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(RESEARCH ARTICLE)

IMPACT OF HUMAN ACTIVITY ON THE DIETARY PROFILE OF THE GIANT MARSH FROG *Hoplobatrachus occipitalis* (GÜNTHER, 1858) IN THE GBÊKÊ REGION (CENTRAL CÔTE D'IVOIRE)

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ABSTRACT

This study assesses the impact of human activity on the diet of *Hoplobatrachus occipitalis* in the Gbêkê region, in central Côte d'Ivoire. Two sites with contrasting levels of human impact were surveyed: Allakro (a lightly humanised peri-urban area) and Tolla (a heavily humanised urban area). The physico-chemical parameters of the water were measured in situ, and the stomach contents of the captured frogs were analysed. The results reveal a marked gradient of human impact. Tolla shows signs of water quality degradation: high temperature, acidic pH, high conductivity and eutrophication. Trophic analysis confirms the status of *H. occipitalis* as a generalist predator, with a diet dominated by invertebrates. However, [17]'s similarity index (α = 0.082) indicates very low similarity between the diets of the two populations. At Allakro, the diet is stable and insectivorous. At Tolla, it appears unstable and includes the consumption of anurans, indicating cannibalistic behaviour. Females consume larger prey than males, a difference that is less pronounced at Tolla. Individuals at this site show a significant reduction in size (−11 per cent) and mass (−27 per cent) compared with Allakro, reflecting the impact of environmental stress and collection pressure. This study demonstrates that human impact alters the feeding behaviour and body condition of *H. occipitalis*, confirming its potential as a bioindicator of aquatic ecosystem quality.

Keywords: *Hoplobatrachus occipitalis*, Human impact, Diet, Bioindicator, Côte d'Ivoire.

1 INTRODUCTION

Drastic changes to natural habitats resulting from human activities, occurring at an unprecedented rate, are the main threats to biodiversity on a global scale ([1]). This phenomenon, known as anthropisation, results in the large-scale conversion of forests into agricultural land and urban areas, leading to the fragmentation of aquatic and terrestrial ecosystems and profound changes to food webs ([2]).

Within the animal kingdom, one of the groups of vertebrates known to live in the wild in both aquatic and terrestrial habitats is the class of amphibians. These animals, due to their permeable skin, their biphasic life cycle (i.e. aquatic in the larval stage, and terrestrial in the adult stage) and their intermediate position in food webs as both predators and prey, are particularly sensitive to human-induced disturbances affecting their habitats and serve as excellent biological indicators of the health of forest and savannah ecosystems ([3]). Several studies have documented the negative effects of human activity on the diversity and structure of amphibian communities ([4] ; [5]).

One of the most notable amphibian species in West Africa, both as a predator and as prey, is the giant marsh frog *Hoplobatrachus occipitalis*. Its range extends across the whole of sub-Saharan Africa, where it occupies a wide variety of habitats such as riverbanks, pools and ponds in degraded forests and savannahs ([6]). Despite the ecological and socio-economic importance of *H. occipitalis*, which has attracted the interest of a number of authors seeking to improve our understanding of the species (e.g., [7];[8]) research into the diet of this giant frog appears to be insufficiently documented in the savannah habitats of Côte d'Ivoire.

The Gbêkê region, situated in central Côte d'Ivoire, has for several decades been regularly subject to encroachment on its natural habitat, leading to the conversion of semi-deciduous forests into savannah due to the demographic expansion of the city of Bouaké ([9]). These various anthropogenic disturbances therefore provide an ideal setting for analysing the diet of *H. occipitalis* within its habitat.

This study thus helps to address this gap by assessing the impact of human activity on the dietary profile of *H. occipitalis* in savannah areas. More specifically, the aim was, on the one hand, to characterise the physico-chemical environment of the study area and, on the other hand, to determine the composition and diversity of the diet of *H. occipitalis* in different habitats. Finally, the study sought to identify the factors likely to influence the diet of *H. occipitalis*.

2 MATERIAL AND METHODS

2.1 Field of study

The Bouaké department is situated in the centre of Côte d'Ivoire, in the Gbêkê region. Geographically, it lies between latitudes 7°20' and 8°00' North and longitudes 4°20' and 5°20' West (Figure 1). Covering an area of 71,788 km^2, this territory occupies a strategic crossroads position, bordered to the north by the department of Katiola, to the east by that of M'bahiakro, to the south by the departments of Tiébissou and Didiévi, and to the west by Sakassou and Béoumi. From an administrative perspective, the department is organised around five main sub-prefectures: Bouaké, Brobo, Djébonoua, Mamini and Bounda ([10]).

The sampling sites were selected in accordance with the recommendations of [11]. These recommendations state that different habitat types must be taken into account in order to obtain a sample representative of the diversity of the environment. These include open or closed habitats, areas disturbed by human activities, and the presence of bodies of water. Wetlands, which generally serve as breeding sites for amphibians, also guided the choice of sites. The same applies to accessibility.

In the case of our study, the survey phase led to the selection of two types of habitat: permanent marshes situated in the low-lying area of the Tollakouadiokro (or Tolla) district in the heart of the city of Bouaké, and Lake Allakro, a village situated 20 kilometres north of the city of Bouaké, in a peri-urban area (Figure 1).

