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# Impact of Urban Runoff on Benthic and Pelagic Fish Fauna in Ikpoba River: Metals Levels in Gonads

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## Abstract
*This study investigates the impact of urban runoff on heavy metal concentrations in Ikpoba River, focusing on water, sediment, and fish gonads. Two sampling stations, upstream and downstream, were selected to assess variations in contamination levels. The concentrations of heavy metals (Cr, Co, Cd, Ni, Pb) in these samples were analyzed using an Atomic Absorption Spectrophotometer. Histopathological examinations of fish gonad tissues were also conducted. Downstream water samples in August exhibited significantly elevated lead (Pb) levels (0.037 mg/L) and cobalt (Co) concentrations (0.02 mg/L) compared to upstream levels. Sediment analysis revealed marked downstream contamination, with higher lead (Pb) levels (5.208 mg/kg) and cobalt (Co) concentrations (2.067 mg/kg) in August. Gonadal tissue analysis showed alarming contamination levels, with pelagic fish species displaying higher lead (Pb) and cobalt (Co) concentrations compared to benthic fish. These results highlight the vulnerability of pelagic species to heavy metal accumulation and indicate substantial pollution from industrial sources in the Ikpoba River. Urgent pollution control measures and ongoing monitoring are essential to safeguard the river's ecosystem and community health. Further research is recommended to explore the long-term consequences and potential health risks associated with heavy metal contaminants in the river.*

**Keywords:** Heavy metals, Water, Sediment, Fish gonads, urban runoff

## INTRODUCTION
Urbanization's rapid pace has transformed landscapes with impervious surfaces like buildings, roads, and parking lots, intensifying stormwater runoff and its associated pollutants (Shaikh *et al.*, 2023). This surge in runoff carries heavy metals, toxic chemicals, organic matter, and more into nearby water bodies, disrupting natural infiltration processes and escalating surface runoff (Oñate-Valdivieso *et al.*, 2022). The proliferation of impervious surfaces during precipitation events exacerbates hydrological challenges, amplifying flood flow magnitudes and contributing to the urban heat island effect (Adetoro *et al.*, 2022). As impervious surfaces expand, altering watershed hydrology and reducing stormwater infiltration rates, the need to address runoff impacts becomes critical (Thiagarajan *et al.*, 2018).

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Urban runoff is a carrier of various pollutants, including heavy metals, pesticides, and nutrients, originating from sources like road runoff and industrial activities (Johannsen *et al.*, 2016). Of particular concern are heavy metals like lead, copper, zinc, and chromium, prevalent in urban runoff due to industrial activities and improper waste disposal (Choudhary *et al.*, 2023). These toxic metals pose risks to aquatic life, disrupting physiological processes, impairing growth, and accumulating in the food chain, ultimately impacting aquatic ecosystems (Jadaa and Mohammed, 2023). Chronic exposure to heavy metals in aquatic environments can have adverse effects on fish activity, growth, metabolism, and reproduction (Xia *et al.*, 2018). Gonadal pathology in fish serves as a sensitive indicator of environmental stressors, offering insights into fish reproductive health. This study aims to investigate the levels of metals in the Ikpoba River and assess fish gonad pathology to understand the impacts of urban runoff on benthic and pelagic fish fauna. By exploring how urban sources influence fish health and reproduction, this research seeks to inform effective management strategies to mitigate urbanization's negative effects on aquatic ecosystems.

**METHODOLOGY**

*Study area:* The study was conducted in Benin City, Nigeria, located within the humid tropical rainforest belt (Chukwuka and Ogbeide, 2021; Victor and Ogbeibu, 1985). The Ikpoba River, a significant feature of the city, supports local communities' activities but is also impacted by human activities such as waste disposal and wastewater discharge (Chukwuka and Ogbeide, 2021; Tawari-Fufeyin and Ekaye, 2007; Victor and Ogbeibu, 1985). The coexistence of activities these activities in close proximity to the river raises concerns about potential pollution and environmental degradation risks.

