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PATTERN OF MACROINVERTEBRATES TROPHIC STRUCTURE IN SOME SELECTED STREAMS OF KANO RIVER, NIGERIA

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ABSTRACT
Aquatic macroinvertebrate are important organisms in the study of different water bodies of temperate and tropical regions world over, they relatively have longer life span, can easily sample and are good indicators of water conditions. This study aimed and scaled sampled macroinvertebrate communities of the Kano river selected streams into Five (5) Functional Feeding Groups (FFGs) Scrapers which form the base of the structure, Shredders, Gathering Collectors, Filtering Collectors and Predators at the top. The FFGs numerical structure indicate the linkage between shredders and filtering collectors. Gathering collectors Chironomidae revealed the highest (550 species, 48%) FFGs, an increase of collector-gatherers was recorded at sites A18% ; B29% ; D32% and 34% in site E, however declined to 23% was observed downstream at site F. This was followed by the simuliidae filtering collectors exhibited 233 species translating to 20% total abundance. However, other filtering collectors Gammaridae and Oligochaeta expressed equal abundances of 4% respectively and there low number could be due to the absence of preferred feeding host. Overall, scrapers were the most abundant FFG (593 species, 52%) dominated by Hydrophilidae (155 species, 14%), Bitidae (76 species, 6%), Hydrobidae (99 species, 9%), Corixidae (80species, 6%), Hydroptilidae (26species, 3%) and Siplonuridae (157 species, 14%). Species diversity of the Kano river revealed site F(414)>A(403)>E(390)>B(372)>C(303)>(329). This sustain a complex interactions of the functional feeding groups in the river ecosystem. it is therefore recommended, that effect of cascading power of the hydroelectric power plant on the distribution and abundance macroinvertebrate communities at the upstream to the downstream of the River Kano should be investigated.
Keywords: Kano River, Macroinvertebrates, Nigeria, Pattern, Streams, Structure, Trophic

INTRODUCTION
Tiga Dam impoundment of Kano River is a zoned filled earth dam located on River Kano Nigeria, with the Longitude 8° 40' and Latitude 11° 15', it is 47.2 m high above the sea level and 7.24 km long, it has a water storage capacity of 1974 million cubic liters of water (HJRBDA, 2014). The water is to be use to irrigate 180,000 ha (Phase I and II) of land in the Kano River Basin under Kano River Project (KRIP). The Kano River is economically supporting about 10 million people based on the 2006 national head count. It conveys water over distance of 50 sq km.

Every aspect of a stream's ecosystem is influenced by water flowing downstream and aquatic organisms are distributed based on their adaptations and topology of the streams. The flow of a stream transports organic matter, which is eaten by aquatic organisms (Varadinova *et al.,* 2022). Faster flowing stream carry organic matter (e.g., leaves, debris) to slower moving parts, where it settles to the bottom (Tamaris-Turizo *et al* 2018.). Aquatic community structure varies considerably from stream to stream (Kamil *et al*., 2021). Community patterns are the result of various processes acting at different spatial scales, and the occurrence of a species is the outcome of the combined influence of local environmental characteristics and large-scale geographical factors (Paiva *et al*., 2023). Diversity plays an important role in providing a variety of diets for the organisms in the ecosystem. It is diversity that leads to a food web (Jose´ *Luis et al*., 2023); this is decidedly a better situation to have than a real food chain (Gao *et al*., 2023). Diverse ecosystems can sustain complex ecological interactions between biotic and abiotic components in an ecosystem (Chertoprud *et al*., 2023).

Biodiversity and productivity of ecosystems are central issues in ecology, relationships between them are of great interest since global trends in species losses might affect the productivity and thereby ecosystem function in many different ways (Beatriz *et al.,* 2023). Taxonomic keys developed for temperate-zone invertebrates (Merritt *et al*. 2008) often are used to assign tropical macroinvertebrates to trophic and functional feeding groups (FFGs). Understanding the fundamental processes that drive spatio-temporal changes in biological communities is one of the most pressing topics in community ecology (Farooq *et al*., 2022). Macroinvertebrate communities structure are shaped by stochastic versus deterministic processes, the potential for species traits to predict the structure and composition of communities and the role of environmental variability in space and time (Magni *et al*., 2023). There are convincing evidence that the stream hydrological process and variations in water quality are associated with land use changes such as forest, grassland and agriculture (Guerreo Chuez *et al*., 2022).