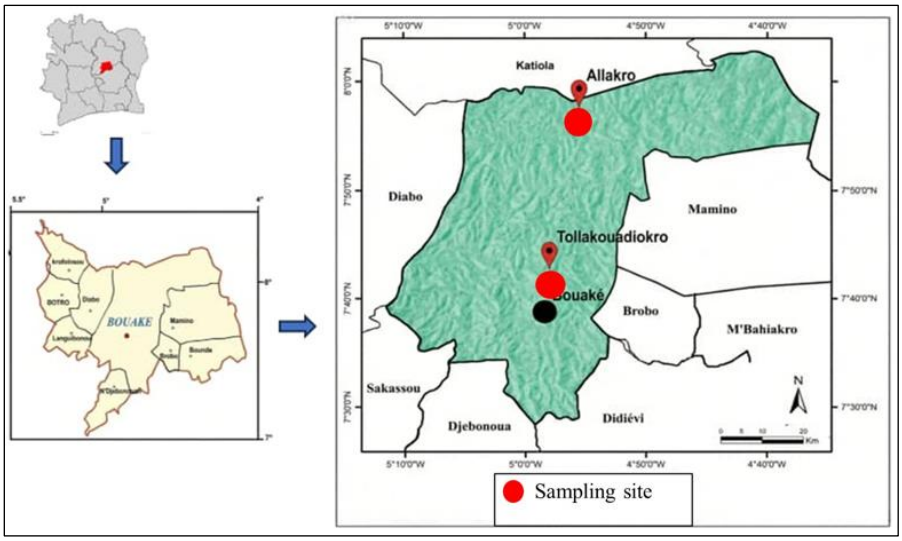

Figure 1: Map of sampling sites (Allakro and Tollakouadiokro)

2.2 Description of the study sites

For the physicochemical characterisation of the water, the physicochemical parameters (conductivity, TDS, temperature) were measured in situ using a portable multi-parameter meter and a pH meter (pH) . At each site, data were recorded at 3 sites (Table 1).

For sampling, morphometric measurements, dissection and sex determination, sampling was carried out from 17 to 21 December 2025, over five consecutive days at both sites. Individuals were immobilised at night using a torch and captured by hand on land or using a dip net when in the water. Captured individuals were immersed in a chlorobutanol anaesthetic solution ([12]).

Once deep anaesthesia had been confirmed, the individuals were euthanised. In the laboratory, the body mass and snout-to-cloaca length (SCL) of each individual were measured, and the stomachs were removed following a ventral incision. The sex of each individual was confirmed during dissection by examining the internal organs, noting the presence of testes only in all males. Furthermore, mature males each had two vocal sacs on either side of the base of the lower jaw, whilst mature females had an oviduct and oocytes present in the abdominal cavity.

Table 1: Description of the study sites

Site	Geographical location	Vegetation	Human activities
Allak	This site is a peri-urban lake, situated in a small village 20 km from the municipal area of Bouaké. It lies between 7°55'24.27‘ north latitude and 5°3'35.03’ west longitude. At the end of the rainy season, the lake covered an area of 1.5 hectares.	The site’s vegetation is divided into three distinct zones: - An open water zone covering an area of 1.5 ha, home to hydrophytes. - A riparian zone extending from the water’s edge 5–20 m inland, the domain of helophytes and creeping plants. - A shrubby savannah zone beyond the riparian zone, where tall herbaceous plants and woody plants are found.	Human activity at the site is characterised by: - occasional fishing for tilapia (Oreochromis niloticus) and African catfish (Clarias gariepinus) by setting traps in the lake; - sporadic hunting of frogs, particularly during the rainy season; - watering of zebu cattle (Bos indicus) herded by Peul herdsmen.
Tolla	This site is situated in the heart of an urban area. It lies between 7°44'1.22‘ north latitude and 5°2'35.59’ west longitude. It contains permanent marshes in a low-lying area covering a total area of 1.7 ha.	Vegetation is sparse across the entire site but concentrated in the low-lying areas. Around the permanent water sources in the low-lying areas, there is vegetation consisting of weeds that rarely exceed 1.5 m in height. This	The shallow water area and its immediate surroundings are under significant pressure from human activity, resulting in numerous permanent structures on either side of the area, where market gardening is practised

		vegetation consists mainly of a herbaceous carpet dominated by Cynodon dactylon (Poaceae), interspersed in places with the creeping Ipomea asarifolia (Convolvulaceae). There are also small to medium-sized weeds, notably Sida acuta (Malvaceae), Ricinus communis (Euphorbiaceae) and Cassia alata (Caesalpinaceae). As for the aquatic vegetation, it consists mainly of a mixture of broad-leaved floating plants such as Pistia stratiotes (Araceae) and others with tiny leaves such as Lemna minor (Araceae).	intensively. Furthermore, there is evidence of sewage and household waste being dumped into this shallow water area. People catching frogs in the stagnant water have even been spotted.