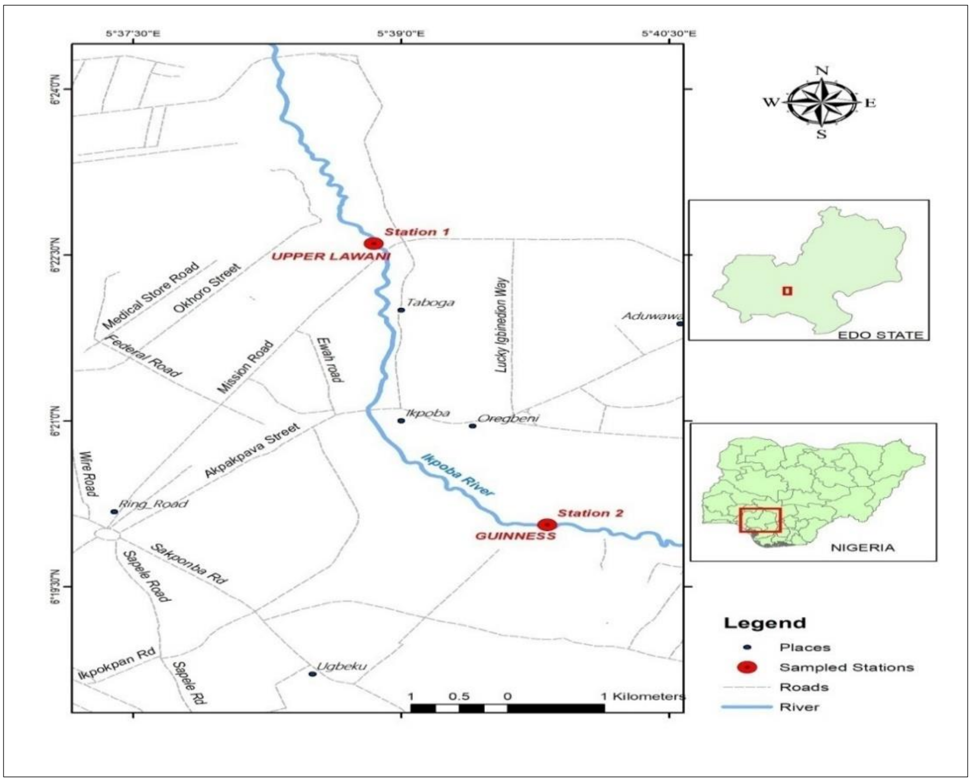


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**Figure 1:** Map showing site locations of the study area

**Sample Collection and Preparation** Two stations, each representing distinct effluent characteristics, were selected for this research. Station 1, upstream of the effluent discharge source, is considered relatively uncontaminated, while Station 2 encompasses the effluent discharge point from a brewery. Water samples were collected from both the benthic and pelagic zones along the Ikpoba River during monthly expeditions from June to August 2023, following the method described by Onyidoh *et al.* (2017). Sediment samples were collected using grab sampling techniques, and fish samples were collected using a fishing net (Chukwuka. *et al.*, 2019).

**Laboratory Analysis** In the laboratory, the fish were cleaned and stored separately in polyethylene bags at -10°C for identification and preservation. The concentrations of heavy metals in water, sediment, and fish samples were determined using methods described by Davies and Ekperusi (2021). An Atomic Absorption Spectrophotometer (AAS) Solar 969 Unicam Series model was used to analyze heavy metals (Cr, Co, Cd, Ni, Pb as described by Zangina *et al.* (2019). Each sample was analyzed in triplicate to ensure representative results. The concentration of metals was calculated using a standard calibration plot method,

**Histopathology of gonad**

The gonads were surgically removed and initially preserved in Bouin's fluid for three days to facilitate tissue hardening, following the method described by Culling (1974). Subsequently, the tissues were transferred and stored in 10% phosphate-buffered formalin for preservation. A dehydration process using graded ethanol dilutions was then performed before embedding the tissues in paraffin wax, following the protocol outlined by Barnhoorn *et al.* (2010) and Chukwuka *et al.* (2019). Finally, 5 mm sections of the tissues were cut, stained with haematoxylin and eosin (H&E), and evaluated using a light microscope.

**Data Analysis**

Data obtained from the analysis was subjected to statistical analysis using SPSS version 21 software. Analyzed data was presented in summary tables as Mean ± S.E. One-way ANOVA and Duncan multiple range (DMR) test will be used for the analysis of measurements within each sampling site

**RESULTS**

***Heavy metals in water samples***

The results presented in table 1and figure 2 indicate significant variations in the concentrations of certain heavy metals between upstream and downstream locations. Specifically, Lead (Pb), Cobalt (Co), and Nickel (Ni) show statistically significant differences, as indicated by a P-value less than 0.05. Conversely, Chromium (Cr) and Cadmium (Cd) do not exhibit any significant difference between the two locations, as their P-values are greater than 0.05. These findings provide a snapshot of the heavy metal concentrations in the Ikpoba River.

