 ng/L (Garankuwa) – 983 ng/L (Onderstepoort) and from < LOQ (Goudkoppies and Robinson Deep) – 216 ng/g dw (Hatherly) in sediment using organic solvents. Using green DES the ΣOPFRs in leachate ranged from 510 ng/L (Goudkoppies) – 1433 ng/L (Soshanguve) and 725 ng/g (Hatherly) – 1224 ng/g (Ennerdale) in sediment. Therefore, these results confirm that DESs can be used, not only as effective solvents for the extraction of compounds with a wide range of polarities such as OPFRs in aqueous and solid environmental media, but also as promising replacements for organic solvents used in the extraction of OPFRs. DESs are more environmentally friendly compared to most organic solvents used for the extraction of OPFRs.

Nanoecotoxicology: from cradle to grave

3.04.01

6

Metabolic Responses of *Caenorhabditis elegans* Following Exposure to CdTe Quantum Dots, CuO Nanomaterials and Their Bulk Counterparts

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Nanomaterials refer to materials that have at least one dimension less than 100 nm in size. They have applications in electronics, bio-imaging and targeted drug delivery. With the increased use of nanomaterials, they are more likely to end up in the aquatic environment; such as pore water. *Caenorhabditis elegans* is used as an ecotoxicological model species for an aqueous environment while metabolomics is used to identify biomarkers of exposure and the effected pathways. This can lead to the identification of pathway fingerprints and biological mechanisms of toxicity *in vivo*. Following ISO 10872 protocol we exposed *C. elegans* to Cadmium tellurium quantum dot nanomaterials, functionalized with ammonium groups (QD-NH₃, 4 nm) and copper oxide nanomaterials (CuO, 14 nm) for 96 h over a range of concentrations to assess reproduction effects. Characterization of nanomaterials in the exposure media was quantified using dynamic light scattering, transmission electron microscopy and AAS. Uptake and distribution were assessed using CytoViva darkfield imaging while an EC₅₀ was calculated for reproduction. Following exposure for 24 h a non-targeted metabolomics approach was used to recognize the toxicity of sub-lethal concentrations of CuO and QD-NH₃, and their bulk counterparts (Cd, Te and Cu). Multivariate pattern recognition analysis reflected the perturbations in the metabolism (amino acids, organic acids, sugars) of *C. elegans* after exposure. Significant variance was seen in 41 metabolites when comparing Cu, CuO and control groups. Seven significant metabolites were detected between QD-NH₃, Cd and Te, but no significant metabolites could be identified for nanomaterials specifically. Several key metabolites can be selected as precursor biomarkers as they have the potential to bring significant change over a longer exposure timeframe. There were however significant changes in the protein and lipid metabolism of nematodes exposed to the bulk metals. These results give more information regarding the mechanism of toxicity of both nanomaterials and their bulk counterparts and form part of an environmental risk assessment of metal-based ENMs.

3.04.02

Shape and Functionalization Influence the Bioaccumulation of Nanogold in *Oreochromis mossambicus* (Mozambique tilapia)

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Engineered nanomaterials (ENM) are versatile, providing applications in several industries, however, the nature, fate, and effect of ENM on aquatic organisms are not well understood. The Mozambique tilapia is a freshwater fish, recognized as an ideal model to investigate the bioaccumulation kinetics and behavioural effects following exposure to gold nanomaterials (nAu). The bioaccumulation kinetics of both cetyltrimethylammonium bromide (CTAB) capped nanogold (nAu) and citrate (Cit.) capped nAu was determined by performing a quantitative differential tissue analysis while assessing swimming behaviour changes over time. The behavioural analysis showed an increase in swimming activity after exposure to Cit. nAu whereas a decrease in activity was observed in the group exposed to CTAB nAu. The quantitative differential tissue analysis indicated that uptake occurred in all analyzed tissues for both nAu. Bioaccumulation orders were determined for both nAu during uptake revealing: Cit. nAu: muscle > GI tract > liver > gills > blood; CTAB nAu: GI tract > blood > liver > gills > muscle. At the conclusion of the depuration period, the bioaccumulation orders were determined: Cit. nAu: muscle > GI tract > liver > gills > blood; CTAB nAu: GI tract > blood > liver > gills > muscle. Although sequestration took place in all tissues, some tissues displayed a persistence to bioaccumulate. Citrate capped nAu demonstrated a high affinity for thiol-rich tissue whereas CTAB nAu exhibited prolonged circulation in the vascular system. In conclusion, the shape, size, and functionality of ENMs govern the bioaccumulation kinetics, which leads to dissimilar alterations in fish behaviour.

3.04.03

Effects of Shape and Functional Groups of Nanogold on the Metabolomic Responses in *Daphnia magna*

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Gold nanomaterials (nAu) have been developed for applications in the biomedical field for imaging and as a drug delivery vector. To ensure the effective dispersion of nanomaterials in biological media, the materials are manufactured in different shapes and have different functionalized groups attached. The release of nanomaterials into the environment has a potential hazardous effect on the aquatic ecosystem. There is limited information regarding harmful effects of these

nanomaterials especially at the molecular level. *Daphnia magna* is one of the most widely used model species due to its ecological importance in the aquatic ecosystem. This invertebrate crustacean is a filter feeder and is an important primary consumer at the base of many aquatic food webs. *Daphnia magna* were exposed to sub lethal concentrations of ionic Au (1 and 4 µg/L), CTAB functionalized rod shaped nAu (2 and 4 µg/L) and spherical shaped citrate capped nAu (2 and 20 mg/L) for 48 h following OECD 202 protocol. Liquid chromatography with tandem mass spectrometry (LC-MS/MS) was used to analyse the metabolites of *D. magna* following exposure to the different treatments. Multivariate analyses were used to assess which metabolites and associated pathways were affected. Exposure to ionic Au, CTAB rod shaped nAu and citrate capped spherical nAu all resulted in a significant increase in Decanamine N decyl when compared to the control. A significant decrease in Chloro Dimethoxyphenethylamine N N bistrimethylsilyl, Cyclohexanebis methylamine bistrimethylsilyl and Dimethoxy nitrophenethylamine N N bistrimethylsilyl for all exposure treatments was found when compared to the control. The affected pathways were identified as follows: Aminoacyl-tRNA biosynthesis; Arginine biosynthesis; Glyoxylate and dicarboxylate metabolism; Alanine, aspartate and glutamate metabolism; Phenylalanine, tyrosine and tryptophan biosynthesis and D-Glutamine and D-glutamate metabolism (amino acid metabolism). All of these pathways are involved in protein and lipid metabolism and any negative effect on these pathways would influence growth and reproduction. The largest effect on sub lethal endpoints were measured in the ionic Au treatment followed by the CTAB nAu. No significant effects were observed in the citrate capped nAu exposures. Keywords: ionic Au; Citrate capped spherical nAu; CTAB rod shaped nAu; Metabolites; Pathway analysis

3.04.04

Joint Effects of Engineered Nanoparticles and Organic Contaminant in Freshwater Systems

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Engineered nanoparticles (ENPs) are increasingly being detected in technical and natural systems from nano-enabled products usage, production, and final disposal of nanowastes. As a result, ENPs now co-exists with different types (or classes) of ENPs and macro-scale contaminants (e.g., antibacterial, etc.). Herein, the toxicity of binary and ternary mixtures of zinc oxide (nZnO), and iron oxide (nFe2O3) nanoparticles fixed at 1000 µg/L; and antibacterial triclosan (TCS) varied from 1 to 1000 µg/L were investigated. All exposures were done in two river water samples (Elands River (ER) and Bloubaan River (BR), South Africa), under visible light (2 hours), and bacterium *Bacillus subtilis* as a model test organism. Interactions between nano- and macro-scale contaminants were determined, and also their cell viability effects. nZnO toxicity was highest in ER (25% reduction in viability) relative to BR water (< 10%). TCS effects were significant at the highest concentration (1000 µg/L); whilst nFe2O3 induced no observable toxicity under these exposure conditions. Joint effects of nZnO/TCS and nFe2O3/TCS were significant in ER water at the highest TCS concentration, but no differences were apparent for nZnO/nFe2O3 irrespective of water matrix. Ternary mixture effects (nZnO/nFe2O3/TCS) were minimal on cell viability, except at the highest TCS concentration. For all mixture combinations, zeta-potential was negative (-11 – -15 mV), and exhibited minimal changes as TCS concentrations were varied. TCS had no influence on nFe2O3 aggregation but inhibited nZnO aggregation with increasing concentrations irrespective of exposure media chemistry. Ternary mixture aggregate sizes decreased with increasing concentrations of TCS, with higher stability in ER relative to BR water. Reduction on nZnO/TCS and ternary mixtures aggregation was linked to the adsorption of TCS, which in turn reduced the nZnO dissolution. Our results illustrate the complexity of contaminants interactions in the environment, and the need to consider their co-existence as this can alter the effects of individual contaminants (i.e., potentiate or attenuate effects).

3.04.05

Application of Adverse Outcome Pathways As a Risk Assessment Tool for Engineered Nanomaterials

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The adverse outcomes pathway (AOP) is a conceptual framework that can be used to show the linkages between sub-cellular initiating events and adverse outcomes. It allows for the organization of available biological information to understand how the health of wildlife and humans may be disrupted due to chemical and non-chemical stressors. The AOP framework therefore integrates (eco)toxicological processes across levels of biological to be implemented in studies from understanding stressor mediated adverse effects to management to risk assessment (both ecological and human). The AOP is a modular framework that elucidates the causal relationships between sub-cellular processes (Molecular Initiating Events; MIEs); cellular, organ level, organ system and organism-level processes (Key

Events; KEs) and population and ecosystem community responses (Adverse Outcomes; AOs). One of the main critiques of the framework is that due to its bottom-up approach there is a very strong focus on the cellular and molecular mechanisms and the outcomes that are important for risk assessment, i.e. protection of populations is not well represented. The use of Bayesian Networks (EN) through the relative risk assessment (RRM) framework is a promising method to incorporate AOPs into quantitative risk assessment. The RRM framework allows for the development of quantitative AOP (qAOP) networks that could define the relationships underlying transition from one KE to the next sufficiently well to allow quantitative prediction of the probability or severity of the AO occurring for a given activation of the MIE. In this presentation we demonstrate the application of the AOP concept using three different indicator organisms, i.e. *Caenorhabditis elegans* (nematode), *Daphnia magna* (freshwater crustacean) and *Danio rerio* (freshwater fish) that were exposed to nanogold. We further demonstrate the potential application of BN-RRMs and AOPs in the risk assessment of nanogold.

3.04.06

Exposure and Toxicity Effects of Engineered Nanomaterials Released From Nano-Enabled Products: A Review

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Nanotechnology advances have enabled the application of engineered nanomaterials (ENMs) to improve the functionality of different materials and products and this has led to extensive application in commercial products. The commercialisation of nano-enabled products is rapidly increasing; for instance, the global nano-enabled products (NEPs) market has been forecasted to increase from ca US\$ 32.9 billion in 2016 to US\$ 125 billion by 2024. The incorporated ENMs are not permanently fixed to the NEPs and can be released along the life cycle. Hence ENMs release into aquatic environments (nanopollution) will proportionally increase with increasing commercialisation. ENMs environmental exposure raised concerns due to higher reactivity and toxicological potential relative to bulk counterparts. To determine the risk of ENMs released along the life cycle of NEPs, particularly usage stage, several studies have been undertaken and are the focus of the current review. The review was exclusive to studies that examined ENMs released from commercial NEPs over the last 10 years, with the overarching aim to evaluate the environmental exposure and ecotoxicity in aquatic environment. While there is still a number of analytical challenges in studying ENMs release from NEPs, it is evident that the ENMs are released from different NEPs during their life cycle and end up in the aquatic environments. The physicochemical properties of the released ENMs varied; an expected finding since the exposure characteristics depend strongly on the NEPs' life cycle. Although the characteristics of the released ENMs varied, they were generally detected exhibiting characteristics as incorporated into NEPs or were detected in the transformed state (i.e., aggregates, ENMs still embedded in the NEPs matrix, or particle size increase or reduction). The toxicity effects of the released ENMs have been investigated on different aquatic organisms. Overall, the NEPs released ENMs were found to induce adverse effects such as growth inhibition and mortality. While adverse effects were induced after exposure to released ENMs, the mechanism of toxicity is not yet understood. Furthermore, several authors attribute the adverse effects to a combination of the released ions, ENMs and other components of the NEPs' matrix. Overall, the toxicity effects of the released ENMs are still not well understood and in some cases are contradictory. Hence the risk of ENMs not well known and understood. Notwithstanding the several studies done on this aspect, more data still needs to be generated to establish the risk posed by released ENMs to the aquatic environments.

Speciation, Bioavailability, and effects of Potentially Toxic Metals (PTMs) in the African and Global Environments

3.05.01

Heavy Metal Bioaccumulation and In Silico Prediction of Protein Domains and Motifs of *Pseudomonas aeruginosa* Strain PAO750 Isolated From Mambila Mining Site, Nguroje, Taraba State, Nigeria

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Increased mining activities globally has continued to be one of the major anthropogenic sources of heavy metal pollution in the environment. Microorganisms thriving in these sites have evolved several mechanisms encoded by gene motifs and domains that help them survive. In this study, heavy metals resistance bacterial were isolated from a heavy metal polluted soil in Mambila mining site and the protein motifs and domains of the isolate were predicted using various bioinformatic tools. 16S rRNA gene sequencing identified the isolate (MAMI 3) with the most favourable bioaccumulation potential for Cd, Pb, Hg, As and Zn to be closely related to *Pseudomonas aeruginosa* strain PAO750. Heavy metal quantification using ICP-MS showed significant ($P < 0.05$) deposition of Cd,

Pb, Hg, As and Zn in the soil at the mining site at 100, 200, 1.82, 10, and 300mg/kg concentrations respectively compared to the control. While *Pseudomonas aeruginosa* strain PAO750, bioaccumulated 20.30±0.28, 50.20±0.14 0.16±0.02, 4.58±0.04 150.08±0.28mg/kg concentrations of Cd, Pb, Hg, As and Zn respectively in situ. Real time RT-PCR showed a significant ($2^{\Delta\Delta ct} \geq 5$) ($P < 0.05$) fold change in relative gene expression of bmtA, czcD, cadB, prbA, merA, zntA and nccA genes by 24.76, 21.26, 17.33, 24.74, 14.52, 23.59, 10.30-fold respectively compared to the control (β -actin). Several domains and motifs belonging to the PFAM superfamily were predicted in this study using SMART, Motifscan and other bioinformatics softwares. Motifscan images of the translated protein sequence, significantly showed important DNA and posttranslational motifs, their functions and the families. Motifscan also predicted protein domains and their scores on the translated protein sequence of the isolate. Predicted domains include the E1-E2_ATPase (P-ATPase) domain (with score = 251.2; match-score = 80.563; e-value $5.7e^{-49}$, at position: 233-414, with 189 amino acids); Heavy-metal-associated (HMA) domain (HMA_1, position 54-83, with 30 amino acids; e-value $8e^{-49}$); HMA_2-Heavy-metal-associated domain profile (position: 49-113; with 65 amino acids; raw-score = 863; match-score = 17.001; e-value $7e^{-40}$); Hydrolase haloacid dehalogenase-like hydrolase (at position.: 430-649 with 220 amino acids; raw-score = 104.6; match-score = 37.782; e-value $7.2e^{-7}$). The Metallothio_Pro domain (at position 1-49, with 49 amino acids; range score = 48.4 – 50.2; match-score = 20.071 - 22.713; e-value $5e^{-16}$) and Cysteine-rich region profile (raw-score = 36; match-score = 8.691; e-value $5e^{-40}$). These results show a strong match between the putative sequences and query sequence of the translated protein, as it is very unlikely that this match is a false positive due to the very large match scores and varied e-values. The gene ontology (GO) functions and processes of the predicted domains include metal ion binding, translocation and sequestration. These biochemical activities play critical roles in heavy metal uptake and bioaccumulation and hence conferring bioremediation potentials to the organism.

3.05.02

Evaluating Consumption Risk and Toxicity Index: A Case Study of Tridax Procumbens

P. Emmanuel, Federal University Wukari, Wukari, Nigeria / Department of Biochemistry; U.J. Anayo, Ebonyi State University / Department of Biochemistry; O. Otitoju, federal University Wukari / Biochemistry of Department This study was carried out to determine the level of some heavy metals, phytochemicals present in Tridax procumbens leaf extracts and its nutritional compositions as it is recently used in phyto-medicine for the treatment of ailments and also used as source of vegetables for human consumption. All compositions was evaluated using modified standard method of AOAC, 2006. The result revealed myriad amounts (mg/100g) of heavy metals in the order of zinc (8.21 ± 0.01) > manganese (7.02 ± 0.01) > Iron (4.02 ± 0.01) > Nickel (0.62 ± 0.01) > lead (0.43 ± 0.01) > magnesium (0.42 ± 0.01) > cobalt (0.21 ± 0.01). The result for vitamins contents were expressed in mg/100g in the order of vitamin A (15.00 ± 1.41) > vitamin B9 (8.65 ± 0.03) > vitamin C (6.33 ± 0.02). It could be deduced that the nutritional composition of this plant must have led to its therapeutic and conventional use as a vegetable but the presence of some heavy metals could be a major health concern as bioaccumulation might lead to impairment of some vital organs in the body.