Each stomach sample was then placed in an individual glass vial containing 70% ethanol to halt enzymatic digestion and preserve the integrity of the ingested prey. To avoid any confusion during subsequent handling, each vial was labelled with a unique code indicating the site and order of capture of the individual.

For the analysis of stomach contents, the contents of each stomach were diluted in a Petri dish containing water in order to separate the various items. The items were then dried on blotting paper and weighed on a precision balance accurate to 0.001 g. Precise identification was carried out using a binocular magnifying glass, with reference to the identification keys by [13]and [14].

2.3 Calculation of dietary indices

2.3.1 Emptiness coefficient (EC)

The emptiness coefficient is expressed as the percentage ratio of the number of empty stomachs (containing no food) to the total number of stomachs examined (Sorbe, 1980). It is calculated using the formula : $EC = (Ev / Ne) \times 100$; Where Ev = Number of empty stomachs,

Ne = Number of stomachs examined. This coefficient helps to understand and analyse the state of stomach fullness. It indicates the percentage of individuals that have not consumed prey recently. A high EC suggests a period of fasting or low foraging activity within the studied population at a given time.

2.3.2 Numerical percentage (N) of prey

According to [15]'s method, this indicator expresses the numerical abundance of a prey category i relative to the total number of prey recorded. The formula used is as follows : $N = (Ni / Nt) \times 100$; Where: Ni = Total number of individuals of prey species i, Nt = Total number of all prey species recorded.

2.3.3 Weighted frequency (P)

Weighted frequency expresses, as a percentage, the ratio between the mass of a given prey category and the total mass of the prey recorded. According to [16], this indicator illustrates the relative proportion of each food item in the diet, without, however, constituting an index of food preference. The calculation is carried out as follows: $P = (mi / mt) \times 100$, where Pi = total mass of prey item i, mt = total mass of all prey items.

2.3.4 Frequency of occurrence (F)

This method involves expressing, as a percentage, the ratio of the number of stomachs containing prey item i to the total number of stomachs containing food. It provides a qualitative picture of the dietary spectrum of a population or subpopulation. [16] proposed the formula for its calculation. This index corresponds to the ratio, expressed as a percentage, of the number of stomachs containing prey item i to the total number of non-empty stomachs studied. This indicator provides a qualitative representation of the dietary spectrum under study. The formula used to calculate it is based on the work of [16].

$F = (Nie / Net) \times 100$;Where Nie = number of stomachs containing prey item i, Net = total number of full stomachs examined

2.3.5 Index of Relative Importance (IRI)

Individual calculation methods often provide only a fragmented view of feeding habits. To obtain a more detailed and comprehensive interpretation of the diet, it is preferable to use a composite index : the Index of Relative Importance (IRI). According to Pinkas *et al.* (1971), this parameter combines several data points to better reflect biological reality. It avoids overestimating small, very numerous prey items (numerical bias) or rare but very heavy prey items (weight bias). It is calculated using the following formula : IRI = (%N + %P) × %F. The calculated IRI value is then expressed as a percentage : %IRI = IRI / (∑IRI) × 100, where %N = numerical percentage of each prey category in the diet; %P = weight frequency of each prey category in the diet; %F = Frequency of occurrence of each prey category in the diet.

2.3.6 Schoener's similarity index

[17]'s similarity index (α) is used to determine the degree of similarity, taking dietary habits into account. In this study, it was used to compare the dietary profiles of individuals from the two environments (the heavily anthropised environment of Tolla and the lightly anthropised environment of Allakro). The value of the index ranges from 0 (no items in common) to 1 (identical items). When α < 0.6, the similarity is not significant. It follows that there is no similarity between the two sets of measurements. If α ≥ 0.6, the similarity is significant and it is concluded that the two diets are similar ([18]). It is calculated as follows : $\boldsymbol{\alpha = 1 - 0,5(\sum_{i=1}^{n} |Pxi - Pyi|)}$; Where Pxi = proportion of prey i consumed by individuals in habitat x, Pyi = proportion of prey i consumed by individuals in another habitat y.

2.4 Analysis of feeding strategy

To estimate the contribution of each prey item to the breadth of the niche and to determine the feeding strategy of the species under study, the graphical analysis proposed by [19] was used. This represents a modification of [20]'s method and enables the analysis of the importance of prey items, their contributions to the extent of the trophic niche and the feeding strategy of predators, based on a two-dimensional representation of the specific abundance of prey items (Si) and their frequency of occurrence (F) ([19]); [21]).

2.5 Statistical analysis of the data

Descriptive statistics (median, range and standard deviation) were used to summarise the morphometric and environmental parameters. As the Shapiro-Wilk test ([22]) indicated that the distributions were not normally distributed, non-parametric tests were applied. The Mann-Whitney test was used to compare the medians of biological and physicochemical parameters between the two sampling sites, as well as between the sexes (males and females). For variables with more than two categories, the Kruskal-Wallis test was preferred, supplemented by multiple comparisons (Dunn's tests). The significance threshold was set at $p < 0.05$. Box plots illustrate the distribution of the data, consistent with the statistical method used.