**Table 1: Monthly variations of heavy metals concentrations in water samples from Ikpoba River**

| Heavy metal | June Upstream Mean±S.E | June Downstream Mean±S.E | July Upstream Mean±S.E | July Downstream Mean±S.E | August Upstream Mean±S.E | August Downstream Mean±S.E | P value |
|---|---|---|---|---|---|---|---|
| Pb | 0±0.000 | 0±0.000 | 0±0.000 | 0±0.000 | 0.029±0.003 | 0.037±0.001 | P<0.05 |
| Co | 0.016±0.002 | 0.02±0.004 | 0.016±0.002 | 0.02±0.004 | 0±0.000 | 0±0.000 | P<0.05 |
| Cr | 0.032±0.002 | 0.045±0.002 | 0.032±0.002 | 0.045±0.002 | 0.042±0.002 | 0.047±0.002 | P>0.05 |
| Cd | 0±0.000 | 0±0.000 | 0±0.000 | 0±0.000 | 0±0.000 | 0±0.000 | P>0.05 |
| Ni | 0.04±0.001 | 0.047±0.001 | 0.04±0.001 | 0.047±0.001 | 0.032±0.002 | 0.04±0.001 | P<0.05 |

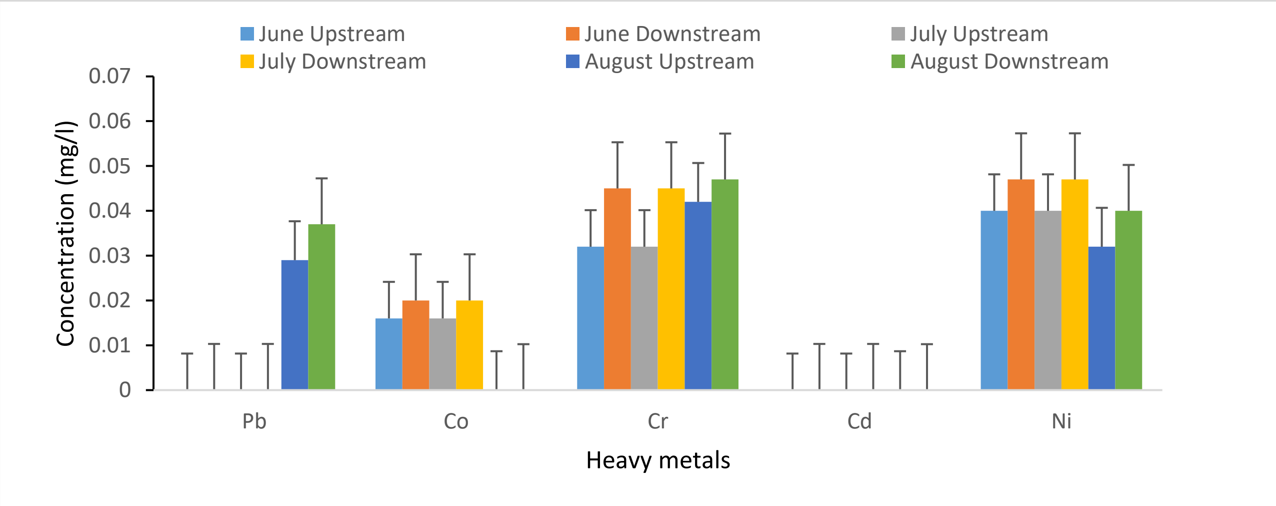


**Figure 2: Monthly variations of heavy metals concentrations in water samples from Ikpoba River**

### *Heavy metals in sediment samples*

The sediment samples from the Ikpoba River show significant monthly variations in the concentrations of certain heavy metals as presented in table 2 and figure 3. Notably, there are significant differences in the concentrations of Lead (Pb), Cobalt (Co), and Nickel (Ni) between upstream and downstream locations. However, Chromium (Cr) and Cadmium (Cd) do not exhibit any significant differences. These observations highlight the dynamic nature of heavy metal concentrations in the river's sediment.

**Table 2: Monthly variations of heavy metals concentrations in sediment samples from Ikpoba River**

| Heavy metal | June Upstream Mean±S.E | June Downstream Mean±S.E | July Upstream Mean±S.E | July Downstream Mean±S.E | August Upstream Mean±S.E | August Downstream Mean±S.E | P value |
|---|---|---|---|---|---|---|---|
| Pb | 0.362±0.019 | 0.474±0.004 | 0.362±0.019 | 0.474±0.004 | 5.827±0.595 | 5.208±0.348 | P<0.05 |
| Co | 1.718±0.136 | 2.067±0.058 | 1.718±0.136 | 2.067±0.058 | 0.489±0.019 | 0.513±0.045 | P<0.05 |
| Cr | 2.568±0.297 | 2.155±0.021 | 2.568±0.297 | 2.155±0.021 | 1.899±0.149 | 2.116±0.342 | P>0.05 |
| Cd | 0.181±0.004 | 0.214±0.002 | 0.181±0.004 | 0.214±0.002 | 0.177±0.036 | 0.241±0.022 | P>0.05 |
| Ni | 6.125±0.102 | 7.89±0.193 | 6.125±0.102 | 7.89±0.193 | 1.585±0.061 | 1.447±0.117 | P<0.05 |