3.05.03

Investigating the Effects of Metals on Plant Health Through Distribution Mapping and Physicochemical Properties

M. Dodd, Royal Roads University / School of Environment & Sustainability; C. Darko, S. Yeboah, CSIR-Crops Research Institute; G. Darko, Kwame Nkrumah University of Science and Technology / Chemistry This study was conducted to determine metals distribution and bioavailability in soils at the experimental fields of the Council for Scientific and Industrial Research – Crops Research Institute at Fumesua, Ghana. Characterization and mapping and of metals in soils and food crops, is an important first step in the evaluation of ecological and human health towards the overall achievement of two of the United Nation's Sustainable Development Goals namely; GOAL 3: Good Health and Well-being, and GOAL 12: Responsible Consumption and Production. One hundred and three soil samples were collected along a 100 m x 100 m grid followed by laboratory analyses for soil physicochemical properties and over 30 essential and non-essential elements by x-ray fluorescence. For confirmatory analysis, inductively coupled plasma-mass spectrometry was used to analyze a subset of the samples. The relationship between metal distribution, physicochemical properties, and bioavailability was then explored. The average concentrations of potentially toxic metals such as arsenic, antimony, cadmium, chromium, copper, lead, molybdenum, and zinc were all below the Canadian Council of Ministers of Environment soil quality guidelines for agricultural land use which was used to assess the data due to the lack of Ghanaian soil quality guidelines. However, arsenic, cadmium, molybdenum, and zinc concentrations at a few of the locations exceeded the guidelines. The results of the study including elemental distribution across the experimental fields, the potential accumulation, and effects of beneficial and toxic metals to the crops and their human consumers will be presented.

3.05.04

Elevated Heavy Metal Content of Vegetation and Soil Samples From Abandoned Artisanal Mining Sites in Ghana

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Heavy metal exposure due to metal mining is a significant source of pollution in sub-Saharan Africa. In Ghana, concerns have been heightened due to the recent increase in artisanal gold mining activities. To address the effects of illegal mining, the government of Ghana has instituted a temporal ban on artisanal mining. However, the devastating effects can persist and remain in food, soil and water systems in mining communities over a long period. In this work, we present results of the exposure of toxic and potentially toxic metals in food, vegetation, soil, and water samples from communities where mining activities have been halted for at least one year. The samples were digested using a microwave digestion system with the help of $\text{HNO}_3/\text{HCl}/\text{H}_2\text{O}_2$ mixture and analysed for the levels of mercury (Hg), lead (Pb), chromium (Cr), copper (Co), manganese (Mn), zinc (Zn), arsenic (As), cadmium (Cd), cobalt (Co), nickel (Ni), and iron (Fe), using Inductively Coupled Plasma – Mass Spectrometer (ICP-MS). The results showed generally elevated levels of metals in water, food, vegetation, and soil samples. In vegetation samples, the average concentrations of Pb, Hg, Cd and As were 198.3 $\mu\text{g}/\text{kg}$, 116.2 $\mu\text{g}/\text{kg}$, 74.5 $\mu\text{g}/\text{kg}$, and 519.0 $\mu\text{g}/\text{kg}$, respectively. Average As and Pb levels were 11,111 $\mu\text{g}/\text{kg}$, and 3,518 $\mu\text{g}/\text{kg}$ respectively, in soil samples collected from abandoned mining sites. Food crops (cassava and plantain samples) grown on abandoned mining fields had high levels of Pb (500.7 $\mu\text{g}/\text{kg}$), Hg (15.69 $\mu\text{g}/\text{kg}$), and As (14.38 $\mu\text{g}/\text{kg}$) in samples. The observed widespread exposure, high concentrations, and potential health risks posed by these metals call for proactive measures at reclamation and remediation of affected lands to protect the environment and human lives.

3.05.05

Environmental Assessment of Heavy Metals Contamination of Soil in Selected Dumpsites in Niger Delta, Nigeria

G.E. Dike, Federal University of Petroleum Resources, Effurun, Nigeria This study investigated the concentrations of five (5) heavy metals such as Cadmium, Lead, Copper, Manganese, and Zinc on soil in dumpsites of Osubi vicinity in Delta state, Nigeria. The range of metal concentrations in the Osubi Municipal dumpsite were: Cu(4.7 – 9.25 Mg/Kg) , Pb(1.4 – 3.7 Mg/Kg) , Mn(12.9 -29.5 Mg/Kg) , Cd(< 0.1 Mg/Kg) , Zn(3.05 – 11.4 Mg/Kg) whereas range of metal concentrations in Osubi Abattoir Dumpsite were Cu(9.35 – 23.45 Mg/Kg) , Pb(1.1 – 24.55 Mg/Kg) , Mn(44.1 -71.6Mg/Kg) , Cd(< 0.1 – 0.4 Mg/Kg) , Zn(49.7 – 201.8 Mg/Kg) and the ranges for the control samples were : Cu (2.85 – 3.6 Mg/Kg) , Pb (0.35 – 1.3 Mg/Kg) , Mn (22.15 -67.1 Mg/Kg) , Cd (< 0.1 Mg/Kg) , Zn (5.95 – 17.85 Mg/Kg). The Geo Accumulation index showed no contamination in all samples except Pb and Zn in samples 5, 8, and 9 which shows moderate contamination. The contamination factor showed that all are uncontaminated except Pb and Zn in samples 5, 8, and 9 which are moderately contaminated, and considerable contamination for Cd in sample 9. The Ecological Risk Factor showed that all heavy metals show low risk except Cd which shows the considerable risk for its only sample seen and Lead which shows low moderate risk. In PLI (Pollution Load Index), all samples show no sign of pollution, although its value of 0.91 in sample 9 was close to the baseline of 1. A strong association between Pb/Cu, Mn/Cu, and Zn /Mn. Influenced by anthropogenic activities suggest a similar source. There are more than 20 million people living in Warri. The rapid growth of the population has contributed largely to the increasing rate of waste generation in major cities in Warri. High concentrations of heavy metals in both water and soil, caused by waste disposal, can lead to implications on plant and human health because of their toxicity and tendency to accumulate in food chains.). Therefore, it is very necessary to explore the state of pollution in the soil and assess the potential contamination and risk assessment. Soil samples are digested using acid digestion and analyzed using Atomic Absorption spectrometry. Ecological risk index, Pollution Load Index, and geo-accumulation index are calculated. The results showed a growing risk of pollution in the study area and concluded that contamination is generally low but there are cases of pollution risk in some samples. There is a need to educate the populace around the dumpsites of the risk of dumping wastes illegally.

3.05.08

Validation of the Artificial Mussel to Monitor Lead at Different pH Levels in Freshwater Environments

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Lead, which is extremely toxic to humans and animals, is a potential metal found in acid mine drainage. Artificial mussels (AMs) are a fairly novel tool usually utilized for the monitoring of metals in either freshwater or marine environments. In this experiment, the efficacy of the artificial mussel in the presence of lead was tested. The AMs were assembled and then exposed to various pH levels, from 2 to

7, in the presence of 50 mg/L of lead acetate for 24, 48 and 96 hours. Water quality parameters, such as pH, electrical conductivity and temperature were measured as well. When the artificial mussels were exposed to lead acetate in aqueous solutions ranging in pH, the uptake in the AMs at lower pH's, such as 2,3 and 4, did not show an increase over the exposure duration. At elevated pH's, such as 5, 6 and 7, the AMs have a relatively steady uptake of lead, especially over a longer duration. This is related to the speciation of Pb at the different pH values. It is attributed to competitive binding or the lack thereof for the free ions at the various pH levels, thus allowing for either more or less efficient binding of the metals to the Chelex-100 beads. Thus, AMs are not suitable tools to monitor Pb levels at pH levels that are representative of AMD.

3.05.10

The Effect of Acid Mine Drainage and Diffuse Sources of Pollutants on Macro-Invertebrate and Fish Species Abundance and Diversity in the Yellow Jacket and Mazowe Rivers

Z. Jiri, Bindura University of Science Education / Biological Sciences

Macro-invertebrates and fish are good bio-indicators of water quality. Their structure and species composition can be used in determining the condition or health of rivers. Acid mine drainage (AMD) is characterised by low pH and increased bio-availability of metals. The effect of AMD and diffuse sources of pollutants on macro-invertebrate and fish species composition, abundance and diversity in the Yellow Jacket and Mazowe Rivers, Zimbabwe was investigated during two low flow and two high flow periods. The South African Scoring System (SASS version 5) biotic index for rapid assessment of water quality using benthic macro-invertebrates was employed. A total number of 33 macro-invertebrate taxa were recorded during all the sampling surveys with the lowest macro-invertebrate taxa being the Athericidae while the Chironomidae was the most abundant taxa. The rare taxa included the Aeshnidae, Elmidae, Athericidae and Corduliidae while the most common taxa included Coenagrionidae, Chironomidae, Corixidae and Thiaridae. No organisms were caught at site 2 and 3 during low flow 1 with only the Chironomidae being caught at site 2 in the subsequent seasons. Generally low fish diversity was observed during this study with site 1 having the highest diversity during high flow 1. Two exotic species, *M. salmoides* and *O. niloticus*, were sampled and the most abundant fish species was *Oreochromis niloticus/mossambicus* hybrid. A disparity in macro-invertebrate and fish species diversity between site 1 above Iron Duke Mine and downstream sites was observed and could presumably be attributed to metal contamination from the mine. The rehabilitation of the mine dumps by Iron Duke Mine have not solved the chronic acid mine problem and the evaporation ponds are strongly affecting the water quality of the two rivers.

Towards a Harmonized Approach for Microplastics Research in Africa

3.06.01

A Synopsis and Critical Review of Microplastics Research Southern Africa: Working Towards a Harmonized Approach for Microplastics Research in Africa

C. Sparks, Cape Peninsula University of Technology / Conservation and marine sciences

Plastics production is increasing globally and with this comes challenges regarding plastic litter. Due to poor waste management practices, plastic litter is ever increasing in the environment. The degradation of plastics results in the formation of smaller plastics, referred to as microplastics (< 5 mm). These types of plastics and the production of microplastics are becoming more prevalent in coastal and marine environments of Africa and potentially poses a threat to the health of organisms and ecosystems, as well as human health. Microplastics research is currently being done at the Cape Peninsula University of Technology (CPUT) in Cape Town, South Africa. The aim of this presentation is to show the results of microplastics research conducted by CPUT staff, post graduate and undergraduate students. Research undertaken is focused on microplastics research in coastal areas and results on catchment areas will also be presented. The challenges encountered regarding resources and quality control to undertake microplastics research is shared with the intention to foster collaboration with partners undertaking similar research and to contribute to the global discussion on standardized protocols. The envisaged future of microplastics research in Africa is presented in the hope that the presentation will contribute towards the harmonization of microplastics research in Africa.

3.06.02

The Dispersal Potential of Microplastic Associated Coliform Bacteria and Antibiotic Resistant Genes in the Ocean: A Microcosm Study

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Microplastics can originate from aquatic-based sources through the weathering and photolysis of discarded plastic items in the water or land-based sources such

as runoff and wastewater outfalls. The presence of antibiotic-resistant bacteria and antibiotic-resistant genes in biofilms means that microplastics may not only be pollutants but may also act as vectors of antimicrobial resistance in marine environments. The aim of this study was to isolate coliform bacteria from microplastics in a simulated marine sewage outfall. Microcosms have been set up by spiking artificial seawater with WWTP (wastewater treatment plant) effluent. Polyethylene, polypropylene and polystyrene of 5mm in size were added to the microcosm. Selective media and incubation conditions were used to isolate *Enterobacteriaceae*. Polypropylene has been found to harbour the most pathogens with 37% of these isolates being resistant to eight of the antibiotics tested. Sequencing results showed the presence of *Shigella* spp. The 16S rRNA gene fragments are not suitable to differentiate between *E. coli* and *Shigella* spp. due to a close relatedness. Even so, *Shigella* spp. have a higher pathogenicity than *E. coli* with a low infectious dose thus making it of utmost importance to correctly identify the microorganisms. The housekeeping genes of *E. coli* are highly conserved, but they were found in isolated *Shigella* spp. as well. Furthermore, the isolates should be screened for virulence factors as these microplastic-associated microorganisms are able to survive in colder conditions, harbour virulent genes and disperse throughout the ocean by means of microplastic transportation. **Keywords:** microplastics, wastewater, coliforms, antibiotic-resistance.

3.06.03

Metals and Microplastics (Including Antifouling Paint Particles) in Coastal Sediment at Simons Town (Cape Town, South Africa)

A. Awe, CPUT / Conservation and marine sciences; C. Sparks, Cape Peninsula University of Technology / Conservation and marine sciences
Maintenance of maritime vessels includes the removal of paint from hulls that ultimately ends up the aquatic environment. Coastal maritime vessel maintenance is a source of antifouling paint particles (APPs) that ends up in the coastal environment that have the potential to impact coastal organisms. The extent of the impact of APPs is not well understood as APPs are considered to be sources of metals and persistent organic pollutants. APPs are also characterised as microplastics (MPs) due to polymers that make up APPs. Simons Town is a small urban area in False Bay, Cape Town where numerous maritime activities take place (there is a naval harbour, marina and boat maintenance facility). The aim of this study was to measure metals and APPs in coastal sediment in Simons Town as well as ascertain the characteristics of MPs (APPs). Sediment samples were collected from 6 sites during winter 2018. Sediment and extracted APPs were analysed for metal content and MPs characterised based on type (visual and polymer), colour and size. Metal and MP concentrations were highest at the slipway of a boat maintenance facility, decreasing with increased distance from the slipway. Interestingly, MP fibres were highest at a site close to a stormwater outfall pipe. Our results suggest that boating maintenance facilities are potential sources metals and MP fragments, with stormwater pipes potential sources of MP fibres.

3.06.04

Assessment of Microplastic Pollution in the Diep River (Milnerton), Western Cape, South Africa

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Rivers play an important role in the water cycle and serve as habitat to various species in aquatic ecosystems. They serve as a source of microplastics litter into the ocean. Microplastics are ubiquitous, with the potential for accumulation in the environment. Improperly disposed plastics often end up in the freshwater ecosystems. The Diep River runs through the City of Cape Town via neighbourhoods with different land use types into the ocean. In this study, microplastics particle burden in the Diep River was assessed. Water and sediment samples were collected from five sites on the Diep River and analysed for microplastics. Some physico-chemical parameters of the river water were measured onsite. On the field, 100 L sample was filtered through a 250 µm mesh and 20 L collected for processing in the laboratory. The 20 L sample was filtered through a 20 µm mesh in the laboratory. The microplastics extracted were characterized using microscopy and Fourier-transform infrared spectroscopy (FTIR). The results revealed that the Diep River physico-chemical parameters such as pH, dissolved oxygen, conductivity, and temperature were within the South African Water Quality standards regulatory limits. Fibres were the most predominant microplastics particles identified in water and sediment samples. Tourist and recreational had higher microplastics burden relative to non-tourist areas. This study will provide information for management strategies in policy development and implementation, protection, and other mitigation strategies about

the microplastic burden of the Diep River.

3.06.05

Fisheries Diversity, Macro- and Microplastic Distribution in Surface Water, Sediment, Macroinvertebrates and Fish Species of the Lagos Lagoon, Nigeria
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The increase in the use of plastics has led to an uncontrolled buildup of plastic wastes in the environment. The fragmentation of plastic materials produces microplastics (< 5 mm) which have been found in environmental matrices such as surface water, sediments and aquatic organisms. In this study, Six (6) anthropogenically impacted areas (Abule eladun, Bariga, University of Lagos, Makoko, Ebute ilaje and Okobaba) of the Lagos lagoon, Nigeria will be assessed and characterized for plastic pollution over a period of three (3) months (May 2021 to July 2021). Surface water and sediment physicochemical parameters, macrobenthic invertebrate and fish species diversity will be evaluated. Further, macroplastics and microplastics will be quantitatively assessed and characterized in the surface water, sediments and fish species collected from the sampling areas. Studies will be conducted following standard protocols. In the first month of study (May 2021), most of the surface physico-chemical parameters tested were within the regulatory limit. A total of Six (6) macrobenthic invertebrate species from Five (5) families and Eight (8) fish species from Seven (7) families were recorded with Okobaba having the highest diversity of macrobenthos species (0.778) and Abule eladun having the highest diversity of fish species (0.803). *Penaeus monodon* (Prawn) and *Tenualosa toli* (Toli shad) being the most abundant macrobenthos and fish species respectively. The average macroplastic weight ranged from 2.21 kg at Ebute Ilaje to 12.09 kg at Makoko comprising mostly of Polyethylene terephthalate (PET bottles) and Polyethylene (plastic bags). A total of Three (3) ingested plastic fragments were found in *Tenualosa toli* collected at Okobaba and Four (4) plastic fragments were found in the sediment collected at Abule Eledun. The results delineate plastic pollution hotspots on the Lagos lagoon and the potential adverse impact to fisheries. We recommend the strict monitoring on plastic use, disposal and recycling to curb plastic pollution in the lagoon in support of the United Nations Sustainable Development Goals 14 (Sustaining Life Below Water).