A Principal Component Analysis (PCA) was carried out to identify correlation patterns between the variables and to establish a typology of the study sites. This ordination method, which is particularly well-suited to the exploration of complex datasets ([22]), enabled the observation units to be projected into a reduced space according to their abiotic and biotic affinities. To account for differences in units between the parameters (physico-chemical and morphometric), the data were first centred and scaled (standardised). This analysis was used to assess the spatial structure of our sampling design, in particular the separation between the two sampling sites, thereby justifying the comparison of dietary regimes according to the anthropisation gradient. All statistical calculations and analyses were carried out using Statistica 7.1 software ([23]).

3 RESULT

3.1 Variations spatiales

Spatial variations in water temperature at the sampling stations are shown in Figure 2. Generally speaking, temperatures vary across all study sites. Indeed, the waters in the heavily anthropised area (Tolla) are warmer, ranging from 29.1 to 32.3°C. In contrast, the water is cooler in the lightly anthropised area (Allakro), ranging from 26.5 to 29.5°C. The median temperature values vary significantly from one area to another (Kruskal-Wallis test, $p < 0.05$).

Spatial variations in the pH of the water at the sampling stations are shown in Figure 2. The minimum pH value of 7.1 was recorded in the lightly anthropised area (Allakro), whilst the maximum value of 8.1 was recorded in the heavily anthropised area (Tolla). The waters of the heavily anthropised area (Tolla) are more basic than those of the lightly anthropised area (Allakro). The median pH values vary significantly between these waters (Kruskal-Wallis and Mann-Whitney tests, $p < 0.05$). Spatial variations in water conductivity at the sampling stations are illustrated in Figure 26. The waters of the heavily anthropised environment (Tolla) recorded the highest conductivity value (531 µS/cm), whilst the lowest (182 µS/cm) was recorded in the lightly anthropised environment (Allakro). The median conductivity values

differ significantly between the environments (Kruskal–Wallis and Mann–Whitney tests, $p > 0.05$). Figure 2 shows the spatial variations in total dissolved solids (TDS) in the waters of the study sites. Heterogeneity in TDS levels is observed across the entire study area. In the heavily anthropised environment (Tolla), the TDS values (140 to 260 ppm) indicate that the water at this site is the most turbid (containing more dissolved solids) compared with that of the lightly anthropised environment (Allakro), where the water is less turbid (83 to 130 ppm). The median values for the dissolved solids concentration vary significantly between the environments (Kruskal-Wallis test, $p<0.05$).

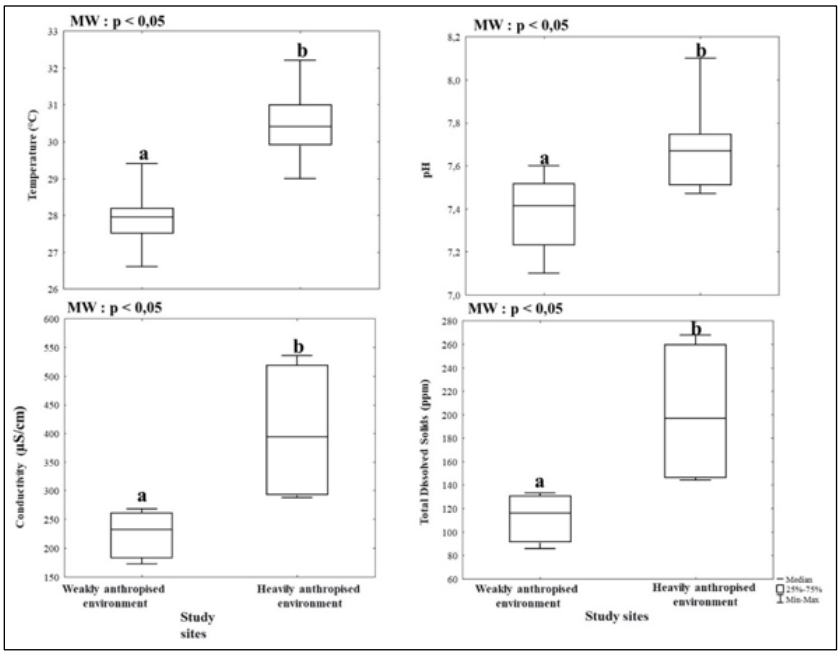

Figure 2: Spatial variation in the physico-chemical parameters of the water in the two study areas