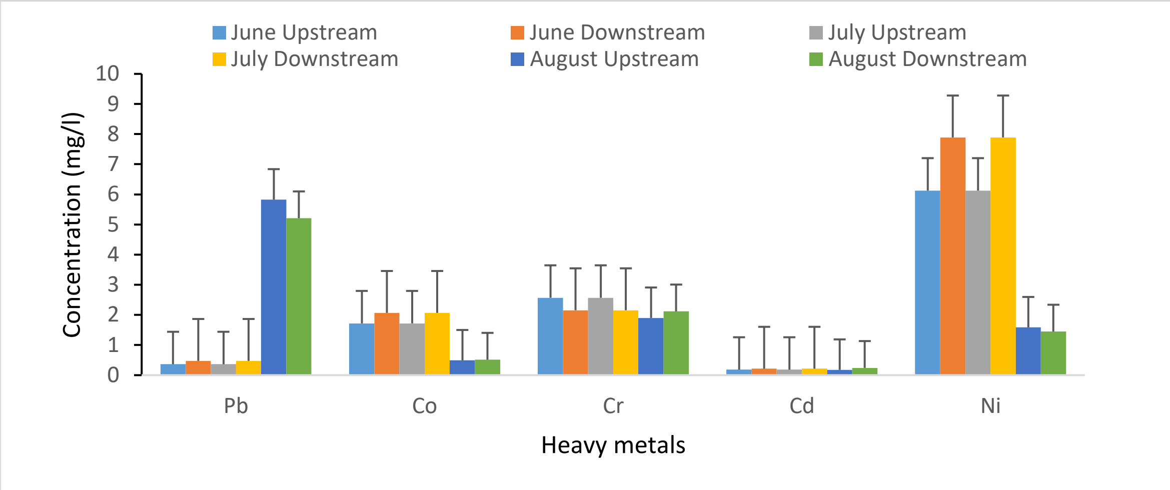


**Figure 3: Monthly variations of heavy metals concentrations in sediment samples from Ikpoba River**

### *Heavy metals in Gonad of Pelagic and Benthic fish samples*

The heavy metals concentrations in the gonads of both benthic and pelagic fish samples from the Ikpoba River presented in table 3 and figure 4, show significant variations over the months of June, July, and August. Notably, there are significant differences in the concentrations of Lead (Pb), Cobalt (Co), and Nickel (Ni) between benthic and pelagic fish. However, Chromium (Cr) and Cadmium (Cd) do not exhibit any significant differences. These observations highlight the dynamic nature of heavy metal concentrations in the river's aquatic life.

**Table 3: Heavy metals concentrations in Gonads of benthic and pelagic fish samples from Ikpoba River**

| | June | | July | | August | | |
|---|---|---|---|---|---|---|---|
| | Benthic | Pelagic | Benthic | Pelagic | Benthic | Pelagic | P value |
| Heavy metal | Mean±S.E | Mean±S.E | Mean±S.E | Mean±S.E | Mean±S.E | Mean±S.E | |
| Pb | 0.0386±0.004 | 0.042±0.002 | 0.0386±0.004 | 0.042±0.002 | 0.3943±0.051 | 0.2818±0.020 | P<0.05 |
| Co | 0.0414±0.002 | 0.055±0.007 | 0.0414±0.002 | 0.055±0.007 | 0.03725±0.002 | 0.02825±0.003 | P<0.05 |
| Cr | 0.2832±0.106 | 0.4318±0.116 | 0.2832±0.106 | 0.4318±0.116 | 0.21975±0.015 | 0.1585±0.025 | P>0.05 |
| Cd | 0.0256±0.003 | 0.0678±0.038 | 0.0256±0.003 | 0.0678±0.038 | 0.02625±0.002 | 0.019±0.003 | P>0.05 |
| Ni | 0.6262±0.101 | 0.6734±0.101 | 0.6262±0.101 | 0.6734±0.101 | 0.04125±0.006 | 0.04425±0.002 | P<0.05 |