3.06.06

The Impacts of Stormwater Outlets on Microplastic Distribution and Coastal Biodiversity in Cape Town, South Africa

R. Ariefdien, CPUT; A. Awe, CPUT / Conservation and marine sciences; C. Sparks, Cape Peninsula University of Technology / Conservation and marine sciences; M. Pfaff, Department of forest fisheries and environmental
An estimate of 4.8–12.7 million tonnes of plastic waste is released into the sea from coastal areas annually as a result of poor waste management. Associated with this is the degradation of plastics into smaller particles (< 5mm), referred to as microplastics (MPs). The City of Cape Town is a large coastal city with 4.5 million inhabitants, covering 307 km of coastline that is highly ecologically diverse and productive. Therefore, the coastal ecosystem of Cape Town has a high probability of being impacted by stormwater outlets, especially during the rainy season (winter). The aim of this study was to identify the distribution of MPs around stormwater outlets in sediment, water and three different invertebrate feeding groups (filter-feeders, grazers and carnivores). This was done to ascertain whether these outlets are sources of higher abundance of MPs in the coastal environment and to identify if MPs change the structure of biodiversity on rocky shores close to stormwater outlets. MPs were sampled in summer and winter at impact and control sites at Camps Bay, Three Anchor Bay and Mouille Point during spring low tide. MPs were extracted from samples and analyzed based on type (visually using microscope and polymer type by FTIR-ATR), colour and size. Higher concentrations of MPs were recorded during the rainy season (winter) as well as at all impact sites than control sites. The results suggest that stormwater outlets are sources of MPs and potentially affect the biodiversity of coastal ecosystems. Further research is required to analyze the impacts of MPs from coastal outlets on coastal biodiversity in South Africa.

3.06.08

Characteristics and Distribution of Litter and Microplastics in Table Bay, Cape Town, South Africa

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Litter in marine and coastal environments are known to negatively affect local ecosystems, with subsequent impacts on the economy and human health. Most litter comprises plastics that subsequently degrade into smaller particles (< 5 mm) known as microplastics. The relationship between plastic litter and microplastics is poorly known, as most research and monitoring tend focus on one or the other.. Hence, the aim of this study was to investigate the summer and autumn characteristics and distribution of litter and microplastics in Table Bay, Cape Town at Woodbridge Island and Derdesteen sites, approximately 15 km apart. The

two sampling sites were chosen based on their similar exposure to wind and current as well as based on their difference in the frequency of visitors, major land use and the proximity to residential areas (suburban or rural) and river. Each sampling site comprised a 100 m stretch of beach, with litter samples collected over a period of 10 consecutive days to determine daily accumulation rates. Litter was analysed based on type and weight. Microplastics were extracted and digested from water and sediment and characterised based on type, colour, and size. Polymer identification of litter and microplastics was done using a Perkin Elmer Two FTIR-ATR Spectrometer. The results indicated that plastic was the most abundant type of litter at both sites (based on counts and weights) for both seasons.. For microplastics, the most predominant type was fibres that were red and smaller than 0.5 mm at both sites and for both seasons sampled. Given the limited microplastics fragments sampled, it was not possible to derive correlations between plastic litter and microplastics, but the research protocol followed provides a basis for the development of a routine monitoring protocol of coastal areas.

3.06.09

Microplastics in filter-feeding, Grazing, and Scavenging Invertebrates at a Rocky Shore in Simons Town, Cape Town, South Africa

L. Ferguson, Cape Peninsula University of Technology / Conservation and marine sciences; A. Awe, CPUT / Conservation and marine sciences; C. Sparks, Cape Peninsula University of Technology / Conservation and marine sciences
Microplastic (MP) contamination is an ever-growing threat to the natural environment, but minimal research has been done in South Africa on the dynamics of MPs within rocky shores. Aided by their long lifespan, MPs are resuspended within rocky shores due to their buoyant nature and are biologically available to marine organisms for a longer period. The aim of this study was to determine whether there is a difference in MP concentrations between invertebrates with different feeding strategies at a rocky shore. Sampling was done in February 2020 (summer) at an enclosed rocky shore in Simon's Town, Cape Town. Water, sediment, and biota (filter-feeders, grazers, and scavengers/predators) were sampled at low tide, digested, and analysed based on MP type (visually using microscopy and polymer type using an FTIR-ATR), colour and size. Environmentally, higher concentrations of MPs were found in water than in sediment samples. Rocky shore invertebrates had higher concentrations of MPs in scavengers/predators and grazers when compared to filter-feeders. However, filter-feeders ingested a broader range of microplastics when based on type, size, and colour. This is likely due to filter-feeders being non-selective feeders and feed on randomly suspended MP particles in the water column. The findings suggest that filter-feeders are more likely to take up MPs than grazers and scavengers/predators. As a baseline study for the area, this study provides motivation for further research to be done on monitoring of MPs in order to assess trophic transfer of MPs in rocky shores. The sampling and sample processing also presents a Standard Operating Procedure for microplastics sampling that can be used to analyse microplastics in rocky shores in South Africa.

3.06.10

First Report on the Occurrence and Distribution of Microplastic Residues in Surface Waters of Lake Hawassa, Ethiopia

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Plastics are synthetic polymers known to have made a significant change in our life since their inception into commercial products. The continuous use of plastics in different forms of consumer products and their application as a non-recyclable and single usable material results in the continuous entry of plastic residues into the terrestrial and aquatic environment. Due to the paucity of information on macro and microplastic contamination in Ethiopian water resources, we conducted this study to investigate the occurrence and distribution of micro and macroplastic residues in the surface water of Lake Hawassa in Southern Ethiopia. A preliminary survey was conducted to categorize the sampling sites in lakes and to organize them into zones based on the level of human and industrial activity. The surface water was sampled for the extraction of macro and microplastic residues. The microplastics were extracted from the water samples by separation on a 500µm sieve followed by H₂O₂ oxidation and density separation on NaCl solution. The samples were further filtered on a 0.45-micron filter and individual particles were visually inspected for separation of microplastic residues. High variability in the microplastic residues was observed based on the type and colour and an increased number of particles were obtained in the region of high human activity. The current study is the first of its kind in lake Hawassa and further studies were planned to investigate the spatial distribution of Microplastic residues in sediments and biotic organisms. **Keywords:** Microplastic, Surface water, Hawassa, Distribution.

3.06.11

Environmental Concentrations of Microplastics in Selected Echinoderms in Rocky Shores of the Western Cape, South Africa

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Plastic debris is accumulating in all environments at an alarming rate. South Africa's poor waste management plan has led to an increase in plastic contamination in freshwater, estuarine and marine environments. Microplastics are defined as plastic particles less than 5 mm in diameter and information about microplastics in coastal environments and biota in South Africa is poor. The aim of this study was to determine coastal concentrations and ingested microplastics in echinoderms. Echinoderms (n = 20 per site) were sampled in summer 2020 during low tide at 14 rocky shore sites along the coast of the Western Cape, South Africa. Sampling effort was subject to availability of echinoderms at the sites sampled, but at least two types of echinoderms were analysed per site. Environmental and biota samples were digested and microplastics extracted and analysed based on visual type, colour, size and polymer type (using an FTIR-ATR). Filter-feeding echinoderms (sea cucumbers) had higher concentrations of microplastics compared to grazing echinoderms (sea urchins and cushion stars) and predators/scavengers (starfish). Higher concentrations of MPs were found in urban areas when compared to rural areas. The concentration of microplastics were higher at Cape Town sites than False Bay and the West Coast. The results suggest that filter-feeding echinoderms in urban areas are more susceptible to ingesting microplastics than those found in rural areas. This study will contribute towards historical data and assists in providing baseline information regarding microplastics contamination along the coast of southern Africa.

3.06.14

Microplastics in the Veldwachters River, Cape Town: Contribution of a Wastewater Treatment Plant

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Microplastics (MP) occurrence in aquatic ecosystems is a global concern. MPs enter freshwater and marine ecosystems through many sources. Significant contribution is from wastewater treatment plant (WWTP) effluents discharged into receiving waterbodies. This study investigated the physicochemical properties of the WWTP effluent and the occurrence of MPs in the plant's influent and effluent samples. Water and sediment samples were collected upstream, point of discharge and downstream of the receiving Veldwachters River in spring and autumn months. MPs in water and sediment samples were extracted, digested, and identified using microscopy and Fourier-transform infrared spectroscopy (FTIR). The physicochemical characteristics for both seasons were largely within the South African regulatory limits for effluent discharge. The total dissolved solids (TDS) in spring (470 ppm) was an exception with slightly higher values than the required standard (460 ppm). Particles of MPs in the 2000 – 1000 µm and 1000 – 500 µm were the most predominant and fibre/filament were the mostly identified MPs types in the samples. The WWTP processes did not effectively remove MPs from wastewater. Other sources of pollution contributed to the MP burden upstream and downstream of the river. These results will provide insights into the fate and transport of MPs in freshwater; this will be valuable for the holistic assessment of the environmental risk posed by MPs.

3.06.15

Profiling Microplastic Pollution in Mangrove Dominated Estuaries of the Eastern Cape Region in South Africa

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Microplastic (MP) pollution has been recognized as a global environmental threat. A wide variety of plastic spheres, differing physically and chemically, have been detected in all major marine and coastal environments and various marine fauna. Baseline levels for MP pollution in many biodiverse ecosystems and geographical regions, have not yet been established and this is particularly true for Africa. This is concerning, since countries like South Africa rank highly in terms of marine plastic pollution globally. Additionally, recent reports suggest that these ecosystems are sinks for plastic pollution. This study forms part of the first comprehensive assessment of MP pollution in the mangrove-dominated estuarine systems of South Africa, providing some of the first data on estuarine MP levels in the Eastern Cape region. The study aimed to quantify the distribution, typology (size, morphotype, colour and chemical composition) and density of microplastics in relation to selected disturbances acting on these systems. Surface water samples were collected at the mouth of each estuary, while sediment samples were collected within three intertidal zones (at varying distances from the main channel) in four mangrove-dominated estuaries. Preliminary results suggest potential differences in MP profiles between urban and rural systems; urban systems had higher MP levels (~ 70% more) in both sediment and surface water. Microfibers dominated in sediment and surface water for this study. The results

are in agreement with recent studies which have reported higher levels of MPs in anthropogenically disturbed estuaries and the dominance of fibres. This study, therefore, supports a growing opinion that mangroves represent MP sinks. The ultimate goal of the study is to both understand and communicate the implications of MP pollution in this ecosystem to encourage land use and waste management practices that reduce plastic pollution inputs into them.

3.06.16

The Cytotoxic Effects of Virgin and Recycled Polyvinyl Chloride Microplastic Leachates and Adsorbents

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Plastics have become ubiquitous in all environments. One of the most abundant plastic polymers is polyvinyl chlorides (PVC). Despite PVC's reputation for the additive use of bisphenol-A, phthalates, and brominated flame retardants in its production, it is still largely used in the industrial sector today. Plastics are not biodegradable and therefore every piece of plastic ever produced, is still in existence today. Larger plastics disintegrate due to weathering into smaller fragments (< 5 mm) known as microplastics (MPs). Microplastics have the ability to concentrate and transport hazardous pollutants in marine and terrestrial environments. There is also the additional concern of pollutants such as persistent organic pollutants and polycyclic aromatic hydrocarbons that adsorb to the plastic. Furthermore, the recycling process introduces additional additives to plastic, and once the plastic is unable to be recycled it ends up in the environment regardless, however now with added pollutants. Whilst additives may leach into water, and the pollutants that have adsorbed to the plastic may desorb, a large number of organisms will ingest these microplastics, raising concern about the direct effect of the accumulated chemicals on these organisms. Whilst the effects of individual additives and adsorbents have been studied, their combined effect provides a more realistic understanding of the potential hazards. The aim of this study was to determine the influence of virgin and recycled PVC MP leachates and adsorbents on the viability of human duodenum cells. Plastic pellets (< 5 mm) were collected from a plastic factory. Three types of virgin PVC with different constituents, and three types of recycled PVC were leached in ethanol for 24, 48 and 96 hours at 4°C and 30°C. HuTu-80 cells were used in an MTT (3-[4,5-dimethylthiazol-2-yl]-2,5-diphenyltetrazolium bromide) assay to determine the cytotoxicity of leachates and adsorbents. Overall, the recycled plastics were more cytotoxic than the virgin plastics. Cytotoxicity was apparent at both 4°C and 30°C. However, the 24 and 48 h leaching periods appeared to be the most cytotoxic. Recycled plastics, therefore, may pose a higher risk when released into the environment.

3.06.18

Plastic Pollution in the Environment in Nigeria: A Rapid Systematic Review of the Sources, Distribution, Research Gaps and Policy Needs

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Plastic are emerging pollutants requiring urgent intervention for its management. In African developing countries like Nigeria, the evidence base to inform plastic pollution management is scanty. This rapid review aimed to systematically evaluate evidence on the distribution, sources, biological effects, research gaps and policy needs of plastic pollution in various environmental matrices in Nigeria. Peer-reviewed journal articles on nano- micro-, meso- and macroplastics contamination of water, sediment, air, soil and biota were accessed from PubMed, Google Scholar and Science Direct, screened, comprehensively revised and critically appraised for inclusion, data extraction and evidence synthesis. 356,242 articles were accessed from any publication date up till May 30, 2021. Only 30 articles met the inclusion criteria and critical appraisal. Only 21 of the included studies reported the distribution, levels and effects of microplastics (MPs) (n = 10), macroplastics (n = 10) or both (n = 1) in water, sediment and biota. Only 23 of the 36 states and the Federal Capital Territory had any data on micro- and macroplastics. Macroplastics from land-based sources were majorly reported from educational institutions, residential areas and markets. Flooding, fishing activities, wind deposition, wastewater treatment plants, tire wear, e-waste sites, runoff, wastewater irrigation, among others were identified as sources of MPs in the aquatic environment in Nigeria. Biological effects (oxidative stress, neurotoxicity, reduced plant root biomass) of virgin MPs were reported in crab, African catfish and lime tree only. MPs data in biota were limited to select fish species, aquatic insects and gastropods. Research gaps on plastic distribution in aquatic ecosystems in Northern Nigeria, terrestrial biota, soil, air, other aquatic biota, ground and potable water sources and biological effects were identified. Policy needs identified include stakeholder education, polymer replacement, recycling tax and incentives to support the sustainability of life below water and on land (UN SDGs 14 and 15).

Ecological Risk Assessment: Environmental management frameworks in emerging economies

4.01.01

A Tiered Weight-Of-Evidence Risk Assessment Methodology for Informing Decisions and Drawing Conclusions About Chemical Management

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This paper presents a tiered approach to WoE developed through workshops in Africa and elsewhere. A tiered approach begins with a relationship among assessors and risk managers as they address a problem from their unique perspectives. For practical reasons, it makes sense to begin simply and to ensure there is a shared understanding. The fundamental elements of WoE are present in these initial steps. This ensures a continuum of understanding and purpose. This guides the marshaling of evidence that the assessor and manager collectively understand are needed to ensure a reliable basis for decision-making. We outline a tiered WoE approach that reflects lessons learned and input from a number of workshops at SETAC meetings around the globe. Importantly, there is keen interest in reliable starting points (i.e., Tier 1) within developing countries. The approach is organized around three tiers and is designed to complement recent OECD guidance. The relationship aspects between assessors and managers are emphasized and guidance is provided on the types of information and tools that might be used at each tier. The approach also incorporates explicit feedback mechanisms to guard against unknowns. This is believed to be especially important for management of emerging chemicals. While it might be challenging to reach consensus among stakeholders around complex chemical use and management problems, the proposed tiered WoE could be the framework for achieving a shared understanding and the confidence needed to make decisions regarding acceptability, unacceptability, use restrictions, or the need for further information.