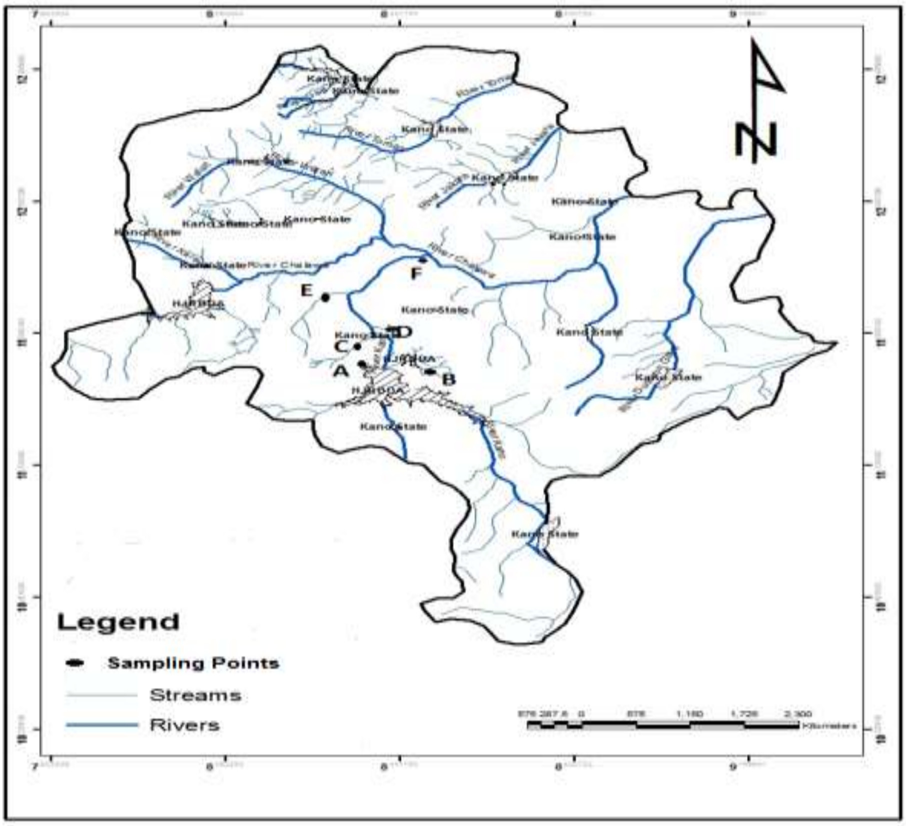
Macroinvertebrates community provide services by functioning as a whole and the environmental change poses potential impacts on biodiversity (Weckström and Sonja, 2023), however, earlier in 2005, Jax, linked to the functioning of the specific parts, such as "which processes occur" or "how" do organisms interact with each other and with their environment". The keystone species concept is one of the best-known ideas in community ecology (Briddle and Hoffmann, 2022). Although it is true that many species potentially interact with one another in aquatic ecosystem and depicted aquatic trophic structure (Nelson and Miller, 2023). The species whose presence or absence, or substantial increase or decrease in abundance, profoundly affects other species in the community (Brain *et al*., 2016). Community evidence usually comes from experiments in which taxon group at different trophic levels are depicted. The host of biotic interactions that are responsible for shaping ecological systems in food chain or complex food web (Farooq *et al*., 2022). In recent times however, Medina-Contreras *et al.* (2023), attempt to integrate majority of community assembly mechanisms into food chain and food web. Trait-based approaches have been suggested as an alternative to food web models (Ewelina *et al*., 2022; Sotomayor *et al.,* 2023). The host of biotic interactions and seasonal changes are responsible for shaping these systems in food chain or complex food web (Wang *et al*., 2023). Food webs are generally described as "Pyramid of Species Richness" (Turney and Buddle, 2016). An ecological pyramid is a pictorial representation of the relationship between different organisms in an ecosystem. Each of the bars make up the pyramid represents a different trophic level, and their order, which is based on who eats whom, represents the flow of energy which stabilizes the food webs (Neutel and Johan, 2002). Energy moves up the pyramid, starting with the primary producers, or autotrophs, such as plants and algae at the very bottom, followed by the primary consumers, which feed on these plants, then secondary consumers, which feed on the primary consumers, and so on. The height of the bars numerically varied, each bar is based on the quantity of the aspect being measured. Although trophic diversity structure is generally pyramidal, under many conditions the structure is consistently uniform or inverse-pyramidal. Macroinvertebrates quantitative pyramidal structure can take any form of shape depending on the sampling effort and season (Charnut *et al*., 2023). Ecological pyramid of Numbers depicts the number of individual organisms at different tropic levels of food chain. This pyramid was advanced by Charles Elton (1979). He pointed out the great difference in the number of the organisms involved in each step of the food chain. It does not show the energy transfer between successive level, however it depicted the quantitative numbers of organisms at different sampling sites and between seasons. Although Seasonal changes in macroinvertebrate taxon abundances can be related to their life history, temporal variation into macroinvertebrate community structure can potentially affect the status assessment of river (Elisabeth *et al*., 2017). A gradient of disturbance was highlighted by Canonical Community Ordination and macroinvertebrates could be grouped accordingly according to Cristina *et al.* (2020). An ecological pyramid of numbers not only shows us the feeding patterns of organisms in ecosystems of the selected site (Cheshire *et al*,. 2005), but can also give us an insight into how efficient on the influence that a change in numbers at one trophic level can have on another trophic levels above and below it (Benjamin *et al*., 2023). Also, when data are collected over years, the effects of the changes that take place in the environment on the organisms can be studied by comparing the analysed data. If an ecosystem's conditions are found to be worsening over the years because of pollution or different scales of disturbance on the assemblages of inhabiting biological communities (Kai *et al*., 2017), action can be taken to prevent further damage and possibly reverse the trend.