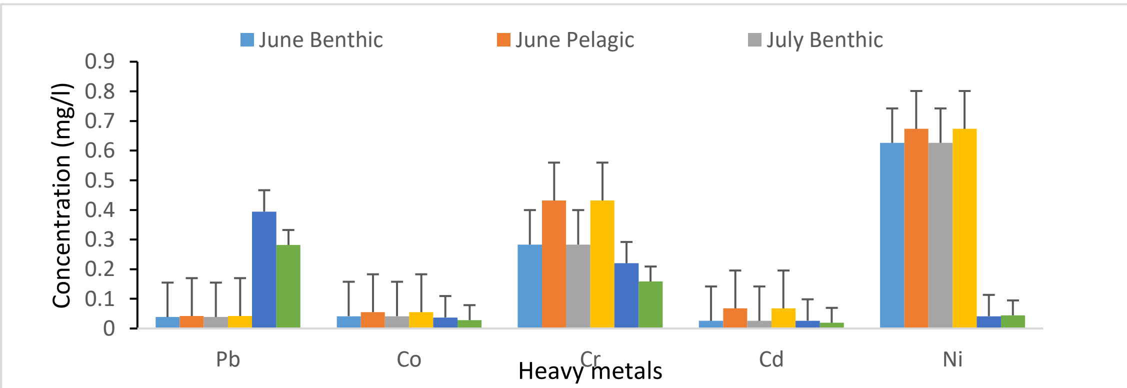


**Figure 4: Heavy metals concentrations in Gonads of benthic and pelagic fish samples from Ikpoba River**

***Concentration of metals in water and sediment samples***

The research conducted on heavy metal concentrations in the Ikpoba River in Benin City, Nigeria, highlighted significant differences between water and sediment samples. The study revealed that heavy metals such as lead (Pb), cobalt (Co), and nickel (Ni) exhibited higher concentrations in sediment compared to water ($P<0.05$). Specifically, lead concentrations were notably higher in sediment than in water ($P<0.05$), emphasizing the tendency for heavy metals to accumulate more in sediment than in the water column. This distinction underscores the importance of understanding the behavior of heavy metals in different environmental compartments to effectively manage and protect water quality and ecosystem health in the Ikpoba River.

**Gonad Pathology of fishes from Ikpoba River**

The gonad tissues of *Tilapia zilli* and *Clarias barachus* obtained from the Ikpoba River were meticulously examined over the course of three months, revealing distinct changes indicative of developmental and pathological processes.

In June a observed in Fig 5a, the gonad tissues of *Tilapia zilli* exhibited demarcated membranes (chorion) that appeared indistinct, accompanied by reduced cellularity of germinal vesicles and yolk granules. Conversely, the gonad tissues of *Clarias barachus* in June showed membranes with proliferative changes, hinting at varying stages of tissue development (Fig 6a).

Moving into July, the observations for *Tilapia zilli* revealed membranes with mild proliferative changes, suggesting ongoing cellular activity within the tissues (Fig 5b). Similarly, *Clarias barachus* displayed unremarkable features in July, with visible mononuclear exudates, indicating a different pattern of tissue response compared to the previous month (Fig 6b).
By August, the gonad tissues of *Tilapia zilli* showed unremarkable germinal vesicles and fatty changes (adipocytes), pointing towards potential alterations in tissue composition and health (Fig 5c). In contrast, *Clarias barachus* exhibited remarkable membranes with prominent germinal vesicles and yolk, along with diffused deposits of basophilic deposits, highlighting significant changes in tissue structure and composition (Fig 6c).

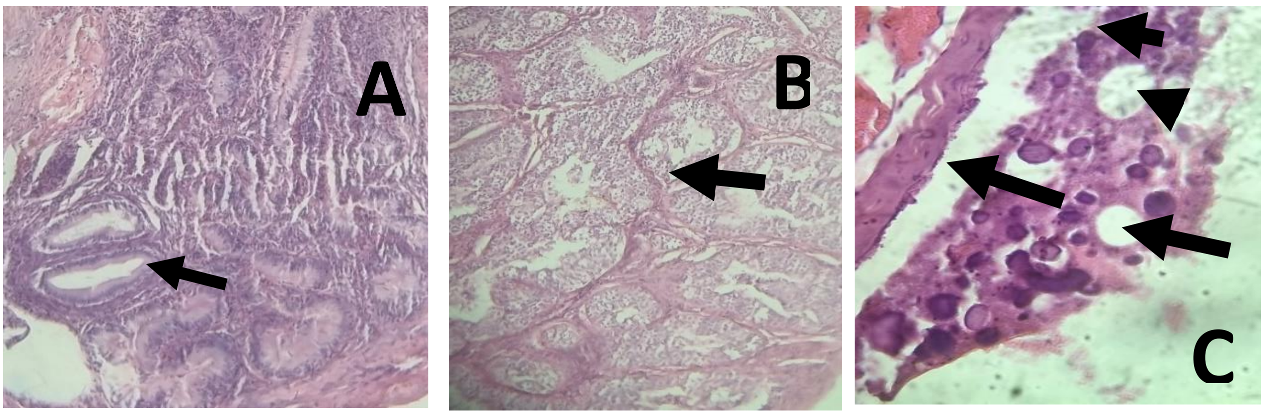


**Fig 5:** Gonad tissues of *Tilapia zilli* obtained from Ikpoba River

a) Observations for June demarcated membranes (chorion) that appears not distinct with reduced cellularity of germinal vesicles and yolk granules. b) Observations for July showing membranes (chorion) with mild proliferative changes c) observations for August showing unremarkable geminal vesicles (short arrow) and fatty changes (adipocytes) (long arrow).