4.01.04

Incorporating Regional Risk Assessment and Ecosystem Services to Inform Amphibian Conservation Management Strategies in the Phongolo River Floodplain, South Africa

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The Phongolo River floodplain in South Africa is the largest inland floodplain in South Africa and is considered a biodiversity hotspot. Human communities living in the floodplain are highly dependent on the system for subsistence in terms of water use, agriculture, and fisheries. The floodplain falls within a malaria risk region where DDT and other pesticides are used for indoor residual spraying of homesteads. There is mounting evidence that these pesticides do reach and accumulate in the aquatic environment of the floodplain. We conducted a regional risk assessment using a Bayesian network methodology to assess the risk to amphibian well-being posed by these chemicals and other stressors in the environment. A parallel assessment of the effect of these stressors on ecosystem services in the region was conducted using a matrix model approach. The combination of the two assessments served to place risk to amphibian well-being in context with the socio-ecological balance of the system. Based on the risk distribution outcomes of these assessments analysed through current state and desired state scenarios, priority habitats were identified where intervention would have the greatest impact in reducing the risk. The assessment of amphibian well-being showed the highest probability of being at moderate risk across all habitats. The aquatic habitats, namely: river, temporary pans (wetlands), and permanent pans were identified as top priority habitats for managing risks to both amphibian well-being and ecosystem services in the floodplain. Furthermore, amphibians were shown to be more sensitive indicators for the stressors in this region than ecosystem services. The outcome of this study qualifies the use of amphibian well-being as a monitoring tool for chemical risks within the Phongolo River floodplain as early detection for potential socio-ecological impacts.

4.01.06

Ecotoxicological Evaluation of Effluent Quality From a Municipal Wastewater Treatment Plant in Western Cape, South Africa

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Complex effluents released into the water bodies lead to the pollution of the receiving inland water. Recently, environmental protection, water quality monitoring, and management use ecotoxicological assessment of effluents to complement routine chemical evaluations. This study assessed the ecotoxicological effects of a wastewater treatment plant (WWTP) effluent using a battery of tests. The study evaluated the WWTP effluent quality by measuring the Physico-chemical characteristics of the effluent and its potential effects on the

organisms in the receiving waterbody. Model organisms used in the battery of tests included a producer- *Pseudokirchneriella subcapitata*, a consumer- *Daphnia magna*, and a decomposer- *Tetrahymena thermophila*. The algal, crustacean, and protozoan tests were used to determine the potential toxicity levels and sensitivities of each test model in the ambient environment. Toxicity assessment of the WWTP effluents samples was performed using Microbiotests' ToxKits. The chemical oxygen demand (COD) values ranged between 41-83 mg L⁻¹; dissolved oxygen (DO) values were 2.7-3.1 mg L⁻¹. Corresponding values for redox potential and total dissolved solids (TDS) were 189-265 mV and 656-718mg L⁻¹ respectively. The findings revealed that analysed physicochemical parameters were within the World Health Organization (WHO) acceptable thresholds with few exceptions. *D. magna* mortality rates in the whole effluent were the same (15%) for autumn and summer months but mortality tripled (45%) for samples collected in winter. The toxicity effect was therefore dependent on the seasonal variation with the highest observed in the winter season. The results showed that the WWTP whole effluent exerted toxicity to test organisms but dilution mitigated the effects considerably. The use of ecotoxicological assessment methods for municipal WWTP effluents may enhance existing water management strategies

Integrated Environmental Assessment and Management (general)

4.02.02

Risk Assessment of the Pesticide Residues in Samples of Irish Potatoes From Jos, Nigeria

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The indiscriminate use of pesticides has raised serious concern due to the toxic effects of residues on most non-target organisms. Analysis of pesticide residues in food and other environmental commodities have become an essential requirement for consumers, producers, food inspectors and authorities. The estimation of pesticides residues via dietary intake constitutes a vital integral part of regulatory processes that seeks to preserve public health. This study is focused on validation of an accurate, rapid and reliable method for residual analysis of pesticides in samples of Irish potatoes. Different samples of Irish potatoes were collected from five different markets (Terminus market, Faringada market, Bukuru market, Kwararafa market and Gadabiu market) in Jos, Plateau state. The pesticide residue analysis was carried out using GC/MS. From the result, 17 different pesticide residues were identified with ten (10) organochlorines, two (2) organophosphates, one (1) thiocarbamate, one (1) benzamide and two (2) of them unclassified. The concentration of these pesticides were determined which was then used to determine the estimated daily intake. The results obtained shows that of these pesticide residues exceeded their ADI and MRL making them hazardous to the human health. Considering the health risk index of consumers; Aldrin, Heptachlor, Mecarbem and Dieldrin proved to be very hazardous (p>1). These pesticides can cause harmful effects on the food commodities which ultimately causes a damaging impact on the health of humans. To guarantee food safety, continuous monitoring is recommended for pesticide residues in Irish potatoes and other food source in Nigeria.

Pollinators in Sustainable Agriculture: Approaches to Bridging the gap Between Science and Societal Needs

4.03.06

Flowering Seasons Affect Diversity, Quality and Levels of Pesticide Residue Contamination on Honeybee-Collected Pollen

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Insect pollinators, and particularly honeybees, play a crucial role in the pollination of agricultural crops. Honeybees depend on pollen for protein which is essential for colony health and brood development. Landscapes and flowering seasons play a huge role in determining floral resource availability to honeybees and understanding the role of the two aspects is important for pollinator health. This study was carried out in the Murang'a agricultural landscape, where landscape is highly fragmented and natural vegetation replaced by food crop cultivation. Landscape was characterized according to the degree of greenness using the Normalized Difference Vegetation Index (NDVI) into: high, medium, and low NDVI zones. We determined how the corbicula pollen quality and quantity fluctuated across the three different NDVI landscape types, flowering seasons, and the levels of pesticide residue contamination on the pollen. We did this through a monthly sampling of honeybee-collected pollen from 18 apiaries for 12 months (November 2019 - October 2020). Floral origin of the pollen was done via palynology, crude protein content was measured through spectrophotometry, while multiresidue analysis was used to detect pesticide residues present and their concentrations. Pollen crude protein ranged between 0.39 - 7.11 %. A total of 11

pesticides residues were detected, and their concentrations ranged between < 0.1 to 1203 ppb. Our findings suggested that insecticides (9) were the most widely used chemicals while fungicides (2) were the least used. We traced these pesticides to originate from 11 plant families. The families Rubiaceae and Poaceae were the most abundant at 20.5%, while Lauraceae and Theaceae occurred at 11.8%. Our results suggest that while land use itself may not correlate with the quality or quantity of available pollen resources, the nutritional landscape of Murang'a is seasonally dynamic imposing seasonal resource limitations for both managed and native bee species. There is, therefore, a need to supplement domesticated bees with alternative non-contaminated pollen sources due to the seasonal resource limitations.

4.03.07

Impact of Acute Oral Exposure to Paraquat and Glyphosate on the African Honey Bee, *Apis mellifera* Lepeletier

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Paraquat, (*N, N'*-dimethyl-4, 4'-bipyridinium dichloride) and Glyphosate *N*-(Phosphonomethyl) glycine are among the most commonly used non-selective herbicides worldwide. Damaging effects of these herbicides have been documented in non-target organisms such as the African honey bee, *Apis mellifera* Lepeletier, a critical pollinator. Our study, determined the effects of paraquat and glyphosate oral exposure to the African honey bee under controlled laboratory conditions. Bees were fed on a range of concentrations, that included the manufacturer recommended high and low field relevant applied concentrations (paraquat; 0.8 to 1.2 g/L and glyphosate; 3.375 to 6.75 g/L). Honey bee survival rates were dose -dependent. After 48 hours of post herbicide feeding and monitoring of survival, we found that the lethal concentrations (LC₅₀) of paraquat and glyphosate were 0.234 and 4.99 mg/mL, respectively. These findings suggest that foraging workers are at risk of experiencing high mortalities since they are at the front line of being exposed in the fields hence endangering the whole colony. We suggest that the currently recommended field doses be regulated to save these crucial pollinators.

Science communication and social issues linkage for sustainable policy development

5.01.01

African Agriculture, Neonicotinoid Insecticides Use, and Impact: Using Science and Stakeholder Engagements to Help Inform Policy Formulation

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Agriculture is crucial to Africa's future. Faced with a rapidly increasing population, high vulnerability to climate change, and low food productivity, the task of ensuring food security remains one of the greatest challenges facing the continent. This situation is exacerbated by the indiscriminate use of pesticides, which remain weakly regulated in many African countries. Of particular concern is neonicotinoid insecticides due to their extensive usage, high environmental mobility, and their detrimental effects on non-target organisms, including pollinators. Neonicotinoid insecticides have been shown to contribute to the loss of ecosystem services from pollinators, and harmful to beneficial insects and non-target organisms. This has led to their ban in the EU and other countries. With the current ban or restrictions in use in Europe, there is growing concern about their use on the African continent where there are weak regulation and lax enforcement of environmental laws. Faced with this concern, The InterAcademy Partnership (IAP) and the Network of African Science Academies (NASAC) collaborated in a study to examine the use and implications of neonicotinoid insecticides for ecosystem services and sustainable agriculture in Africa. The study was conducted through two workshops with leading expert scientists from 17 African countries, as well as an extensive review of relevant African research in a total of 28 African countries. Among key findings and messages to policymakers, the report generated concludes on an urgent need for action to prevent further deterioration in the sustainability of African agriculture and its biodiversity from indiscriminate and preventative use of neonicotinoids and alternative insecticides. The report was disseminated through various stakeholder engagements involving regulators, farmers, researchers, and government agencies in addressing the challenge of the misuse of pesticides and the need to protect biodiversity. This project demonstrates the critical role of science communication, research, and stakeholder engagements in informing policy development on environmental management on the continent.

5.01.02

Citizen Observation of Marine Litter in African Coastal Ecosystems

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Biological Sciences; P. Annasawmy, Lynker Technologies; A. Catarino, Flanders Marine Institute / ILES

Plastic pollution can be detrimental in marine ecosystems due to the potential hazardous effects to biota. It can also affect human health via ingestion of plastic-contaminated food items, and impact local economies by reducing ecosystem functions and services in many ways, e.g. potentially killing commercial fish species, degrading habitats, affecting the tourism industry and acting as a hazard to navigation. The presence and accumulation of plastic litter in coastal environments have become issues of high priority for policymakers around the globe. However, in many regions such as West Africa, the exact amounts of plastic litter reaching the coastal areas are still poorly known. Citizen science programs are instrumental in addressing data gap issues, assisting in shoreline sampling worldwide, and are effective in increasing public awareness of plastic pollution. The Citizen Observation of Local Litter in coastal ECosysTems (COLLECT) project is a citizen science initiative which aims to acquire distribution and abundance data of coastal plastic debris in six African countries (Benin, Cabo Verde, Cote d'Ivoire, Ghana, Morocco and Nigeria). The project consists of training students (15 - 18 years old) from secondary cycle institutions on macro-, meso- and microplastic sampling and analysis in beach sediments using a standardized procedure. The project will also measure the impact of the citizen science intervention by assessing shifts in knowledge of the nature/purpose of scientific research, attitude/awareness towards environmental conservation, and promoting knowledge transfer among the plastic ocean observing communities, simultaneously considering gender aspects. The COLLECT project aims to contribute to the United Nations' Sustainable Development Goals (SDG) by focusing on sustainability of communities (SDG 11) and sustainable use of the ocean (SDG 14), but further considering impact on good health and wellbeing (SDG 3) and gender equality (SDG 5), while promoting a responsible disposal of consumer goods (SDG 12). The results obtained by COLLECT will contribute to establishing baseline information on coastal plastic debris, with citizen science being an enabler of open science, allowing data collected to be freely available to the public, academics and policymakers. Results will further contribute to the identification of hotspots of plastic coastal litter, and bring awareness to local communities on the potential consequences of plastic littering.

Poster Abstracts

Aquatic and terrestrial ecology and toxicology (general)

2.01.01

A Study of Bioconcentration of Metals by Aquatic PLANTS in a Coal Mining Area in Zimbabwe

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A study of the Bioconcentration of heavy metals by aquatic plants in a coal mining area was conducted. Water, plant and sediment samples were collected during the dry and wet season from 4 different sites in a coal mining area in Zimbabwe. Total dissolved solids, pH, temperature and conductivity of the water was measured on site. Sediment, water and plant samples were prepared and analysed to determine the concentration of copper, lead, zinc and cadmium. The bioconcentration factor of heavy metals in plants was determined using the concentrations in the sediment and plant samples. The lowest pH value observed from the sites was 1.79 whilst the highest pH value was 8.32 during the wet season. High levels of TDS and conductivity were observed with some sites recording TDS figures of 1.20 ppt and conductivity of 2.41 mS/cm. Copper and zinc concentrations observed were higher in the wet season compared to the dry for plant samples whilst water and sediment samples had higher concentrations in the dry season compared to the wet season. Zinc in plant samples had the lowest bioconcentration factors whilst cadmium had the highest bioconcentration factors in this study. Coal mining activities result in pollution that greatly affects aquatic life and is potentially a health hazard to humans. Therefore there is a need to consistently monitor pollution levels in the environment.

2.01.03

Anaerobic Benzene Mineralization by Iron-Reducing Bacteria From Wetland Sediment of Niger Delta

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The Niger Delta contaminated wetland is one of the world's most damaged ecosystem mainly due to hydrocarbon exploration accidents. There is an urgent and vital need for a sustainable clean-up and restoration of the natural resources to save for the future. We investigated the natural attenuation potential of Niger Delta subsurface sediment for anaerobic hydrocarbon degradation using benzene as a model compound under iron-reducing, sulfate-reducing, and methanogenic conditions. The microbial communities of benzene-mineralizing enrichment cultures were characterized by next-generation sequencing of the genes coding for 16S rRNA and methyl coenzyme M reductase A (mcrA). Benzene was slowly mineralized under iron-reducing conditions using Fe(III) chelated with nitrilotriacetic acid, or poorly crystalline

Fe(III) oxyhydroxides as electron acceptors, analyzed by measurement of ^{13}C produced from added ^{13}C -labelled benzene. The highest mineralization rates were observed in microcosms amended with Fe(III) oxyhydroxides while microcosms amended with Fe(III) nitrilotriacetic acid produced methane. Abundant phylotypes were affiliated to Betaproteobacteriales, Ignavibacteriales, Desulfuromonadales, and Methanosarcinales of the genera Methanosarcina and Methanotrix, illustrating that the enriched benzene mineralizing communities were diverse and may contain more than a single benzene degrader. The diversity of the microbial communities was furthermore confirmed by scanning helium-ion microscopy which revealed various rod-shaped and filamentous microbial morphotypes. The study underpins the importance of microbial ecosystem services in contaminant degradation as a sustainable environmental means of mitigating harmful chemicals.

2.01.04

Assessment of Physicochemical Qualities, Heavy Metals Concentrations and Bacterial Pathogens in Andoni River, Rivers State, Nigeria

C.P. Aleru, Rivers State University / Medical Laboratory Science; E. Bartimaeus, Rivers State University / Department of Medical Laboratory Science

Water bodies can be polluted through different means and by microorganisms. Although, oil pollution occurs when oil from roads and parking lots is carried in runoff into water bodies, intentional and accidental oil spills are also sources of oil pollution. Oil pollution and other chemicals are sources of heavy metals, which could be carcinogenic and mutagenic. The latter is capable of causing antibiotic resistance in bacteria found in the river. This study was carried out at Andoni river, as some residents of the area still build toilets on water bodies and generally in Nigeria, there is increasing cases of oil spill, disposing of untreated sewage into water bodies, the use of human and animal excreta as manure and siting of dumps very close to water bodies. Analysis of physicochemical parameters, Heavy metals concentrations and bacterial detection were carried out using 72, 18 and 120 water samples, respectively. Physicochemical parameters were analysed periodically and seasonally. The heavy metals were analysed only seasonally. Heterotrophic plate count technique was performed both periodically and seasonally. The most probable number technique and Eijkman test were performed for the detection of *Escherichia coli* (*E. coli*). Confirmed *E. coli* isolates were subjected to antibiotic profiling. Among the physicochemical parameters, only temperature did not fall within the recommended standard values. Temperature was highest in the evenings and in the months of April. This result may have been influenced by the intensity of sunlight in Nigeria during this season. Concentrations of cadmium, arsenic, chromium and nickel fell within the recommended limits, while the concentrations of mercury and lead were higher than the limits. Concentrations of mercury were more in April than in other months, while lead was more in November. Reduced rainfall in November and April may have influenced the results. The highest count of heterotrophic bacteria observed was in the evening of July. Coliforms and *E. coli* were found in high number in both periods and seasons. Of the 139 isolates of *E. coli*

subjected to antibiotic profiling, 102, 28 and 3 showed multiple antibiotic resistance index of 0.0, 0.1 and 0.2, respectively. By this study, bacteria were found, including *E. coli* and this is indicative of faecal pollution. In fact, resistance of *E. coli* to the antibiotics may also have resulted from chemical pollutants in the water body.