3.2 Typologie des habitats

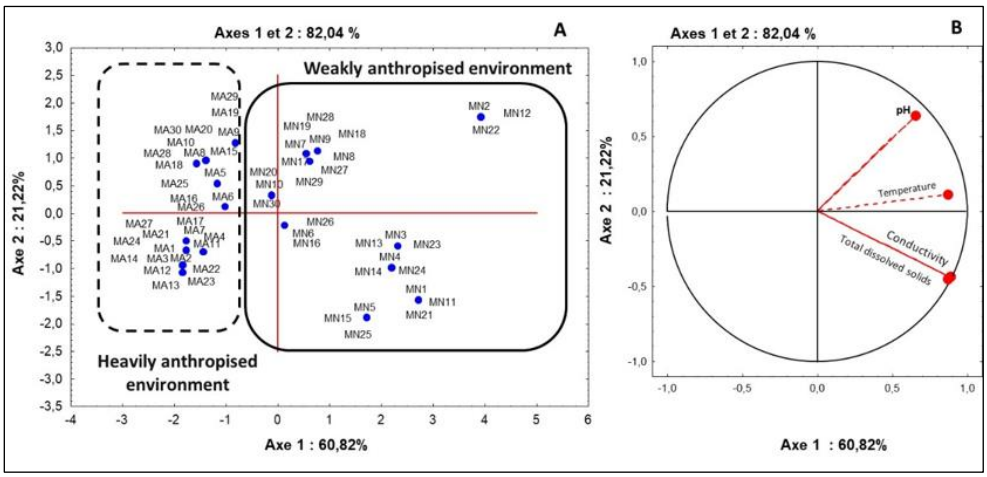

Figure 3: Principal Component Analysis (PCA) carried out on the basis of the variables measured in the various study areas.

A = Factor plot showing the distribution of stations in the two study areas according to their physico-chemical characteristics; B = Correlation circle of abiotic parameters on the factor axes; MN = low-impact area; MA = high-impact area

Principal Component Analysis (PCA) carried out on the abiotic data enabled the 60 sampling points (30 per environment) from the urban (Tolla) and peri-urban (Allakro) areas of Bouaké, which exhibited physico-chemical similarities, to be grouped together (Figure 3A). This classification is based on the median values for each parameter. Axes 1 and 2 account for 60.82 per cent and 21.22 per cent respectively, totalling 82.04 per cent of the information in the matrix. The correlation plot shows a strong positive correlation between conductivity, total dissolved solids, temperature and pH on axis 1, whilst axis 2 is strongly correlated with pH (Table 2). The PCA factor map illustrates the

distribution of sampling points according to their physico-chemical characteristics (Figure 3B). Axis 1 distinguishes heavily anthropised environments (MA) in its negative region and lightly anthropised environments (MN) in its positive region. Axis 2 does not distinguish any groups.

Table 2*:* Factor loadings of the parameters on the first two axes (1 and 2) of the PCA based on the physicochemical parameters of the water in the two study areas

Variable	Axe 1	Axe 2
Total dissolved solids (ppm)	0.889588	-0.436479
Conductivity (µS/cm)	0.887531	-0.439367
Temperature (°C)	0.873711	0.110562
pH	0.656359	0.633791

3.3 Feeding profile and strategy of *H. occipitalis*

3.3.1 General feeding profile

Dissection of the individuals made it possible to distinguish males from females on the basis of their internal organs. Of the 70 individuals captured, 25 were males and 45 were females. Following the identification of prey using a binocular magnifying glass, the count revealed 220 prey items consumed across both study sites, comprising 98 and 122 prey items at the Tolla and Allakro sites respectively. The general dietary spectrum of *H. occipitalis* in both habitats is presented in Table 3 below.

Table 3*:* General dietary profile of *H. occipitalis* in the two study habitats

	Relative Importance Index (%)	
CLASSES ORDERS	**Allakro (n = 29)**	**Tolla (n = 25)**
Blattoptera	0.00	0.00
Coleoptera	23.21	3.32
Diptera	2.07	32.53
Hemiptera	33.48	0.00
Hymenoptera	40.11	1.71
Lepidoptera	0.00	17.29
Odonata	0.17	9.57
Orthoptera	0.00	6.95
INSECTS	**99.04**	**72.95**
AMPHIBIANS Anurans	0.00	23.30
ARACHNIDS Araneids	0.00	0.64
GASTEROPODS Hygrophiles	0.00	1.58
Pebbles	0.00	1.00
Plants	0.96	2.10

The calculation of the Schœner similarity index yielded a value (α = 0.082) that is significantly lower than the generally accepted threshold of (α = 0.6). The prey consumed differs radically from one site to another, indicating a significant difference between the prey consumed by *H. occipitalis* in the two study habitats. The feeding strategy of *H. occipitalis*, as indicated by the [20] diagram modified by [19] (Figure 4), suggests that some individuals show a strong tendency to specialise on different prey in the two study habitats.

At the heavily anthropised site (Tolla), there is a clear dominance of Anurans, which account for over 50 per cent of the relative abundance, although their frequency of occurrence remains moderate (around 8 per cent). Diptera constitute

the most frequent prey (occurrence close to 28 per cent), highlighting their constant availability in this urbanised environment.

Conversely, at the minimally human-altered site (Allakro), the feeding strategy appears to shift towards a preference for Hymenoptera, whose relative abundance exceeds 50 per cent with an occurrence frequency of around 20 per cent. There is also a more balanced contribution from prey such as Coleoptera and Hemiptera, which show higher occurrence frequencies than in the anthropised environment (reaching 30 per cent and 27 per cent respectively).