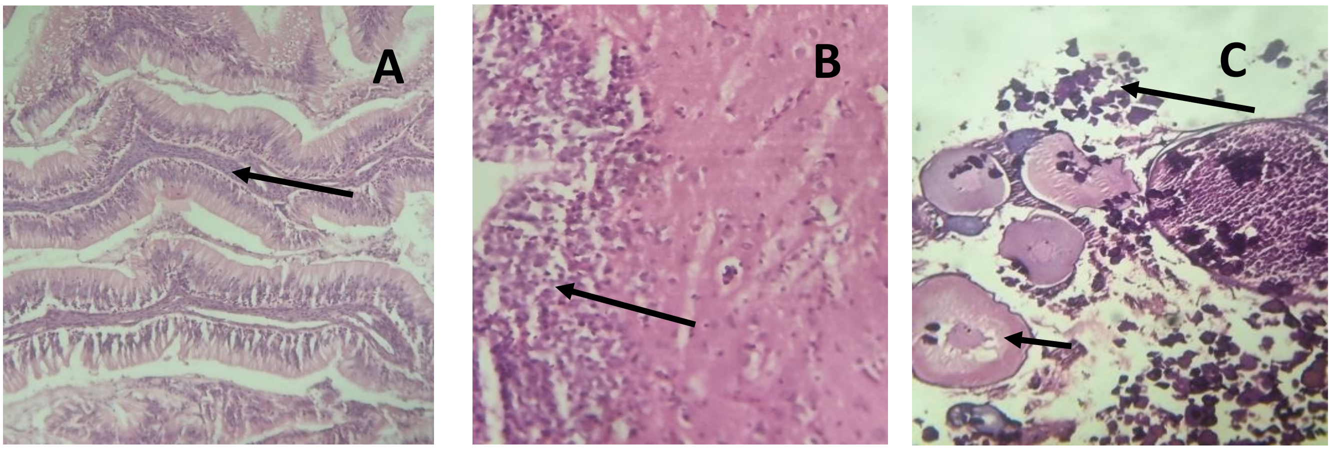


**Fig 6:** Gonad tissues of *Clarias barachus* obtained from Ikpoba River

a) Observations for June showing membranes (chorion) with proliferative changes
b) Observations for July showing unremarkable features with visible mononuclear exudates (arrow)).
c). Observations for August showing remarkable membranes (chorion) with prominent germinal vesicles and yolk (long arrow) with diffused deposits of basophilic deposits (short arrow)

**DISCUSSION**

Understanding the effects of urban runoff on benthic and pelagic fish fauna in the Ikpoba River ecosystem is crucial for evaluating metal levels in gonads and determining the potential consequences for aquatic organisms and overall ecosystem health. Studies have shown that the Ikpoba River is subjected to pollution from various sources, including industrial effluents and urban runoff (Akpe *et al.*, 2018; Igboanugo *et al.*, 2013). These pollutants can have detrimental effects on the water quality, leading to increased metal concentrations in fish gonads (Okonofua and Oghoyafedo, 2019) .In the present study, the impact of urban runoff on benthic and pelagic fish fauna in Ikpoba river was investigated.

**Heavy metals in Water**

The analysis of metal concentrations in the Ikpoba River has revealed significant variations in lead (Pb), cobalt (Co), chromium (Cr), cadmium (Cd), and nickel (Ni) levels between upstream and downstream locations. These variations underscore the potential impact of both anthropogenic activities and natural sources on metal pollution within the river ecosystem (Areguamen *et al.*, 2023). These findings suggest that the presence of these heavy metals in the water samples may pose health risks to both humans and aquatic organisms (Anya and Odo, 2023; Jonah and Mendie, 2023). The elevated levels of these metals, particularly in the downstream areas, exceed the permissible limits set by international organizations and standards for drinking water quality (Gabi *et al.*, 2022; Lim *et al.*, 2012). Studies have shown that the spatial variability of metal concentrations in rivers can be influenced by factors such as industrial effluent dispersion, wastewater pollution, and urban runoff (Mishra *et al.*, 2020). Studies have shown that elevated levels of lead in aquatic environments can have detrimental effects on fish health, reproduction, and overall ecosystem functioning (Orata and Sifuna, 2023). The higher concentrations of lead downstream compared to upstream in the Ikpoba River indicate a potential source of contamination that warrants further investigation and remediation efforts to protect aquatic organisms. Similarly, the distinct patterns observed in cobalt concentrations between upstream and downstream areas, which may reflect the impact of anthropogenic sources on water quality. Studies have shown that high cobalt levels have been observed in polluted rivers, indicating the impact of industrial activities on metal concentrations in water bodies (Schrauzer, 2004). Similar studies by Ojekunle *et al.* (2016) and Hong (2014), and , have highlighted the spatial variation of heavy metal including cobalt in water bodies influenced by land-use patterns and industrial activities in Nigeria.

The consistent levels of chromium in both upstream and downstream locations of the Ikpoba River suggest a relatively uniform distribution of this metal in the river Jordan and Stamer (1995). This distribution may be influenced by various factors, including natural sources and background levels of chromium in the environment. Studies by Fuhrer *et al.* (1996) and Groover *et al.* (2023) have provided insights into the distribution and behavior of chromium in water bodies and aquifer materials, shedding light on the factors affecting its spatial distribution..