2.01.09

Comparative Toxicity of Petroleum Products From Artisanal Refineries in the Niger Delta on Selected Aquatic Biota

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The spill of petroleum products; petrol (PMS), diesel (AGO) and kerosene (DPK) from artisanal refineries has become a menace in the Niger Delta, leading to devastating effects on the adjoining recipient aquatic ecosystems. The toxicity of these products from selected artisanal refineries in Bolo (Rivers State), Twon-Brass (Bayelsa state) and Ekpemu (Delta state) of the Niger Delta on environmental biota were investigated using the Department of Petroleum Resources of Nigeria Standard. Three representatives of different trophic levels in the aquatic habitat; Fish (*Tilapia guineensis*), Crustaceans (*Palaemonetes africanus*), and Molluscs (*Tympanotonus fuscatus*) were selected for the study. The LC_{50} was the indices used for toxicity assessment of the petroleum products on the test organisms, and was calculated using probit analysis. The physicochemical properties of the petroleum products were tested using American Standard Testing Methods (ASTM). The study revealed that the petroleum products from the different sample stations were all toxic to the test organisms. The degree of toxicity of PMS followed the trend; for *Tilapia guineensis* - Twon-Brass (LC_{50} - 0.01ppt) > Bolo (LC_{50} - 0.02ppt) > Ekpemu (LC_{50} - 0.03ppt); for *Palaemonetes africanus* - Bolo (0.33ppt) > Ekpemu (0.65ppt) > Twon-Brass (2.18ppt); and for *Tympanotonus fuscatus* - Ekpemu (29.90ppt) > Twon-Brass (80.85ppt) > Bolo (906.67ppt). The degree of toxicity of AGO followed the trend; for *Tilapia guineensis* - Ekpemu (0.17ppt) > Bolo (0.23ppt) > Twon-Brass (0.26ppt); for *Palaemonetes africanus* - Twon-Brass (0.10ppt) > Bolo (0.32ppt) > Ekpemu (2.69ppt); and for *Tympanotonus fuscatus* - Twon-Brass (5.85ppt) > Bolo (27.96ppt) > Ekpemu (68.38ppt). The degree of toxicity of DPK followed the trend; for *Tilapia guineensis* - Ekpemu (0.03ppt) > Twon-Brass (LC_{50} - 0.33ppt) > Bolo (LC_{50} - 3.64ppt); for *Palaemonetes africanus* - Twon-Brass (5.66ppt) > Ekpemu (10.17ppt) > Bolo (32.10ppt); and for *Tympanotonus fuscatus* - Twon-Brass (6.64ppt) > Ekpemu (7.89ppt) > Bolo (207.56ppt). The degree of sensitivity of the test organisms to the petroleum products were; *Tilapia guineensis* > *Palaemonetes africanus* > *Tympanotonus fuscatus*. The Sulphur and heavy metals levels in the products could be attributed to its toxicity, as a result of the crude method used in refining. The findings further emphasize the need to control spillage into the aquatic ecosystem.

2.01.10

Effects of Inorganic Pollutants on the African Kale (Brassica Oleracea Var Ccephala) Grown Using Sewage Sludge Manure

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Sewage sludge contains valuable organic matter and nutrients like phosphate and nitrates released from wastewater treatment processes and when applied to agricultural soil assists by improving the physical and mechanical properties of the soil, thereby increasing crop yields. It also contains toxic materials which include heavy metals and pathogens. In Zimbabwe sewage sludge is commonly by peri urban small scale farmers. We investigated the levels and effect of pollutants on grown and enzymatic activities of the African kale plants grown on soil with sewage sludge manure. Soil and industrial sludge were sampled. Soil and sludge mixtures in the ratios 50:50 and 20:80 respectively were prepared. Control soil without sludge was also prepared. pH and conductivity were measured in the different soil mixtures. Kale seedlings of 10- 13 cm were planted on the different soil-sludge mixtures. Leaf length was measured 21 days post transplanting for four weeks. Sixty days post transplanting, the leaves were harvested for metal and biochemical analysis. Sewage sludge decreased the soil's pH and increased the conductivity. Fifty percent soil – sludge mixture increased leaf length by 40% on average when compared to the leaf length in plants grown on soil free of sludge. Plants grown on sewage sludge had higher levels of cadmium, copper and zinc compared to plants grown on sludge free soil. Superoxide dismutase and glutathione peroxidase activities were higher in plants grown on soil applied with sewage sludge when compared to enzyme activities in plants grown on sludge free soil. High levels of metals and enhanced antioxidant enzyme activity were attributed to contaminated sewage sludge.

2.01.11 Emerging Endocrine Disruptors in Maize Soil

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In South Africa, a country with an increasing population rate and in which there is a constant battle to provide food security, the use of agrochemicals is very common. These agrochemicals include pesticides, seed coatings, hormones, antibiotics, plant activators, soil fumigants and fertilizers. Agrochemicals are used to reduce crop losses. These chemicals find their way into the environment, where non-target organisms are exposed to chemical mixtures. Studies have shown that agrochemicals such as glyphosate-based herbicides and DDT can have negative effects on non-target organisms. Agrochemicals can act as hormone-mimicking compounds that cause endocrine disruption in non-target organisms. In this study, the genetically modified MDA-kb2 cell line was used to determine if water-soluble agrochemicals influence the androgen and glucocorticoid (AR and GR respectively) receptors. The AR plays a prominent role in the human body regarding developmental and reproductive processes, cardiovascular and haemopoietic systems as well as the neural and immune system. Cortisol is the primary ligand for the GR which is important to maintain the body's response to stress. Soil samples were collected from the maize farms in the Vaalharts Irrigation Scheme (Northern Cape province) and in the Mpumalanga province, South Africa. The

water-soluble agrochemicals were extracted from the soil samples and a luciferase reporter gene bioassay was done to screen for AR and GR agonists or antagonists. The cytotoxic effects of these extracts were determined with the MTT viability assay. The expected outcome of the study is that agrochemicals in the maize soil have an (anti-) agonistic effect on both the androgen and glucocorticoid receptors. The results can be used to determine the risks of agrochemical mixtures on aquatic ecosystems and act as a warning signal to encourage future monitoring of water sources.

2.01.15 Glyphosate-Based Herbicide Usage: South Africa's Killer?

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Agriculture is a cornerstone of the South African economy and important for food security which is why herbicides are used to reduce crop losses. The most used herbicide worldwide is glyphosate-based herbicides (GBHs). The introduction of genetically modified crops that are glyphosate (GLY) resistant, resulted in the increased use of GBHs. Glyphosate is highly water-soluble and has been found in water and soil samples throughout the world. There are, however, no records on the concentrations of GLY and its metabolite, aminomethylphosphonic acid (AMPA) in the South African environment. This study used GBH application data of the four popular crops, maize, soybeans, wheat, and sunflower, to identify areas that are subjected to glyphosate contamination in South Africa. The crops are treated with GBHs with every planting cycle over millions of hectares and represent 80% of all GBH used in South Africa (15 484 tonnes). Distribution maps of the four crops together with the volume GBH applied in 2017 were created using geographic information systems. The data was bought from a market research company that surveyed pesticide-use by South African farmers. In 2017, the region with the highest GBH applications was the Free State province bordering the Vaal River (2 436 tonnes). The 4-crop data visualisation approximates to 80% of the total GBH market in South Africa at an active ingredient level. The most GBH was used on maize (54%) followed by soybean (15%). The share of GBH used in industrial and urban areas is estimated to be between 2 and 2.5%. In areas where maize is rotated with soybeans, more GLY is applied within the same year and due to its half-life in soil (1–197 days), it may accumulate in those areas. Since it had been shown that GBHs cause a wide array of human disorders including Alzheimer's and Parkinson's diseases and cancers. With these potential effects, it is of great importance that we learn what the levels are in the South African environment to determine risks posed to human and environmental health.

2.01.16 Identification and Molecular Characterization of E. Coli Isolated From Elechi Creek, Port Harcourt, Nigeria

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Pollution of water bodies in Nigeria occurs in both rural and urban areas. In the rural areas, some residents drink water from rivers and streams. These streams and rivers are usually

polluted by sewage, human and animal excreta, agricultural runoff, oil spills, and organic substances from dumps located very close to them. Pollutants found in water environment could cause mutation in microorganisms. When mutation occurs in microorganisms, this could lead to changes in structural or colony characteristics or loss in sensitivity to antibiotics. This study was carried out in order to know if indicator bacteria are found in the river and to characterize them using molecular methods. The latter is important, as it would help to know if the bacterial isolates have resistance or virulence genes. In this study, 120 water samples were investigated for the presence of *E. coli* in Elechi Creek. Most Probable Number (MPN) Technique, Eijkman test and molecular techniques were used for the isolation and detection of *E. coli*. The analysis was carried out both periodically (morning and evening) and seasonally (end of rainy season (November), the start of rainy season (April) and in the middle of rainy season (July)). All the isolates of *E. coli* recovered from the water body were screened for resistance genes in the pathotypes of *E. coli* (EHEC, EPEC, EAEC, ETEC and EIEC), including SHV, CTX-M, TEM and MCR genes. According to the results, 100% of the water samples from Elechi Creek, harboured coliforms, including *E. coli*. The distribution of individual genes in the *E. coli* isolates is as follows: SHV (5.0%), CTX-M (6.7%), TEM (5.8%), MCR (0.0%), stx1 and stx2 (7.5%), esV and bfa (5.0%), aaiC (2.5%), elt (0.8%) and invE (2.5). The EHEC was the most found of all the resistance genes. This study revealed that coliforms, including *E. coli* were isolated from the water body. The presence of *E. coli* is indicative of faecal pollution and as a consequence, it is probable that other pathogenic microorganisms are present in the river because *E. coli* is an indicator microorganism. The bacterial isolates had resistance genes although, it is not clear if they had the resistance genes before they were introduced into the water body. It is therefore recommended that human activities that cause pollution of rivers by biological, chemical and physical pollutants be discouraged, as this may cause a serious health consequences in residents who consume the water.

2.01.17 Micronano-Plastics Induced DNA Damage and Oxidative Stress: Implications for Genome Instability

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The ubiquity of micro(nano)-plastics (MP/NPs) in the environment constitutes global environmental and toxicological related issues of the 21st century. Its potential health impacts on humans and wildlife are still poorly studied. This study is a systematic review aimed at determining whether exposure to MP/NPs is associated with genome instability. Outcome of the systematic secondary data collected and analysis revealed that MP/NPs are present in all components of the human environment including consumer products (sea food, milk, beer, honey, bottle and tap water, salts, tea, drinks), and in human faeces and placenta. There is evidence suggesting mechanisms of MP/NPs uptake and translocation in the body. During these mechanisms, free radicals are generated and oxidative stress induced. This is subsequently associated with cytotoxicity, chromosome and DNA damage, and other pathophysiological effects. Comet assay and

micronucleus test were the most utilized assays for DNA damage assessment in invertebrates, vertebrates and in vitro test system. Others include DNA fragmentation in fish and chromosome aberration in plant root tip meristems. Although, available reports did not present clear evidence that the damage DNA is associated with aberrant DNA-secondary-structure formation due to gross chromosomal re-arrangements, aneuploidy, polyploidy, gene amplifications, DNA strand breaks, and breakdown in DNA damage repair mechanisms, hallmarks of genome instability. However, there were evidence that MP/NPs altered growth-regulating genes and increased cell proliferation. These are some consequences of genome instability that may invariably enhance cancer formation. This review provides evidence for possible genome instability induced by MP/NPs and its possible linkage with cancer, ageing and other genetic related disease in wildlife and human studies. **Keywords:** DNA damage, Micro(nano)-plastics, Genome instability, Reactive species and oxidative stress.

2.01.18

Occurrence of Polyaromatic Hydrocarbons in Soil From a Coal Mining Area in Zimbabwe and Activity of Biotransformation Enzymes in *Achatina Fulica* Exposed to the Soil

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Anthropogenic activities such as mining threaten the capacity of soil to be productive biologically. A study was conducted in order to evaluate the spatial distribution of polyaromatic hydrocarbons from a coal mining area in Zimbabwe and assess xenobiotic metabolising enzyme activity in land snails, *Achatina fulica*, exposed to the soil. Land snails (*Achatina fulica*) collected from a relatively pristine environment and reared under laboratory conditions (for 1 year) were exposed to soils collected from 4 different sites at a coal mining town for 45 days. Levels of polyaromatic hydrocarbons (PAHs) and pH were measured in the collected soil. Activities of glutathione S-transferase (GST) and ethoxyresorufin-O-deethylase (EROD) were also determined in the exposed land snails. The mean pH value of soil from the coal mining area was found to be slightly acidic (5.53). Photo-degradation of PAHs is high at such low pH. Soils from site D (close to thermal power plant) had markedly higher levels of naphthalene, acenaphthene, phenanthrene, anthracene, flouranthene, pyrene, benzo(k)fluoranthene, benzo(a)pyrene and indeno(1,2,3-c,d)pyrene compared to soil from reference site. The sum of polyaromatic hydrocarbons ($\Sigma 14$ PAHs) was markedly higher than 1000 $\mu\text{g}/\text{kg}$ allowable in soil by United States Environmental Protection Agency. The $\Sigma 14$ PAHs determined in soil samples from the coal mining area were in the decreasing order: D > B > C > A > Reference. Fluoranthene was the most abundant PAH accounting for 20.1 and 16.0% of the $\Sigma 14$ PAHs in soils from site B (7 km north west of site D) and D respectively. High molecular weight (HMW) polycyclic aromatic hydrocarbons were predominant in soil samples from the coal mining area. Occurrence of HMW PAHs in soils from the coal mining area was in the decreasing order: C > A > B > D. Site C (close to coal gauge) had the highest

proportion of carcinogenic PAHs. The greatest value of the total toxicity benzo(a)pyrene equivalent concentration was observed in soils from site D. Hence soils at site C and D had the highest carcinogenic potency. The highest GST and EROD activities were observed in snails exposed to soil from the Site C and D. Thus invertebrates residing at these areas were most likely to be experiencing oxidative stress. It is therefore necessary to assess pollutants in soils at coal mining areas in order to determine the risk posed by contaminants that may ultimately be deposited in aquatic systems.

2.01.19

Organochlorine Pesticide Accumulation in Charismatic Elasmobranch Species Along the South African Coast

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Even after being banned from use in 2004, many OCPs are still present in almost all areas of everyday life. OCPs were recorded to be present in water, sediment, soil, and biota and to be persistent in each of these environments with varying degrees of possible and present negative effects upon the environment and organisms. However, minimal research has been done on the marine environment and OCP contamination around the coast of South Africa. The current study on OCP contamination in elasmobranchs aims to provide a clearer picture of the contamination present within marine systems, as well as to provide insight into the accumulation of contaminants within different apex predators. A total of 18 muscle tissue samples collected from four different shark species (*Galeocerdo cuvier*, *Carcharhinus obscurus*, *Sphyrna lewini*, and *Mustelus mustelus*) were analysed for the presence of 22 potential OCPs. GC- μECD analysis detected 18 of the 22 OCPs in varying concentrations (ng/g lipid weight). Differences in OCP accumulation between shark species were calculated using multivariate (canonical discriminant function analysis) and univariate (one-way ANOVA followed by a Tukey HSD posthoc analysis) statistical methods. Any statistically significant values were reported ($p < 0.05$), and *G. cuvier* displayed an 80.6% difference between itself and the rest of the group of sharks. An OCP accumulation gradient within the shark species was observed from the west coast representatives to the east coast representatives with increasing OCP concentrations within the shark species around the eastern coast of South Africa.