The aim of the study is to sample and indentified macroinvertebrates species and characterized into trophic structure from some selected streams of Kano River and evaluate species count and abundances. Therefore, grouping of macroinvertebrates species in streams is fundamental to evaluation of river ecosystem structure and function. Another reason for the study is to inform policy on human activities and species biodiversity and conservation.

MATERIALS AND METHODS

Study Area

Kano state is located between latitude 10° 30' to 12° 40' N and longitude 7° 40' and 9° 30' E. The climate is classified as tropical dry and wet type. Kano River is located on the Southern part of Kano between the latitude 10° 10' to 11° 50' N and longitude 8° 17' and 8° 40' E (Olofin, 1985). Kano River confluence with Challawa River at Tamburawa Bridge and is about fifty-eight kilometers (58.8km) in length from Tiga dam discharge outlet. It flows southeast to north meandering to north-east at confluence (Figure 1) (Suleiman and Abdullahi, 2016).



Source: Carto. Geography Department, BUK 2015
Fig. 1: Map of the Study Area Showing Sampling Points

Sites were selected spatially using a randomized systematic procedure described by USEPA (2002), and Olsen and Peck (2008). Sites were delineated as A, B, C, D, E and F along the river streams from the Hydroelectric power plant construction area (Site A) down to the confluence point Tamburawa water intake station (Site F).

Sample Collections

Sampling of the macroinvertebrates was conducted in early morning hours along the river reaches in triplicate each month and sampled in three sampling occasion for Twelve (12) months using the standardized kick-net method as described in Gabriels *et al*. (2010), macroinvertebrates sampling protocol was based on Stark *et al.* (2001), and their count from selected sampling sites was on the rule of Barbour *et al*. (1999), Mereta *et al*. (2013), and Helson and Williams (2013). The samples were fixed in the field with 40% formalin and taken to Bayero University Kano, Department of Biological Science laboratory in individual sites labeled plastic containers. Samples were sorted, and all individuals were identified mostly to family with the aid of taxonomic keys of Mugnai *et al*. (2010) and groups indentified were classified based on functional feeding groups following Rimcheska and Vidinova (2022).

Data Analyses

The study used the numerical abundance of the sampled macroinvertebrates to construct the structure of trophic number of individual macroinvertebrates species groups from the selected streams of the Kano River water was constructed using IBM Version 23 of 2015.