Conversely, the consistently low levels of cadmium in both upstream and downstream locations of the Ikpoba River indicate minimal contamination of the river with this toxic metal (Areguamen *et al.*, 2023). The low cadmium levels may be attributed to limited anthropogenic inputs or effective natural attenuation processes in the river system. Studies by Rivaro *et al.* (2004) and Islam *et al.* (2021) has addressed the presence and impact of cadmium in water bodies, emphasizing the importance of monitoring and managing this heavy metal to prevent environmental and health risks.

The fluctuations in nickel concentrations with notable differences between upstream and downstream areas underscore the dynamic nature of metal pollution in the river ecosystem (Izegaegbe *et al.*, 2022).

**Heavy metals in Sediment**

The analysis of heavy metal concentrations in sediment samples from the Ikpoba River in Benin revealed significant variations in metal levels between upstream and downstream locations. Lead (Pb) concentrations showed a notable difference, with higher levels recorded upstream in August compared to downstream during the same month. This disparity in Pb concentration between the two areas suggests a potential source of contamination that requires further investigation to understand the impact on sediment quality and aquatic organisms (Ayrault *et al.*, 2014). Lead concentrations in river sediments in Nigeria have been investigated in multiple studies. The studies found that lead levels in sediments exceeded recommended limits in various rivers, indicating pollution and potential ecotoxicological risks (Ipeaiyeda and Onianwa, 2018). Lead (Pb) concentrations in the Ikpoba River exhibit significant spatial variations, with higher levels observed upstream compared to downstream. This phenomenon is consistent with findings from various studies indicating that Pb concentrations tend to fluctuate spatially due to human activities such as mining and industrial discharges (Alexander and Smith, 1988). The presence of higher Pb levels upstream could be attributed to anthropogenic inputs from sources like mining activities or industrial discharges (Alexander and Smith, 1988). Cobalt (Co) concentrations in the river sediment exhibited discrepancies between upstream and downstream sites, with higher levels observed downstream during June and July. This significant difference in Co concentration highlights the need for targeted monitoring and management strategies to address potential sources of cobalt contamination in the river sediment and mitigate associated risks to ecosystem health (Anya and Odo, 2023). In contrast, chromium (Cr) concentrations showed no significant difference between upstream and downstream areas, indicating a relatively consistent level of Cr contamination in sediment samples from both locations. While this finding suggests a more uniform distribution of chromium in the river sediment, ongoing monitoring is essential to assess any long-term trends and potential ecological implications of Cr pollution on benthic and pelagic organisms (Chang *et al.*, 2018).The results also revealed fluctuations in nickel (Ni) concentrations, with significant differences between upstream and downstream locations. The higher Ni levels downstream compared to upstream highlight the potential influence of anthropogenic activities and natural sources on nickel pollution in the river sediment. These findings underscore the importance of continued research and monitoring to identify sources of Ni contamination and implement effective measures to protect sediment quality and aquatic biodiversity.

Studies conducted in various regions of Nigeria have highlighted elevated metal concentrations in river sediments, indicating contamination from sources including various anthropogenic activities. These studies have focused on assessing the levels of heavy metals in sediment samples collected from different rivers in Nigeria. For example, Ololade *et al.* (2023) investigated the concentrations of eight trace metals, including Cd, Cr, Cu, Fe, Mn, Ni, Pb, and Zn, in sediment samples from southwestern Nigeria, emphasizing the presence of these metals in river sediments, Similarly, studies by Okonkwo *et al.* (2023) conducted in Olode and its environs inside Ibadan, , found high levels of heavy metals such as Pb, Zn, Cu, Ni, Co, Fe, Mn, and Cr in stream sediments and rock samples, indicating negative impacts from mining activities.

Furthermore, investigations have delved into the concentrations of heavy metals in water and sediments within the oil exploration zone of the Qua Iboe river estuary in Nigeria, providing insights into the distribution of these metals in a specific region (Ekwumemgbo *et al.*, 2011). Similarly, the monitoring of Cross River by Anya and Odo (2023) revealed high concentrations of heavy metals including Mn, Fe, Zn, Pb, Cu, Cr, and As in both water and sediment samples, exceeding permissible limits and indicating pollution of the river. The sediments of River Ogun in Nigeria were also found to have high concentrations of Fe, Mn, Zn, Pb, Cr, and Co, above permissible limits, suggesting contamination (Ayodele *et al.*, 2023). Additionally, the sediment of Ikpoba River showed the presence of metals such as Cd, Cu, Co, Pb, Ni, and Fe, with Fe being the most abundant, indicating anthropogenic sources and potential ecological and health risks (Areguamen *et al*., 2023).