2.01.20

Physicochemical Evaluation, Acute and Subacute Toxicity of Hair Dressing Salon Wastewater Against the African Sharptooth Catfish

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adebayohorlaitan6089@gmail.com **Abstract**

Hairdressing salons are small-scale businesses that contribute to a country's GDP due to the high demand for human beautification. Salon

wastewater contains shampoos, relaxers, and solvent-based products, which pose risks when discharged into the environment. This study was done to determine the physicochemical parameters of salon wastewater as well as its subacute toxicity to *Clarias gariepinus* fingerlings (The African Sharptooth catfish). In the month of December 2019, samples of salon wastewater were collected from five (5) local salons in Shomolu, Lagos, Nigeria. The pH (11.27), total suspended solids (257 mg/L), and nitrate (163.66 mg/L) levels in the salon wastewater exceeded the NESREA limits, while the other physicochemical parameters and heavy metals were within limits or had no specified limits. Other chemical found in the water included dimethyl phthalate (3.14 ppm), diethyl phthalate (0.05 ppm) and di-sec-butyl phthalate (215.74 ppm). Juvenile fish were exposed to 1/10th of the 96 hLC50 for subacute toxicity. The median lethal concentration (96 hLC50) of the salon wastewater to *C. gariepinus* fingerlings was 109.3 mL/L (10.93 %), while the embryo's 26 hLC50 was 111.06 mL/L (11.11 %). Gill histological alterations in juveniles exposed to the subacute concentration ranged from mild to severe lamellar necrosis. The developmental abnormalities observed in embryos exposed to subacute concentrations ranged from pericardial oedema to pericardial haemorrhage. The number of heartbeats per minute in the exposed embryos was statistically higher (p

2.01.21

Potential Human Health Risks Associated With Ingestion of Heavy Metals Through Fish Consumption in the Gulf of Guinea

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Heavy metals contamination and seafood safety has become an issue of public concern due to the potential adverse human health effects especially on sensitive population. This study assessed heavy metal (As, Cu, Pb, Cd, Zn and Hg) concentrations in muscle tissues of four fish species namely *Sardinella maderensis*, *Dentex angolensis*, *Sphyrna Sphyrna* and *Penaeus notialis* from the Gulf of Guinea and their potential human health risk. The demersal shrimp *P. notialis* recorded the highest concentrations of all the studied metals (Cu: $12.08 \pm 1.46 \mu\text{g}/\text{g}$, Zn: $19.20 \pm 2.27 \mu\text{g}/\text{g}$, As: $8.46 \pm 2.42 \mu\text{g}/\text{g}$, and Cd: $0.03 \pm 0.01 \mu\text{g}/\text{g}$) except Hg, which was very high in *D. angolensis* ($0.14 \pm 0.03 \mu\text{g}/\text{g}$). But for As, all heavy metals were within tolerable limits of the Food and Agricultural Organization, United States Environmental Protection Agency, the Australian and New Zealand Food standard code, and the European Commission (EC). Estimated carcinogenic risks due to the intake of As through *S. maderensis* and *D. angolensis* consumption exceeded the 10⁻⁶ threshold across most age categories except for children aged between 1 and 3 years. Carcinogenic risks due to As intake through *P. notialis* consumption far exceeded the 10⁻⁶ threshold for all age groups in Ghana. The study recommends that the intake of these fish species particularly, the shrimp *P. notialis* among all age population, in particular, children be done with caution, to avoid possible future carcinogenic effects.

2.01.22

Relative Values of Electrolytes in

Tissue/Organs of *Clarias Gariepinus* Exposed to Oilfield Wastewater

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The oil industry in Nigeria is the major revenue earner for the country. Unfortunately, this important industry has also led to enormous degradation of the Nigerian Environment. The Niger Delta is host to most of the oil wealth of the Nation but also at the receiving end of numerous contaminants, including oilfield wastewater. Seafood, including *Clarias gariepinus*, is integral to the diet of the Niger Delta people. This study evaluated the electrolyte levels of *C. gariepinus* exposed to sub lethal concentrations oilfield wastewater for 28 days as a way of understanding the toxicity of this contaminant to biota. A total of 28 samples, with mean body weight 205 ± 12.89 g were used. Six oilfield wastewater concentrations (0% (Control), 10%, 30%, 50%, 70% and 100%) were used to study the relative electrolyte values (Sodium (Na⁺), Chloride (Cl⁻), Calcium (Ca²⁺), Potassium (K⁺) and Bicarbonate (HCO³⁻) in the gills, plasma, kidney, liver and muscles. Relative Na⁺ values were highest in the control (0%) for plasma and kidney. The gills, liver and muscles recorded their highest values at 20%, 60% and 60% respectively. The level of Na⁺ was highest in the gills at 982.50 ± 56.79 g/l at 20% and least in the plasma at 65.75 ± 8.09 at 30%. Cl⁻ values were highest in the plasma at 40%; in gills and kidney, 20% in liver and muscle at 60%. Similarly, Cl⁻ levels were highest in the gills at 640.00 ± 60.00 at 10% and least in the liver recording 69.25 ± 16.46 at 10%. Ca²⁺ values recorded a highly variable response with highest levels recorded at different concentrations and tissues as follows; plasma at 30%, gills at 40%, kidney at 20%, liver at 60% and muscle at 20% with Ca²⁺ activity most in the liver and muscles at 15.00 ± 5.77 at concentrations of 10% and 60% respectively. For K⁺, highest electrolytes level were in plasma, gills and kidney at 40% while liver and muscle recorded highest value at 60% and 0% respectively. HCO³⁻ values in the gills (20.00 ± 5.77), kidney (35.00 ± 5.77) and muscles (25.00 ± 5.77) were reduced at the control (0%) and highest at 40% (58.75 ± 11.82), 20%, (67.50 ± 8.66) and 60%, (45.00 ± 5.77) respectively. Notable electrolyte changes due to exposure to oilfield wastewater were observed in this study. These changes in ionic levels were mostly with no pattern, suggesting homeostatic efforts by the fish. Elevated ions suggest toxic effects on the organs of the biota. This study makes for proper treatment methods to be adopted before disposal into the environment.

2.01.26

The Sperm Quality, FSH and LH of Juvenile Albino Rats Exposed to Light Spectra at Night

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In vitro impacts of various light spectra have been confirmed to have significant effect on the quality of sperm. It is thus important to know if the same effect could be obtained in vivo.

Hence this study investigated the effect of light spectra at night on the quality of albino rats sperm. Juvenile rats at onset of puberty (9 weeks) were exposed to light emitting diode of various colours (Blue, Green, Yellow, Red and White) for 28 days at night (6 pm – 6 am) as ambient light and darkness served as the control. Three rats from each treatments randomly selected from the replicates were euthanized and the sperm analysis was conducted using standard methods. Hormone analysis was carried out using ELISA. Data collected were subjected to the analysis of variance (ANOVA) and the means were separated using Duncan multiple comparison and level of significant was considered at $p < 0.05$. There was no significant different ($p > 0.05$) in progressive motility, vitality and sperm count of the rats but recorded the highest values when exposed to GL (85.0 ± 13.7), RL (89.3 ± 3.1 %) and darkness ($183.7 \pm 75.5 \times 10^6$) respectively and least when exposed to WL, ambient light and RL respectively. Sperm morphology showed that detached-head, free-tail, dwarf-tail and bent-tail were significantly higher under darkness, and abnormal sperms were significantly higher in the rats exposed to YL and darkness. There was no significant different in the value of serum FSH and LH but FSH was the least in the rats exposed to YL (96.57 ± 1.80 ng/ml). YL and darkness seem to be toxicant to male reproductive performance. Key words: Albino rats, light spectra, sperm quality, FSH and LH

2.01.28

Effects of Early Exposure of Chlorpyrifos on Cleavage in *Clarias gariepinus* (Burchell, 1822)

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Freshly fertilized eggs of *Clarias gariepinus* were exposed to 0, 0.01, 0.10, and 10.0 µg/L of chlorpyrifos in a static-renewal test. The study sought to investigate the morphological effects of chlorpyrifos on cleavage during embryonic development and its implication on hatching and larval survival. Morphological observation during embryonic development revealed significant differences in the cleavage stage between treatment groups. At 40 minutes after fertilization, 80% of the control embryos had reached the 2-cell stage, compared to 13.0% in the treatment group with the highest concentration (10.0 µg/L). Similarly, at 210 minutes, 53.5% of the control embryos reached the morula stage, compared to 3.3% in the 10.0 µg/L treatment group. Hatching rates decreased significantly across treatment groups with 100% mortality in the 10.0 µg/L group. Findings from this study indicate that low concentrations of chlorpyrifos interrupt successful cleavage during embryonic development of *C. gariepinus*. Therefore, controlled use of chlorpyrifos for vector control practices should become a priority to avoid its introduction into the aquatic ecosystem, which could result in a massive decline in the wild population of fish due to reproductive failure, upsetting the ecological balance in these ecosystems.

Aquatic risk assessment and validation of the risk assessment using data from lakes and rivers in Africa

2.02.01

Heavy Metals Bioaccumulation in Gills and Liver of *Chrysichthys nigrodigitatus* From Ankobra River

M.O. Soetan, J. Aggrey-Fynn, University of Cape Coast Ghana / Department of Fisheries and Aquatic Science; P.K. Mensah, Rhodes University / Institute for Water Research Artisanal mining (Galamsey) within the Ankobra River watershed has impacted the water quality and health of fish as well as other aquatic organisms. This paper reports on a recent study to investigate the concentrations of mercury and lead in water and organs of *Chrysichthys nigrodigitatus* in Ankobra River. Bimonthly sampling (Dec, 2020 – Apr, 2021) was conducted at 9 sampling points along the River. Physicochemical parameters such as temperature, dissolved oxygen, pH and turbidity were determined. A total of 27 water samples and 60 fish samples were collected. Samples were labelled and stored in ice chest to maintain the freshness and immediately transported to the laboratory where they were frozen at -4°C for further analysis. Results showed that physicochemical parameters of water were within range of fish survival except for turbidity. Results further showed that the spatial and temporal variations in the heavy metal concentrations of the fish and water were significantly different ($P < 0.05$). There was an increase in metal concentration in February and April compare to December which recorded low concentrations. Pb and Hg concentrations in water were significantly different. Pb concentration was higher in water while that of Hg was lower in water. Metal concentration was higher in fish organs than water which explains the bio-accumulative properties of heavy metals in fish. Concentration of heavy metals in gills and liver of *C. nigrodigitatus* were significantly different. Pb accumulate more on the liver compare to Hg which accumulated more on the gills. The research revealed that water and fishes from Ankobra River is polluted with Pb and Hg. This work will contribute to the knowledge of water quality implications on the Ankobra River which empties directly into the ocean. It is recommended that government should make stringent guidelines on the activities of artisanal miners in the area.

Advances in the assessment of chiral pollutants in the environment: Challenges and opportunities

3.01.01

Quantification of Per- and Polyfluorinated Alkyl Substances in Bottled Water Consumed in South Africa

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Per and poly-fluorinated alkyl substances (PFAS's) are a large group of synthesized organofluorine chemicals used in industrial applications and commercial household products. PFASs are ubiquitous in the environment and have been identified to cause various adverse health effects in humans. The full extent of these chemicals in drinking water, general market, environmental fate, human exposure, and toxicological effects is not yet fully known. Therefore, this study is aimed at

investigating the presence of these toxic substances in some bottled water consumed in South Africa. Current studies on these substances in South Africa have focused on various water sources from hotspots without any focus on consumer products including bottled water. Bottled water products were purchased from local stores in Pretoria. During the sample, preparation samples were spiked with Perfluoro-n-nonanoic acid (MPFNA) to monitor the effectiveness of sample preparation and extraction of analytes. Solid-phase extraction was utilized using a C18 cartridge and methanol as an elution solvent. Analytes were concentrated with nitrogen then reconstituted with methanol and finally Perfluoro-n-hexanoic acid (MPFHxA), Perfluoro-n-undecanoic acid (MPFDA), and Perfluoro-n-[1,2-13C₂]octanoic acid (M2PFOA) were added as an internal standard for the application of the internal standard calibration method. Target compounds were separated on an InertSustain C18 (3 µm, 2.1 i.d. x 150 mm) HPLC column. Using multiple reaction monitoring (MRM) under full scan on an LCMSMS, targets analytes were selected and quantified. The recoveries of the surrogate standard, from all four bottled water products ranged from 78.99% - 112.68%. In all four products, a total of seven PFASs were detected in all samples namely Sodium perfluoro-1-pentanesulfonate (L-PFPeS), Perfluorooctanoic acid (PFOA), Perfluorodecanesulfonic acid (PFDS), Perfluorobutanoic acid (PFBA), Perfluoro-n-pentanoic acid (PFPeA), Perfluorohexanoic acid (PFHxA) and Perfluoroheptanoic acid (PFHpA), while Perfluorohexadecanoic acid (L-PFHxDA) was only detected in product B. The PFASs mean concentration detected ranged from 0.11 ng/L - 86.00 ng/L with PFBA detected at alarming levels in all four products. Therefore, high concentrations of PFBA needs to be investigated and monitored consistently in all bottled water products in South Africa, including those not covered in this study.

3.01.03 Characterization of Sodium Alginates Extracted From the Three Main Structural Thalli Parts of the Moroccan Kelp *Saccorhiza polyschides*

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Alginates are widely used biopolymers that attract increasing attention due to their unique properties. Their industrial production is mainly provided from the blade of alginophytes species commonly known as kelps. In the present study, the kelp *Saccorhiza polyschides* was harvested from the NW Atlantic coast of Morocco. Yield and spectroscopic characterization (1H NMR and FT-IR) of the sodium alginates extracted

from the three structural parts of the kelp thalli (blade- stipe- bulb) were investigated. The results showed different alginate yield and chemical composition between the three structural parts. Maximum yield was obtained from the stipe with 26.3%, while that obtained from the lamina and the bulb extractions was 20.19%, and 5.68%, respectively. The FT-IR analysis of the extracted alginates exhibited similarities to the spectra of commercial alginate from Sigma-Aldrich. 1H NMR spectroscopy showed differences within the three structural parts of the thalli, with M/G ratio values ranging from 0.76 to 2.14. High content of β-D mannuronic acid and homopolymeric diads (F_{MM}) were found in alginate extracted from both the blade (F_{MM}= 50.3%) and the stipe (F_{MM}=68.1%), while that extracted from the bulb area exhibited higher content of α-L-guluronic acid (G) and heteropolymeric fractions (F_{GM} = F_{MG}) accounting for more than 45%. Based on these results, the investigated kelp *S. polyschides* could be considered as potential sources of alginates for industrial uses. Optimization of the extracted biomass was proved to be possible, as in addition to the blade usually used for the extraction, both stipe and bulb showed interesting alginates quality and yield.

Environmental and Analytical Chemistry (general)

3.02.01 Assessment of Plant Growth Promoting Bacteria Biodegradability of Pesticides in Soil F. Sunday, Federal polytechnic Ado-Ekiti / Microbiology; O. Adebisi, UNIVERSITY OF ILORIN, NIGERIA / Department of Microbiology

Extensive use of pesticides, though contributing to the improvement in agricultural productivity, has severe impacts on non-target microbial populations and hence may impair soil fertility in the long-term. Here, we assessed soil restoration potentials of some plant growth promoting bacteria (PGPB: Proteobacteria – *Citrobacter amalonaticus*, *Kosakonia sacchari* *Pseudomonas putida*, and Firmicutes – *Bacillus paramycoides*, *Bacillus nitroreducens*, and *Bacillus nakamurai*). Six pesticides (atrazine, diuron, chlorpyrifos, cypermethrin, glyphosate and imidacloprid) were applied to soil at three concentrations (recommended field application level (×1) and higher levels (×2 and ×3)). Biodegradation was monitored for 30 d in soil microcosms using standard CO₂ respiratory assays. Chemical analyses of the end-products of mineralization were conducted using GC-MS and FITR. The biosurfactant-producing PGPB with demonstrable tolerance to ×3 concentration showed variable but high capabilities to mineralize the pesticides up to 65–99% in 30 d. The half-lives (T_{1/2}) ranged from 7–20 d with the Firmicutes having stronger capacity than the Proteobacteria. Chemical analyses showed extensive degradation of the pesticides with the accumulation of certain metabolites specific to an organism.

3.02.03 Toxicity Assessment of Dye Wastewater After Treatment With Biosorbents Using *Allium CEPA* Test D. Aderibigbe, NIGERIA MARITIME UNIVERSITY, OKERENKOKO, DELTA STATE / Chemistry; A. Giwa, Ladoko Akintola University of Technology / Department of Pure

and Applied Chemistry; I.A. Bello, Ladoko Akintola University of Technology, Ogbomosho / Department of Pure and Applied Chemistry; A. Akinboro, Ladoko Akintola University of Technology, Ogbomosho, Oyo State / Department of Pure and Applied Biology
Wastewater contains substances that pollute the environment therefore they must be removed before being discharged into the environment. However, the toxicity of the resultant solution after treatment needs to be ascertained. This was the aim of this study. Simulated wastewater containing Malachite green dye was treated with two biosorbents (RMO and MMO) prepared from *Moringa oleifera* seed husk. Toxicity test was conducted on the dye solution before and after treatment. Sundried *Allium cepa* was prepared by expunging dried roots to expose the stem to grow fresh root. The roots were harvested after 72 hours and measured. The results showed that the two biosorbents were able to decolourise Malachite green solution and the EC₄₀ of the solution before treatment was lower (12 mg/L) than those of the resultant solution (23 and 22 mg/L for treatment with RMO and MMO respectively). Also, the percentage root growth (%RG) before treatment was 42% while that of the resultant solution after treatment with RMO was 63% and for MMO was 74%. In conclusion, the two *Moringa oleifera* seed husk-based biosorbents were effective in decolourising and reducing the toxicity of the wastewater. Keywords: *Allium cepa*, *Moringa oleifera*, Malachite green, biosorbents

3.02.04 Impact of Plant Endophytes on Health, Secondary Metabolites, and Future Biocontrol Trends in Hemp (*Cannabis sativa*) C.D. Ahuchaogu, S. Dhekney, B. Khatabi, University of Maryland Eastern Shore / Department of Agriculture, Food and Resource Sciences

In response to the recent U.S legalization of industrial hemp (*Cannabis sativa* L.), a critical need for environmental disease management and alternatives to reduce chemical inputs are being sought actively. Hemp like any other crops is affected by several plant diseases. Due to the introduction of hemp, the incidence, emergence, and outbreak of diseases and pests are expected to increase in the United States. Hemp growers are poorly equipped with disease management strategies and few pesticides or fungicides are registered for use on hemp. Several pioneering research and development projects have been carried out to improve plant health using microbial-derived products like bio-fertilizers, bio-pesticides and bio-control agents. It is now clearly established that plant-associated microbial communities play an important role in crop husbandry. Currently, little is known about beneficial cannabis microbes associated with various tissues of the plant, and its role in supporting and controlling plant diseases and modulating the production of secondary metabolites. So far, 23 fungal, 17 pathogenic bacterial strains and 16 endophytes have been isolated from hemp. The aim of this study is to (i) examine the fungal and bacterial communities associated with hemp diseases in Maryland (ii) isolate, identify, and characterize plant endophytes from hemp in Maryland (iii) examine the impact of plants endophytes on secondary metabolites and (iv) study the plant root endophytes to control hemp pathogenic fungal and bacteria.