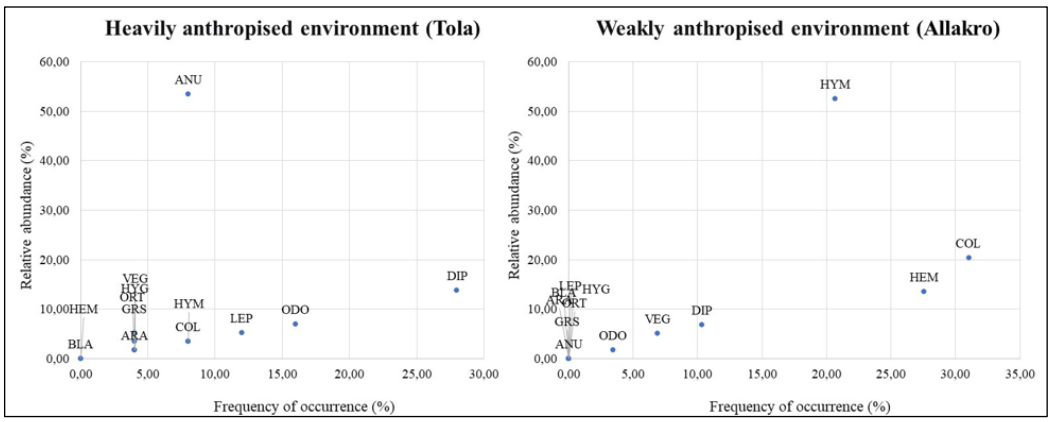

Figure 4: [20]'s diagram, modified by [19]showing the feeding strategies of *H. occipitalis* in the various study habitats.

(ANU = Anurans; ARA = Araneids; BLA = Blattoptera; COL = Coleoptera; CLX = Pebbles; DIP = Diptera; HEM = Hemiptera; HYG = Hygrophiles; HYM = Hymenoptera; LEP = Lepidoptera; ODO = Odonata; ORT = Orthoptera; VEG = Plants)

3.4 Variation in dietary profile by sex

Table 4 shows the variation in the dietary profile of *H. occipitalis* by sex across the different study sites. There is a marked difference in the nature of the prey consumed between the two sites. At Allakro (a lightly human-impacted environment), both sexes specialise almost exclusively on insects (over 98 per cent). Conversely, at Tolla (a heavily human-impacted environment), there is a diversification of the diet, with a significant presence of vertebrates (anurans), accounting for approximately 15.84 per cent in females and 14.62 per cent in males. This consumption of vertebrates, which is absent at Allakro, may indicate a clear shift in feeding ecology linked to human impact.

Although the main prey categories are similar within the same site, distinct preferences emerge between the sexes. At Allakro, females show a strong preference for Hymenoptera (56.57 per cent), whilst males exhibit a massive and almost exclusive consumption of Hemiptera (85.12 per cent). At Tolla, the difference between the sexes manifests itself differently. Females mainly consume Lepidoptera (37.09 per cent) and Diptera (27.70 per cent), whilst males favour Orthoptera (33.89 per cent) and Diptera (21.48 per cent). A striking contrast lies in the ingestion of non-biological material at Tolla: females ingest pebbles (2.01 per cent), whilst males consume plant matter (15.28 per cent). These items are almost entirely absent from the diet at Allakro, with females ingesting just 1.53 per cent plant matter.

Table 4*:* Dietary profile of *H. occipitalis* by sex in the study sites

		Relative Importance Index (%)			
		Females (39)		**Males (15)**	
CLASSES	**ORDERS**	**Allakro (n=22)**	**Tolla (n =17)**	**Allakro (n=7)**	**Tolla (n=8)**
	Blattoptera	0.00	0.00	0.00	0.00
	Coleoptera	32.12	0.70	5.63	7.59
	Diptera	1.47	27.70	3.40	21.48
	Hemiptera	8.31	0.00	85.12	0.00
	Hymenoptera	56.57	0.81	2.80	3.65
	Lepidoptera	0.00	37.09	0.00	0.00
	Odonata	0. 00	11.58	3.05	3.49

	Orthoptera		0.00	0.00	33.89
INSECTS		98.47	77.88	100	70.01
AMPHIBIANS	Anurans	0.00	15.84	0.00	14.62
ARACHNIDS	Araneids	0.00	1.19	0.00	0.00
GASTEROPODS	Hygrophiles	0.00	3.07	0.00	0.00
	Pebbles	0.00	2.01	0.00	0.00
	Plants	1.53	0.00	0.00	15.28

An analysis of feeding strategies based on [20]'s diagrams highlights remarkable trophic plasticity in *H. occipitalis* in response to the anthropisation gradient (Figure 5). In a lightly anthropised environment (Allakro), a segregation of feeding niches between the sexes is observed: females specialise in Hymenoptera, whilst males preferentially feed on Hemiptera. Conversely, the heavily anthropised environment (Tolla) is characterised by the emergence of a predation strategy focused on vertebrates (anurans), which is particularly dominant amongst females.