RESULTS AND DISCUSSION

Table 1: Density of Macroinvertebrates Species Across and Between the Sites of the Study Area from June 2014 - May 2015

	Sites							
Species	**A**	**B**	**C**	**D**	**E**	**F**	**%Abundance**	**Total**
Simuliidae	57	31	35	16	47	37	20	223
Hydrophilidae	39	24	34	15	12	31	14	155
Batidae	10	14	25	2	13	12	6	76
Hydrobidae	15	6	11	24	11	32	9	99
Gammaridae	7	1	5	6	17	2	4	38
Vivaltidae	9	13	1	10	5	11	5	49
Hirudidae	2	4	11	2	16	30	6	65
Platycnemididae	38	19	31	16	24	14	12	142
Aphelocheiridae	9	17	19	15	8	18	7	86
Nemouridae	48	50	35	36	27	57	21	253
Corixidae	13	2	12	19	23	11	6	80
Agriidae	5	5	4	5	4	11	4	34
Oligochaeta	0	8	27	8	5	15	4	63
Planariidae	0	2	0	2	5	2	2	11
Chironomidae	71	101	52	98	132	96	48	550
Hydroptilidae	7	13	2	0	0	4	3	26
Siplonuridae	44	35	19	18	26	15	14	157
Hydrometridae	28	22	35	29	15	16	12	145
Lymbricoidae	1	5	5	8	0	0	3	19
Total	**403**	**372**	**363**	**329**	**390**	**414**	**100**	2271

Table 2: Functional Feeding Groups Abundance of Indentified

Species	Functional Feeding Group	% Abundance
Simuliidae	Filtering collectors	20
Hydrophilidae	Scrapers	14
Batidae	Scrapers	6
Hydrobidae	Scrapers	9
Gammaridae	Filtering collectors	4
Vivaltidae	Shredders	5
Hirudidae	Predators	6
Platycnemididae	Predators	12
Aphelocheiridae	Predators	7
Nemouridae	Shredders	21
Corixidae	Scrapers	6
Agriidae	Predators	4
Oligochaeta	Filtering collectors	4
Planariidae	Shredders	2
Chironomidae	Gathering collectors	48
Hydroptilidae	Scrapers	3
Siplonuridae	Scrapers	14
Hydrometridae	Predators	12
Lymbricoidae	Gathering collectors	3
Total	**Five Groups (Indentified)**	**100**

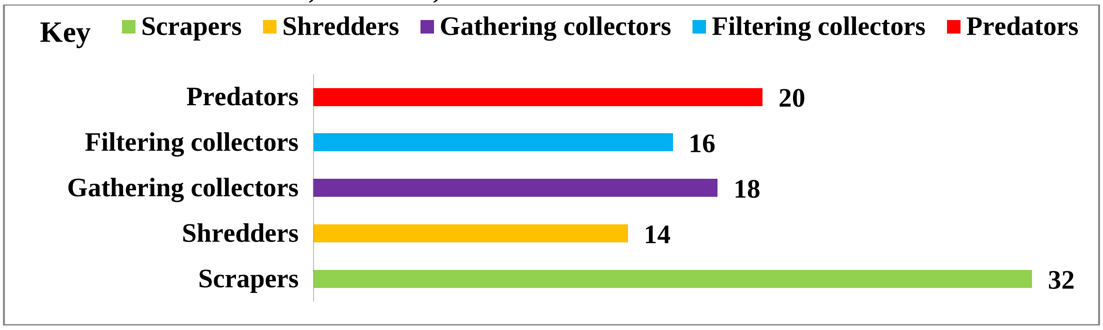


Fig. 1: Trophic Structure of Number of Individual Macroinvertebrates Functional Feeding Groups at Site A, Kano River