Innovative sample preparation and detection techniques for legacy and emerging pollutants in different environmental matrices

3.03.01

PFASs Concentrations in Borehole and Drinking Water in Gauteng Province, South Africa

K. Mashiloane, Tshwane University of Technology, Pretoria, South Africa; J.O. Okonkwo, Tshwane University of Technology / Environmental, Water and Earth Sciences, Faculty of Science; E. Jordaan, Tshwane University of Technology, Pretoria, South Africa / Biotechnology and Food Technology Per- and polyfluoroalkyl substances (PFASs) are known as emerging organic pollutants with persistent, bio-accumulative, and toxic effects on humans and the ecosystem. Products treated with PFASs additives together with municipal waste are most often, deposited into landfill sites without any pre-treatment at the end of their life cycle. Since PFASs are used as additives in a myriad of products, they have the potential of leaching into the surrounding environment thereby, contaminating water sources such as groundwater. Furthermore, widespread reports of PFASs in tap water and landfills have resulted from their widespread usage, particularly in metropolitan areas. Presently, few studies have been reported on PFASs in boreholes located near landfill sites and tap water. This paper aimed at determining the concentrations of some PFASs in borehole samples collected from monitoring boreholes from selected landfill sites and tap water in Gauteng Province. The samples were extracted using solid phase extraction (SPE) and analyzed using liquid chromatography tandem mass spectrometry (LC-MS/MS). Mean PFAS concentration ranged from < LOQ- 0.79 ng/L and 0.24-27.55 ng/L in borehole and tap water respectively. PFPeA and PFBA were the most dominant compound in boreholes and tap water samples respectively. The levels of PFASs in these samples are lower or comparable to those in developed countries. The present study shows that landfills may be a significant source of concern for PFASs in groundwater. In addition, PVC-pipes and drinking water treatment plants may also be a source of PFASs in drinking water.

3.03.02

Optimization of Extraction Methods and Quantification of Per- and Polyfluorinated Alkyl Substances in Wastewater Treatment Plant Samples From Gauteng, South Africa

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In the past 50 years, there has been a worldwide increase in the production and use of industrial chemicals known as per and polyfluorinated alkyl substances (PFASs). PFASs have been detected in several environmental matrices as well as humans. Some of these PFASs have been listed as Persistent Organic Pollutants (POPs) under Stockholm Convention and some have been proposed for restricted use/banning

because of their ubiquitous distribution, bioaccumulative and toxic properties. Therefore, there is a need to generate more data that policy makers can use to regulate the use of PFASs in the country. For this purpose, wastewater samples were collected from two wastewater treatment plants in Gauteng, South Africa. Samples were collected from the influent, secondary sedimentation tank, biological nutrient removal (BNR) and the final effluent. Solid Phase Extraction (SPE) method was optimized, and samples were analyzed using LC-MS/MS. Surrogate recoveries ranged from 72.48- 121.9%. PFASs concentrations were as follows: 9.956-36.48 ng/L L-PFPeS, 0.7544-1.575 ng/L PFOA, 0.1888-1.339 ng/L PFDA, 80.43-331.4 ng/L PFBA, 6.841-17.46 ng/L of PFOS, 15.15-20.11 ng/L L-PFHps, 59.97-403.1 L-PFBS, 2.667-8.065 L-PFdUA, 2.910-20.22 PFPeA, 0.4571-1.2512 ng/L PFNA, 0,3802-0,5357 ng/L PFHxDA, 0,3874-36,89 ng/L PFHxA, 1.438-23.41 ng/L PFHpA and 4.676-340.4 ng/L L-PFHxS. PFASs concentrations as high as 331.4 ng/L for PFBA were observed in the BNR effluent samples. An increase in concentration of PFASs were also observed from the influent to the final effluent. This may be due to biodegradation of PFASs precursors. Due to difficulty of PFASs to be degraded by wastewater treatment plants, the production and use of PFASs should be regulated to prevent contamination of water resources.

3.03.03

First Time Non-Target Screening of Emerging Organic Pollutants in Sediments and Fish From the Eastern Mediterranean Coast (Lebanon)

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The urbanization and the overexploitation of coastal resources along the Lebanese coast are constantly increasing. In addition, the coastal area is subjected to various anthropogenic pressures due to the presence of uncontrolled solid waste dumpsites and the discharges of domestic and industrial effluents into the sea without prior treatment. Hence, the objective of the present study was to assess the state of the Lebanese marine environment by determining the occurrence of emerging Persistent Organic Pollutants (POPs) in marine sediments collected along the Lebanese coast during November 2019. Sediments samples were sequentially extracted using a semi-pressurized solvent extraction device (EDGE from CEM), a fat clean-up was applied and then samples were pre-concentrated. Semi-volatile organic pollutants such as OCPs, BFR and their metabolites, PCDDs, PCDFs, PAHs and PCBs were screened using single quadrupole GC-EI-MS. As an extension study, preliminary tests were conducted on GC-APCI-tims-TOF HRMS since ion mobility spectrometry (IMS) offers an orthogonal separation dimension based on the ions' size, shape, and charge, known as collisional cross section (CCS). Thus, IMS enhances peak capacity and can be adapted to complex sample matrices. Meanwhile, CCS

values provide a further confident identification parameter. For the first time in Lebanon, these contaminants are identified, quantified and reported on the following: extract ion, mass spectrum, and retention time for experiments run by GCMS and exact mass, true isotopic pattern, and ion mobility for the parallel appraisal run by GC-tims-TOF. PAHs concentrations in sediments ranged between 15.08 and 2132.88 ng/g dw, while PCBs levels ranged between 0.044 and 32.13 ng/g dw. Various pesticides and herbicides were also detected for the first time in the Lebanese marine environment. Sediments and fish collected near landfills and effluent discharges showed significant concentrations of various contaminants. The results of the present study highlighted the potential contribution of coastal landfills and discharges to the organic pollution. The perspectives and benefit of Non-Target Screening by GC-timsTOF are also promising on halogenated contaminants and their byproducts where more studies are being investigated to ensure the reproducibility of the method and to enrich the in-house compound library. **KEYWORDS:** Pesticide, Persistent Organic Pollutants, Marine Sediments

3.03.05

Analysis of Fullerene Colloidal Nanoparticles by Ultrasonic-Assisted Dispersive Liquid-Liquid Extraction and High Performance Liquid Chromatography in the Environment

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This work presents a cheap and simple analytical method for the quantification of fullerene derivative in the river, wastewater and drinking water by ultrasonic-assisted dispersive liquid-liquid extraction (UADLLE) and liquid chromatography ultraviolet-visible spectroscopy (HPLC-UV-vis). Fullerene colloidal nanoparticles were synthesised and characterized by high resolution transmission electron microscopy (HRTEM) and ultraviolet-visible spectroscopy. The HPLC-UV-vis was used for quantification of fullerene colloidal nanoparticles in water samples. Ultrasonication step accelerated mass transfer of fullerene colloidal nanoparticles from aqueous matrixes into the toluene phase and resulted in a short extraction duration. Also, the addition of dispersive solvent and addition of sodium chloride salt destabilized fullerene derivative aggregates and promoted mass transfer into the toluene phase. Several extraction parameters were optimized, and the optimum conditions established were: 5 mL toluene as extraction solvent (2 cycles); 200 mL water sample; 1% sodium chloride salt; 15 min ultrasonication and 400 µL methanol as dispersive solvent. The mean absolute recoveries established in drinking water, wastewater and river water were 117%, 103% and 93% respectively. The developed analytical method was found to be linear in the ranges between 0.25 µg L⁻¹ – 250 µg L⁻¹ with linear regression coefficient of 0.9958. The limit of detection for a signal-to-noise ratio of 3 was 0.11 µg L⁻¹ and limit of quantification for a signal-to-noise ratio of 10 was 0.38 µg L⁻¹. The precision ranges from 2% to 11% and accuracy percent error ranged from -7% – 14% for spiked concentration levels of 0.25 µg L⁻¹, 50 µg L⁻¹ and 250 µg L⁻¹. The developed analytical method was applied in river water, wastewater

and drinking water, fullerene colloidal nanoparticle (C61-PCBM) were found to range from not detected to 10.54 µg L⁻¹. Overall, according to our knowledge, this is the first report on the determination of fullerene colloidal nanoparticle (C61-PCBM) in potable and wastewater in the African continent using this developed method. This method allows the rapid determination of the environmental relevant levels of aqueous fullerene colloids while using a cheaper instrument. **Keywords:** Fullerene, nanomaterials, Ultrasonic, Chromatography, Organic nanomaterials

3.03.06

A Study of Solvent Free Extraction

Techniques of Volatile Organic Compounds

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A comparative study was undertaken of different solvent free extraction methods for the isolation of volatile organic compounds from *Murraya koenigii* (curry leaf plant). The solvent-free extraction techniques of headspace analysis and headspace solid phase micro-extraction (HS-SPME) were investigated. In the evaluation of SPME, two different fibre coatings, poly(dimethylsiloxane) and poly(acrylate), were compared. Preliminary work to determine the effect of extraction parameters, such as extraction time, was carried out. The volatile oils in the fresh leaves of *Murraya koenigii* were isolated by the above extraction techniques and analysed by gas chromatography-mass spectrometry. The main aroma contributing compounds were identified by comparison of their retention times with those of standards and their mass spectra with those of known compounds contained in the National Institute of Science and Technology Standard Reference Database 1A (NIST 98). The essential oil contained mainly terpenes: monoterpene and sesquiterpene hydrocarbons. Headspace analysis proved effective in the detection of the very volatile analytes. Headspace-SPME combined with GC-MS was found to be suitable for the identification of both monoterpenes and sesquiterpenes of *M. koenigii*.

Speciation, Bioavailability, and effects of Potentially Toxic Metals (PTMs) in the African and Global Environments

3.05.06

Distribution of Heavy Metals in Soils From Abandoned Dump Sites in Kumasi, Ghana

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This study investigated the heavy metal content and the extent of pollution in soils from abandoned dump sites in Kumasi, Ghana. Concentrations of heavy metals in the 70 soil

samples were determined using a Niton XL3t GOLD field portable X-ray fluorescence spectrometer and confirmed on an Agilent 7800 inductively coupled plasma-mass spectrometer. Mercury was determined with a Lumex mercury analyzer. Mean concentrations of metals in soils were in the order: Zn (166 mg/kg), Cr (67 mg/kg) > Cu (32 mg/kg), Ni (22 mg/kg) > Pb (11 mg/kg) Cd (8.9 mg/kg) > As (4.2 mg/kg) > Hg (0.04 mg/kg) for Kronum; and Zn (558 mg/kg), Cu (347 mg/kg), Pb (288 mg/kg) > Cr (77 mg/kg) > Ni (35 mg/kg) > As (11 mg/kg) > Cd (3.0 mg/kg) > Hg (0.19 mg/kg) for Amakom. Pollution indices (geo-accumulation, contamination factor, pollution load and potential ecological risk) indicated very high contamination for arsenic, cadmium and lead at Kronum and arsenic, cadmium, copper, lead and zinc at Amakom. Mercury recorded the least level of pollution for both dump sites. Regular monitoring of these abandoned dump sites is required. Remediation programs in these sites should also be instituted.

3.05.07

Soil Contamination by Heavy Metals (Co, Ni, Cd, Cr, Zn, Pb, Cu and Hg) at Informal E-Waste Recycling Sites in Douala, Cameroon and Bioaccumulation of the Metals by *Alma nilotica*

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Soil contamination can cause risk to soil organisms and other organisms that depend on soil or soil organisms to live. The objective of this study was to assess soil contamination by heavy metals at e-waste activity sites and the bioaccumulation potential of the heavy metals by *Alma nilotica*, a tropical earthworm species. Soil samples (n=10) were collected from 8 informal e-waste recycling sites and 2 reference sites. The 10 soil samples from each site were combined to give one composite sample for the site that was used for laboratory exposure of *Alma nilotica*. Acid digestion proceeded by Inductively Coupled Plasma-Mass Spectrometry (ICP-MS) was used to analyze the concentrations of 9 heavy metals in the samples. Soil contamination by studied metals ranged from moderate to very high based on contamination factors. The order of heavy metal contamination in the e-waste soils were Cu > Pb > Zn > Hg > Ni > As > Cd > Co > Cr. All the e-waste sites studied had ultra-high soil heavy metal contamination based on the modified degree of contamination index and were classified in order of increasing overall heavy metal contamination as: Bonaberi > Genie Millitaire 2 > Terminus 2 > Genie Millitaire 1 > Terminus 1 > Makepe Misoke 1 > Makepe Pont Casse > Makepe Misoke 2. The order of metal ecological risk index was Zn > Pb > Ni > Hg > Cu > Cr > Co > Cd > As. The accumulation of metals by the earthworm, *Alma nilotica*, and the soil metal concentrations had a positive correlation but metals with higher concentrations in the soil tended to have lower bioaccumulation factors. Only Hg and Co had BAFs >1 with Hg having the highest BAF despite having the lowest soil concentration. *Alma nilotica* is therefore capable of accumulating these 2 metals in its body to higher concentrations than found in the soil.

This earthworm species was also capable of accumulating all the other metals (Pb, Zn, Cr, Cd, Cu, and As) to a large extent during the exposure period, despite the low bioaccumulation factors for these metals. The metal profile in the earthworm was similar to that of the soil in which it was exposed. The studied earthworm species (*Alma nilotica*) therefore has a great potential to bioaccumulate heavy metals and is therefore a good bioindicator of soil pollution by heavy metals. This may have implications for the use of this earthworm species for remediation of soils contaminated by these metals. **Key words:** E-waste; heavy metals; soil contamination; earthworm bioaccumulation

3.05.09

The Ameliorating Effect of Glycine in Cobalt Chloride Induced Oxidative Stress

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Cobalt chloride (CoCl₂) is used in the industry and is recognized as one of the many potent environmental contaminants. It induces oxidative stress by increasing the formation of reactive oxygen species (ROS), which involves free radicals and peroxides. This study was carried out to assess the impact of cobalt chloride, a potent oxidative stress-inducing chemical, and the possible protective effects of glycine in male Wistar rats. Thirty-six rats were randomly selected, and assigned to one of six groups: control, cobalt chloride only, cobalt chloride + glycine (50mg/kg), cobalt chloride + glycine (100mg/kg), glycine (50mg/kg) and glycine (100mg/kg) respectively. Lipid peroxidation, the product of ROS, and one of the primary markers/ indicators of oxidative stress was detected as increased malondialdehyde (MDA) and hydrogen peroxide (H₂O₂) generated in liver samples of exposed rats. Accompanied reductions in hepatic antioxidant enzymes activity of glutathione peroxidase (GPx) and superoxide dismutase (SOD) were observed (p < 0.05). However, no significant (p < 0.05) difference detected in reduced glutathione (GSH) contents. Treatment with glycine at 50 and 100mg/kg reduced MDA and H₂O₂ levels, as well as ALT, AST and ALP. Furthermore, GSH and SOD levels were restored and activities of GPx improved. Our result suggests that glycine offered considerable hepatic protection, evidenced by reduced oxidative stress and enhanced antioxidant enzyme activities and could be very useful in protecting the liver following concurrent exposure to Cobalt chloride.