**Heavy Metals in Fish gonads**

The analysis of heavy metal concentrations in the gonads of benthic and pelagic fish samples from the Ikpoba River has yielded some fascinating results. The variations observed in lead (Pb) concentrations between benthic and pelagic fish samples underscore the distinct exposure pathways for these two groups. Research has shown that benthic fish species generally exhibit higher metal concentrations compared to pelagic fish due to increased exposure to sediments and greater contact with contaminants (Akan *et al*., 2012; Das Pinkey *et al*., 2024). Specifically, the highest Pb levels were recorded in June, followed by declines in July and August, indicating a temporal trend in Pb contamination levels (Das Pinkey *et al*., 2024). This temporal variation is significant as high Pb concentrations can lead to nephrotoxicity and have adverse effects on fish reproductive health and overall fitness (Akan *et al*., 2012).

The study findings reveal distinct patterns in cobalt (Co) levels, with concentrations peaking in both benthic and pelagic fish gonads during July. Conversely, the lowest Co concentrations were recorded in June and August, indicating temporal variability in Co contamination levels (Chmiel, 2023).. This variability underscores the significance of targeted monitoring efforts, as cobalt toxicity can have detrimental effects on fish health and ecosystem dynamics (Ngo *et al*., 2022). Studies have shown that cobalt exposure can have sublethal toxic effects on fish, affecting growth parameters and inducing biochemical alterations (Nasri *et al*., 2019).
Benthic fish samples exhibited higher chromium (Cr) levels in July, while pelagic fish had lower concentrations in August. Interestingly, there was no significant difference in Cr concentration between the two fish types which suggest a temporal variation in Cr contamination levels among benthic and pelagic fish species Kumar *et al.* (2023)). Studies have highlighted the impact of Cr contamination on fish health, with observations of alterations in white blood cell counts and red blood cell levels in response to Cr exposure (Authman *et al*., 2015).

The analysis of nickel (Ni) levels in fish across different months revealed the highest concentrations in June for both benthic and pelagic fish. However, significant differences in Ni concentrations between the two fish types were observed, suggesting distinct exposure pathways and potential risks associated with Ni contamination (Kumar *et al*., 2022; Rudiyanti *et al*., 2023).

**Gonad Pathology**

The study conducted on the gonad tissues of *Tilapia zilli and Clarias barachus* from the Ikpoba River over a span of three months revealed significant developmental and pathological changes. Tawari-Fufeyin and Ekaye (2007) have reported a diversity of fishes in Ikpoba river including those observed in this study. In June, the gonad tissues of *Tilapia zilli* showed indistinct demarcated membranes (chorion) and reduced cellularity of germinal vesicles and yolk granules . This could be indicative of a disruption in the normal reproductive cycle of the fish, which is known to be cyclical and seasonal (Blazer, 2002). On the other hand, *Clarias barachus* exhibited proliferative changes in the membranes, suggesting varying stages of tissue development (Bhat *et al.*, 2018; Rabie *et al.*, 2021).

In July, the gonad tissues of *Tilapia zilli* displayed mild proliferative changes, indicating ongoing cellular activity within the tissues (Blazer, 2002). This could be a sign of the fish's attempt to recover from the previous month's disruption. However, *Clarias barachus* showed visible mononuclear exudates, indicating a different pattern of tissue response compared to the previous month[1]. Mononuclear exudates are often associated with inflammatory responses, suggesting possible infection or injury (Blazer, 2002). By August, the gonad tissues of *Tilapia zilli* showed unremarkable germinal vesicles and fatty changes (adipocytes), pointing towards potential alterations in tissue composition and health (Chukwuka *et al.*, 2019). Adipocytes are fat cells, and their presence in the gonad tissues could indicate metabolic disorders or disruptions in the normal functioning of the gonads (Blazer, 2002; Rabie *et al.*, 2021). In contrast, *Clarias barachus* exhibited remarkable membranes with prominent germinal vesicles and yolk, along with diffused deposits of basophilic deposits (Blazer, 2002). These changes highlight significant alterations in tissue structure and composition, possibly due to environmental stressors or disease (Chukwuka *et al.*, 2019).

These findings underscore the importance of continuous monitoring and assessment of the health status of fish populations, particularly in relation to their reproductive health. Further studies are needed to fully understand the implications of these observed changes and their potential impact on the fish populations in the Ikpoba River.

## CONCLUSION

The study on the impact of urban runoff on heavy metal concentrations in Ikpoba River has revealed significant contamination downstream, particularly in water, sediment, and fish gonads. Elevated levels of lead and cobalt were found in downstream samples, indicating potential pollution from industrial sources. Pelagic fish species were shown to have higher concentrations of heavy metals compared to benthic fish, highlighting their vulnerability to contamination. Urgent pollution control measures are necessary to protect the river's ecosystem and the health of communities relying on it.

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