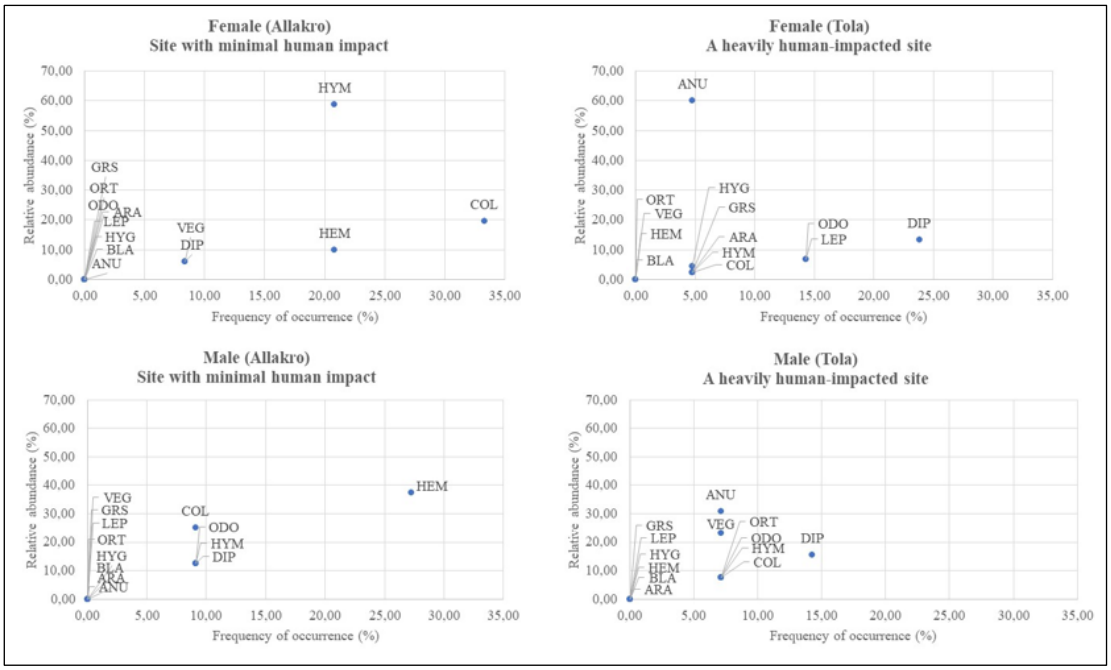

Figure 5: [20]'s diagram, modified by [19] showing the feeding strategies of *H. occipitalis* by sex.

(ANU = Anurans; ARA = Araneids; BLA = Blattoptera; COL = Coleoptera; CLX = Stones; DIP = Diptera; HEM = Hemiptera; HYG = Hygrophiles; HYM = Hymenoptera; LEP = Lepidoptera; ODO = Odonata; ORT = Orthoptera; VEG = Plants)

3.5 Influence of environmental characteristics on the measurements of *H. occipitalis*

A comparative analysis of the measurements of *H. occipitalis* (Table 5) reveals a clear and statistically significant morphometric disparity between the two study areas, correlated with the degree of human impact on the environment. The Allakro site, characterised by low anthropogenic pressure, is home to a robust and mature population. Individuals there achieve optimal growth values, with an average snout-to-cloaca length (SCL) of 90.53 mm and an average mass of 75.26 g. In contrast, individuals at the Tolla site, a heavily human-impacted environment, show a marked reduction in all biometric variables. The average SL drops to 80.44 mm and body mass falls to 54.56 g. This morphometric decline may reflect a biological response to urban environmental stresses.

Table 5: Summary of individuals' measurements

Trapping sites	TOLLA (Urban environment)	ALLAKRO (Peri-urban environment)
Level	Highly anthropised	Slightly anthropised
Stability of insectivorous diet	Unstable insectivorous diet	Stable insectivorous diet
Number of specimens	35	35
Min. weight (g)	28.93[a]	37.04[b]
Max. weight (g)	126.22[a]	116.59[b]
Average weight (g)	54.56[a]	75.26[b]
Min. SCL (mm)	64.3[a]	70.4[b]
Max. SCL (mm)	105.8[a]	106.5[a]
Average SCL (mm)	80.44[a]	90.53[b]

4 DISCUSSION

Analysis of the physicochemical parameters reveals a marked contrast between the two sites, confirming the existence of a distinct gradient of human impact. The Allakro site exhibits characteristics typical of a relatively well-preserved ecosystem: an average temperature of 27.45 °C, a pH of 7.12 (close to 7) and low electrical conductivity (154.3 µS/cm), indicating a limited pollutant load. In contrast, the Tolla site shows clear signs of degradation. The higher temperature (29.18 °C) is attributable to the urban heat island effect and reduced vegetation cover (Grimmond, 2007). The more acidic pH (6.45), the conductivity three times higher (485.6 µS/cm) and the high level of dissolved solids (242.8 ppm) indicate significant contamination.