Towards a Harmonized Approach for Microplastics Research in Africa

3.06.07

Microplastic Concentrations in the Zandvlei Catchment and Estuary, Cape Town, South Africa

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Microplastic pollution in South Africa is widespread, yet limited research is available for catchment areas. Given the serious implications of microplastic pollution in estuaries and the scarcity of information available on surface

water and sediment in these areas, this study investigated the abundance and characteristics of microplastics in the Zandvlei catchment and vlei area in Cape Town, South Africa. Surface water and sediment was sampled seasonally between 2018 and 2021, digested and identified by microscopy. Additionally, Fourier-transform infrared spectroscopy (FTIR) analysis was done to identify polymer types. Samples consisted of fibres (78%), films (3%), fragments (16%), foams (1%), spheres (0.76%) and nurdles (0.25%). Blue/green (22%) and smaller than 125 µm (84%) were most common microplastics recorded. This study provides baseline and quantitative information on microplastics in the catchment and Zandvlei Estuary. It assesses bioavailability of microplastics within the area and will contribute to long term microplastic monitoring in the estuary and the surrounding areas.

3.06.13 Microplastics Occurrence and Spatial Distribution in the Plankenburg River, Stellenbosch, South Africa

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Several studies on microplastic (MP) pollution in marine systems have been reported in South Africa but there is little information about microplastics contamination in freshwater systems in the country. The abundance and occurrence of microplastics were determined in the Plankenburg River, which flowed through different land-use practices in Stellenbosch. The physico-chemical characteristics of the river's water samples were measured onsite to determine the river quality relative to regulatory limits. Bulk sampling method was used for microplastic sampling using a metal bucket. Onsite, 30 L water samples were filtered per site. An additional 12 L sample was collected and transported to the laboratory for processing three replicates of 4 L per site. Potassium hydroxide (10%) was used for organic matter decomposition. The recovered microplastics will be characterised morphologically using a stereo microscope. Polymer type identification was done by a random selection of microplastics particles larger than 500 µm using Fourier transform infrared (µ-FTIR) analyses. The results showed an uneven distribution and abundance of microplastics in the freshwater system. Microplastics occurrence was dependent on the anthropogenic activities in the vicinity of the sampling points. More studies on the potential adverse effect(s) posed by microplastics on biota and freshwater environments are on-going. Preliminary results of toxicity to aquatic biota will be presented and discussed.

Ecological Risk Assessment: Environmental management frameworks in emerging economies

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Book

4.01.03 High rates of biochar soil amendment cause increased incidences of neurotoxic and oxidative stress in *Eisenia fetida* exposed to glyphosate

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The use of agrochemicals in the environment can cause undesirable effects on non-target species. One agrochemical that has been extensively used in agriculture is Roundup®. It contains an active ingredient called glyphosate which seems to have detrimental effects on aquatic and terrestrial organisms. The present study was carried out at the University of the Free State, QwaQwa Campus, where *Eisenia fetida* is bred in the Ecotoxicology laboratory. Mortality, biomass, Acetylcholinesterase (AChE) and Catalase (CAT) activity were studied in *E. fetida* in response to 96 hours glyphosate exposure in non-biochar (0%) and biochar (5, 10 and 15%) amended soil. Exposure procedures were carried out in triplicate in 0, 2, 4 and 8 mg glyphosate/kg following the OECD (2004) protocol. The results showed that *E. fetida* was more sensitive to the highest concentration of glyphosate (8 mg/kg) when exposed in the absence of biochar; enduring significant mortality ($p < 0.005$). The lethal concentrations (LC) 10, 20 and 50 of glyphosate in the 0% biochar amendment were 5.54, 7.067 and >8 mg/kg respectively, whereas in all the amended soil, no LCs could be calculated. Significant differences also occurred in the biomass with *E. fetida* in the 8 mg/kg in the absence of biochar losing significantly more weight compared to those in other treatments ($p > 0.05$). The effective concentrations (EC) 10, 20 and 50 of glyphosate were, 5.238, 6.848 and >8 mg/kg respectively in the 0% biochar amendment, whereas in all the amended soil, no ECs could be calculated. For all the biochar amendments, LC₅₀ and EC₅₀ were >8 mg/kg due to lack of significant mortality and biomass loss or gain. These mortality and biomass data indicated a reduction in the toxic effects of glyphosate in all biochar amended soil. For biomarker responses, the 15% biochar treatment showed significantly higher AChE activity in the 0, 2 and 4 mg/kg when compared with other treatments even though the activity was not significantly different from there 10% in the 2 mg/kg and all treatments in the 4 and 8 mg/kg. CAT activity was significantly higher in the 4 mg/kg of the 10% biochar amended treatment when compared to other treatments. Glyphosate exerted adverse effects on *E. fetida*. However, the addition of biochar seemed reduce its toxicity. **Keywords:** Glyphosate, *Eisenia fetida*, Biochar amendment

4.01.07 Lessons Learnt From the Development of an Environmental Evidence Portal for Nigeria and Capacity Building on Evidence-Informed Decision Making in Environmental Management

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The knowledge and capacity for mainstreaming evidence into decision/policymaking in environmental pollution management is important to promote environmental education

and sustainability. In developing and under-developed countries, the knowledge of evidence-informed decision making (EIDM) as applicable to environmental management is still vague. The Evidence Use in Environmental Policymaking in Nigeria (EUEPiN) project was conceived in 2020 in partnership with three (3) environmental government regulatory agencies in Nigeria. The aim was to bridge the gap between stakeholders in the research-practice-policy triad in the field of environmental management in Nigeria. One of the project outcomes include the set up of an Environmental Evidence Synthesis and Knowledge Translation (EESKT) Research Group at a public university in Nigeria. In this study, two (2) initiatives (development of an open access Environmental Evidence Portal for Nigeria (EEPoN)) and capacity building workshop on EIDM in environmental management) were developed and implemented by the EUEPiN Project in collaboration with the EESKT Research Group over a period of three (3) months from April to June 2021. The EEPoN is a 'one-stop shop' to aggregate and disseminate information about policies, guidelines, standards, publications and other environmental information by various stakeholders within Nigeria. The capacity building workshop was developed following a targeted recruitment of participants across the environmental evidence ecosystem in Nigeria in the research-practice-policy triad. 96 applications were received within one (1) week timeline of the call for participants emphasizing the motivation for participation. Subsequently, 40 participants were shortlisted using a two (2) step multistakeholder shortlisting process. Middle to top career level participants across the triad were shortlisted with an equal ratio of males to females. Six (6) participant-driven modules were developed and facilitated by selected experts across the triad from within and outside Nigeria at a three (3) days in-person workshop. The participants provided feedback on the EEPoN with suggestions for improvement. The lessons learnt from these initiatives include the merits of digital platforms, advocacy for co-production and stakeholder-driven programme design to foster knowledge sharing, collaboration, and institutionalized funding mechanisms to promote EIDM in environmental management in Nigeria.

Integrated Environmental Assessment and Management (general)

4.02.01 Microbial Respiratory Quotient Reflects Substrate Quality and Quantity Added to Soils

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The sensitivity of respiratory quotient (RQ: $\sum \text{CO}_2 / \sum \text{O}_2$; mol CO₂:mol⁻¹ O₂) to reflect the quality and quantity of fresh inputs of labile and refractory carbon substrates in soil was evaluated. Background RQ values ranged from 0.68 to 0.89 in four soils with contrasting abiotic and biotic properties and under different land use. When soil was amended with different concentrations of glucose, fructose, sucrose, cellulose or Na-salicylate (0, 2, 4, 5, 10 or 20 mg C·g⁻¹), and phenanthrene, pyrene, hexadecane or octacosane (0, 100, 250, 500,

1000 or 5000 mg kg⁻¹), results indicated that RQ strongly ($p < 0.05$) reflected the type and concentration of carbon substrates added to the soil. The effect of glucose concentration on RQ-values was comparable between four different soils, suggesting that RQ is relatively sensitive to the effect of land use. Sampling depth (0–10 vs. 20–30 cm) and laboratory pre-conditioning (fresh vs. 8-d pre-incubation at 22°C) affected RQ values in soil samples obtained from a vegetated plot but not from the adjacent un-vegetated plot. Collectively, these findings support the claim that RQ is characteristically sensitive to the nature and amount of available substrates and reflect the current microbial eco-physiology in soil.

4.02.03

2,4-Dichlorophenoxyacetic Acid Removal in Water by Activated Carbon Derived From Palm Nut (*Elaeis guineensis*) Shell

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In Africa, the intensive use of chemicals (fertilizers, pesticides...) have become essential in agricultural production. However, the pesticides raises more and more questions about their risks for the environment and especially for human health. Side effects are sometimes associated with their use: toxicity for the user, the risk of residues in foodstuffs, the development of resistance and pollution of soil and natural resources such as natural ground and surface water which are most often used by rural populations. In Togo, the pesticides used are very diverse with a high proportion of insecticides. The share of pesticides with approved active ingredients represents only 8% (Kanda, 2011). Many studies have shown the persistence of pesticide residues in harvested products, in the soil and in water at variable concentrations. The Main objective of our study is proposing a low-cost treatment for the elimination of these pollutants by activated carbon. The activated carbon (AC) is prepared from Palm nut shell. We obtain a mass yield of 74%. The functional groups analysis is recorded using Fourier transform infrared spectroscopy. The morphology and structure of the sample is observed by high-resolution scanning electron microscopy (SEM). The composition, profile, and crystalline structure of the AC is determined by X-ray diffraction (XRD). The specific surface area is measured the Brunauer Emmett-Teller (BET) method. Studies on the treatment of water contaminated with a pesticide, 2,4 D, have been carried out. The parameters influencing the adsorption process were studied: contact time, Activated Carbon mass, pesticide initial concentration, temperature, pH. We also studied the kinetic behavior and the equilibrium behavior of the adsorption process.

Pollinators in Sustainable Agriculture: Approaches to Bridging the gap Between Science and Societal Needs

4.03.02

The Role of Stingless Bees in Pollination of Wild and Cultivated Plants

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Pollination through animals is crucial for the fruit set and reproduction of many wild and

agricultural plants. Most pollinators visit flowers to meet their individual food demands, i.e., collect pollen for their own consumption. Corbiculate bees instead visit flowers more frequently to provide food for their brood. Social bees can play an outstanding role in bee mediated pollination because their ability to learn and recruit nestmates enable them to explore and exploit resources highly efficiently. Along with honeybees, stingless bees are widespread in Africa's tropical and subtropical regions. However, the knowledge on pollination through stingless bees is limited compared to honeybee pollination. Around 35 species of stingless bees are known in Africa so far. About one third of these species is used in meliponiculture and could potentially be used for commercial pollination. In our study we explored the potential of African stingless bee species to serve as efficient pollinators. We investigated the bees' ability to learn and communicate with nestmates. Furthermore, the individual pollen collection behaviour of four stingless bee species was analysed. We sampled pollen collected by *Axestotrigona ferruginea*, *Dactylurina schmidtii*, *Hypotrigona gribodoi* and *Meliponula bocandei* in Nairobi and Kakamega, Kenya. Our results show that bees are highly flower constant, which is important for plants because it facilitates pollination. We will discuss chances and limitations of employing stingless bees for pollination.

4.03.03

"Pollinator Supplementation Mitigates Pollination Deficits in Smallholder Avocado (*Persea Americana* Mill.) Production Systems in Kenya"

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Insect pollination is a vital ecological service for improved quality and yield of crops, contributing to global food security. Avocado is one of the major horticultural crops which heavily rely on insects for pollination. However, there exist knowledge gaps on the benefits of insect pollination in avocado production and the pollination deficits, especially in the tropics. This study assessed the importance of insect pollination in avocado fruit set and estimated the degree of pollination deficit in smallholder farming system in avocado orchards. Additionally, we assessed if supplementation with colonies of the Western honey bee (*Apis mellifera* L.) to farms mitigated potential pollination deficits. Our results revealed a very high dependence of avocado on insect pollinators, insect-pollinated flowers having 89.5% fruit set, while self- and wind-pollinated (17.4%) or self-pollinated flowers (6.4%) had significantly less fruit set. The assessment of pollination deficits indicated 20.7% less fruit set observed under open pollination compared to hand-pollination in the non-pollinator-supplemented farms (control farms). The supplementation of two honeybee colonies per smallholder farm resolved the pollination deficit completely. Our findings suggest that insect pollinators play a vital role in avocado production; thus, bee colony management can

be an excellent strategy to ensure enough avocado pollination and improve high-quality yields.

4.03.04

Effective Pollination of Greenhouse Galla Musk Melon (*Cucumis Melo* L. Var. *Reticulatus* Ser.) by Afrotropical Stingless Bee Species

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Background: Pollination is a critical ecosystem service for the global food production, food security and economy. Over the past decades, honeybee declines have pointed to the need for alternative pollinators to assure global food security. In Africa, knowledge on the pollination efficiency of African endemic stingless bee species is largely lacking. **Methodology:** We compared the foraging behaviour and effectiveness of seven endemic African stingless bee species as alternative pollinators to *Apis mellifera scutellata* on greenhouse cultivated Cantaloupe melons. We determined food resource, foraging position and probing time for each bee species during foraging. We also determine the quality of fruit and seed produced from fruits for each type of pollination. **Results:** Among the bee species, *A. m. scutellata* started foraging sooner (4 days, on average) in the greenhouse than the stingless bee species (between 8 to 16 days). Most flower visits were performed using a top approach position, and stingless bees were mainly harvesting nectar (ca. 2/3 of all flower visits). *Meliponula ferruginea*, *M. togoensis*, *Hypotrigona gribodoi* and *Plebeina hildebrandti* spent more time collecting nectar than other stingless bee species. Fruit maturation was considerably faster when flowers were pollinated by stingless bees compared to honeybees, with the shortest fruit maturation time achieved by *Meliponula bocandei* and *H. gribodoi*. All treatments resulted in fruits of similar roundness and ellipsoid ratios. Highest sugar content was recorded in fruits from flowers pollinated by either *Dactylurina schmidtii*, *M. ferruginea* or *M. bocandei*. Highest fruit weight and fruit volume were obtained from flowers pollinated by *H. gribodoi*, *M. bocandei*, *M. lendliana* and *P. hildebrandti* compared to honeybees. Pollination by the latter 5 stingless bee species resulted in the highest seed counts per fruit but did not affect seed weight or volume. The ratio of germinated seeds was significantly lower (< 80%) by using *H. gribodoi* (greenhouse A) as pollinator compared to other bee species ($\geq 90\%$). **Conclusion:** Endemic African stingless bee species, such as *H. gribodoi*, *M. bocandei*, *M. lendliana* or *P. hildebrandti*, are more efficient pollinators of sweet melon than the African honeybee with regards to fruit weight and volume and seed quality. **Keywords:** *sweet melon*; *stingless bees*; *endemic*, *Africa*, *conservation*, *Ecosystem service*, *pollination efficiency*, *yield quality*; *pollination*; *greenhouse*

4.03.05

Assessment of the Impact of Biopesticides on the Western Honey Bee *Apis mellifera* and African Stingless Bee *Meliponula ferruginea* Using Laboratory and Semi-Field Approaches

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Bees provide pollination service to 90% of wild plants and 75% of crop species worldwide, in addition to honey and hive by-products. These ecosystem services are essential for ecological well-being and food and nutritional security.

Globally, insect pollination service in commercial crops is valued at \$267-657 billion annually. Synthetic insecticides, commonly used to mitigate the agricultural losses caused by insect pests, constitute one of the critical drivers of pollinator populations decline. Biopesticides are increasingly promoted as alternatives. However, information on their safety to pollinators is critical to guide their application. We evaluated the pathogenicity of six fungal-based biopesticides on the honey bee *Apis mellifera* and an endemic African stingless bee species *Meliponula ferruginea* under laboratory conditions. These biopesticides included *Metarhizium anisopliae* (ICIPE 7, ICIPE 20, ICIPE 62, ICIPE 69 and ICIPE 78) and *Beauveria bassiana* (ICIPE 284). Further, we evaluated the impact of *M. anisopliae* ICIPE 69 application on *M. ferruginea* survival, foraging behaviour and pollination success in cucumber *Cucumis sativus* under greenhouse conditions. Immediately after exposure to the biopesticides, *A. mellifera* acquired more conidia (2.8×10^4 - 1.3×10^5 colony-forming units (CFU)/bee) compared to *M. ferruginea* (1.1×10^4 - 2.3×10^4 CFU/bee) in the laboratory. However, the biopesticides caused < 40.4% mortality and < 18.5% mycosis to both *A. mellifera* and *M. ferruginea* in 10-day laboratory bioassays. In the greenhouse, *M. ferruginea* survival, flight activity, flower visitation rate, and pollen load were not affected by *M. anisopliae* ICIPE 69 application. The cucumber fruit set was not affected and a high yield was obtained. These findings establish that the six biopesticides are safe for use in integrated pest and pollinator management (IPPM) programmes as per International Organization of Biological Control (IOBC) toxicity classification limit

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