This mineralisation results from the discharge of domestic wastewater, rubbish dumping and intensive market gardening, which promote eutrophication, as evidenced by the proliferation of *Pistia stratiotes* and *Lemna minor* in Tolla. This phenomenon of eutrophication, characterised by nutrient enrichment and the proliferation of aquatic macrophytes, has also been documented in Ivorian water bodies subject to agricultural and urban pressures by [24] and in several regions of the world according to the study conducted by [25]. This physico-chemical alteration causes significant stress to *H. occipitalis,* whose permeable skin directly exposes the organism to variations in pH and pollutant load, according to [26]. The analysis of stomach contents in our study indicates a generalist dietary profile consisting mainly of invertebrates. Insects account for 99.04 per cent of the prey ingested at Allakro (a lightly humanised environment), of which 40.11 per cent are Hymenoptera, compared with a total of 72.95 per cent of insects at Tolla (a heavily humanised environment), of which 32.53 per cent are Diptera. This finding is consistent with other studies on the diet of *H. occipitalis*, confirming that its diet is generally based on invertebrates, with insects predominating. The study carried out by [12] in the degraded habitats of Banco National Park (Ivory Coast) indicates that the diet of *H. occipitalis* consists of 66 per cent insects, of which 30 per cent are Hymenoptera. The study conducted by [27] in Nigeria confirms our findings, revealing an insectivorous diet in *H. occipitalis* dominated by Trichoptera (50.37 per cent) and Hymenoptera (21.27 per cent). As for the study conducted in three basins in Benin by [28], it confirms this trend for H. occipitalis, which favours insects in its diet, accounting for 62.9 per cent, 62.1 per cent and 57.6 per cent respectively in the Ouémé, Mono and Niger basins. A notable finding of our study is the presence of tadpoles in the stomach contents of a few individuals originating exclusively from the Tolla habitat. This consumption of anurans at the larval stage indicates an intensification of predatory behaviour in degraded habitats. This finding is corroborated by that of [12], who observed the presence of anurans in the stomachs of adult *H. occipitalis* individuals in degraded habitats within Banco National Park. In the studies by [27] in Nigeria and [28] in Benin, the same tendency for *H. occipitalis* to consume anurans in these disturbed environments was observed. Indeed, [26]Wells argue that cannibalism among amphibians is associated with adverse conditions, a scarcity of prey, and high density or nutritional stress. In *H. occipitalis*, the consumption of anurans has been reported when invertebrate resources become insufficient ([29]).

The observation of this cannibalistic behaviour exclusively at Tolla reinforces the hypothesis that human activity profoundly alters trophic interactions within amphibian communities. Three complementary factors may explain the change in diet. Firstly, physico-chemical disturbances and human activities at Tolla are thought to affect invertebrate populations, reducing their diversity and favouring pollution-tolerant taxa. These habitat disturbances are described by [30], who support the view that human activity has consequences for the entire spectrum of freshwater biodiversity, from microbes to megafauna. These disturbances would therefore force *H. occipitalis* to become more opportunistic. Secondly, individuals from Allakro are larger in size and mass (SCL: 90.53 mm; 75.26 g) than those from Tolla (80.44

mm; 54.56 g). This morphological reduction could reflect a less optimal diet at Tolla. Thirdly, harvesting pressure at Tolla could favour individuals that reach sexual maturity rapidly at a smaller size. These results demonstrate that the ecological plasticity of *H. occipitalis* enables it to survive in an urban environment, but at the cost of a shift in its trophic niche and a decline in its body condition. The biometric data from our study establish a direct link between the degree of human impact and the physical condition of the individuals. Indeed, the population at Allakro (an area with low human impact) is characterised by robust individuals (SCL: 90.53 mm; mass: 75.26 g). The Tolla population exhibits a SCL (80.44 mm) and mass (54.56 g) that are 11 per cent and 27 per cent lower, respectively. Compared with the work of [28] in Benin, individuals from the various sampling sites show no significant difference between males and females in terms of length and mass. However, unlike our study, which was conducted in two distinct habitats in Bouaké, the studies by [28] were all carried out at communal village sites with a clear anthropogenic impact. To a certain extent, their results are similar to those observed at Tolla, which is an anthropised environment in the same way as the three catchments in the study conducted in Benin. According to [31] the effects of contamination can result in reduced body length, decreased body mass and malformations of the limbs or other organs. Several factors could explain this morphometric reduction in anthropised environments. Physicochemical stress imposes an increased metabolic cost for osmoregulation, to the detriment of growth ([32]). Dietary instability limits the energy intake required for development ([33]). Harvesting pressure targeting large individuals alters the demographic structure, favouring early maturity at reduced size ([34]).

The morphometric reduction observed in this study demonstrates that human impact directly affects the biological condition of individuals. This sensitivity confirms the potential of *H. occipitalis* as a bioindicator, whose biological parameters reflect the level of ecological integrity of the environment.

5 CONCLUSION

The results of this study which primarily aimed to assess the impact of human-induced environmental change (anthropization) on the diet of *Hoplobatrachus occipitalis* in the Gbêkê region of central Côte d'Ivoire reveal a clear gradient of anthropization between the two surveyed sites.

In terms of trophic ecology, the study confirms that *H. occipitalis* is a generalist, opportunistic predator. Its diet consists predominantly of invertebrates mostly insects along with arachnids, mollusks, and small vertebrates. However, the composition of the diet differs significantly between the two sites.

Morphometric data establish a direct link between the degree of anthropization and the physical condition of the individuals.

Reducing domestic and agricultural pollution, preserving breeding habitats, and regulating the harvesting of these frogs are key priorities for ensuring the long-term survival of *H. occipitalis* populations.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

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Disclosure of conflict of interest

The authors declare no conflict of interest.

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