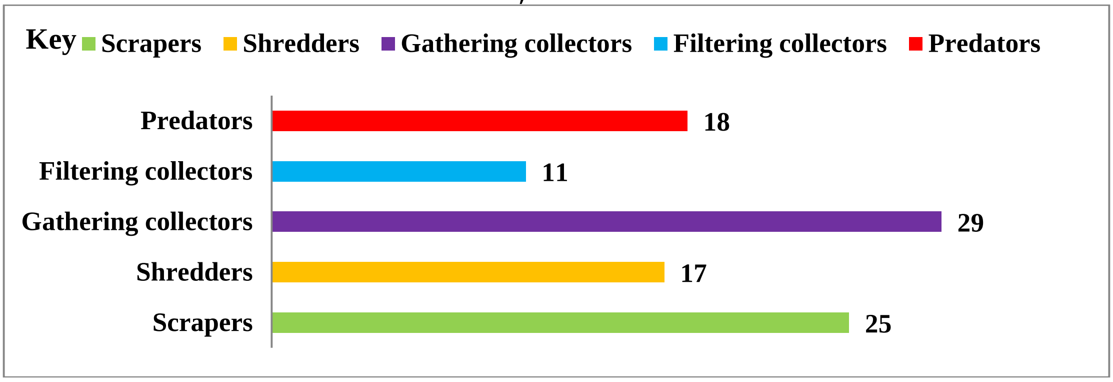


Fig. 2: Trophic Structure of Number of Individual Macroinvertebrates Functional Feeding Groups at Site B, Kano River

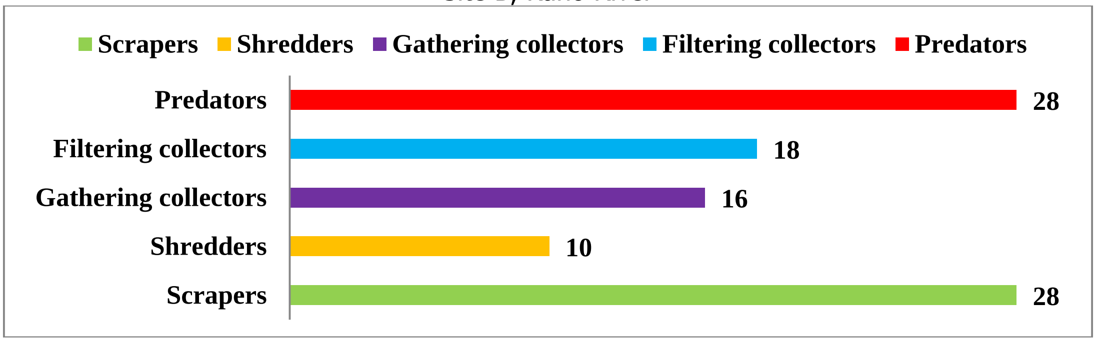


Fig. 3: Trophic Structure of Number of Individual Macroinvertebrates Functional Feeding Groups at Site C, Kano River

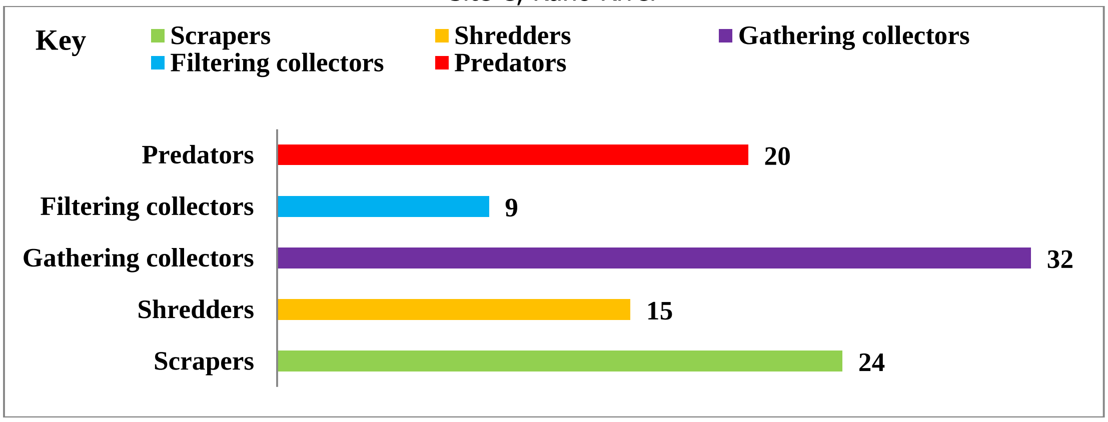


Fig. 4: Trophic Structure of Number of Individual Macroinvertebrates Functional Feeding Groups at Site D, Kano River

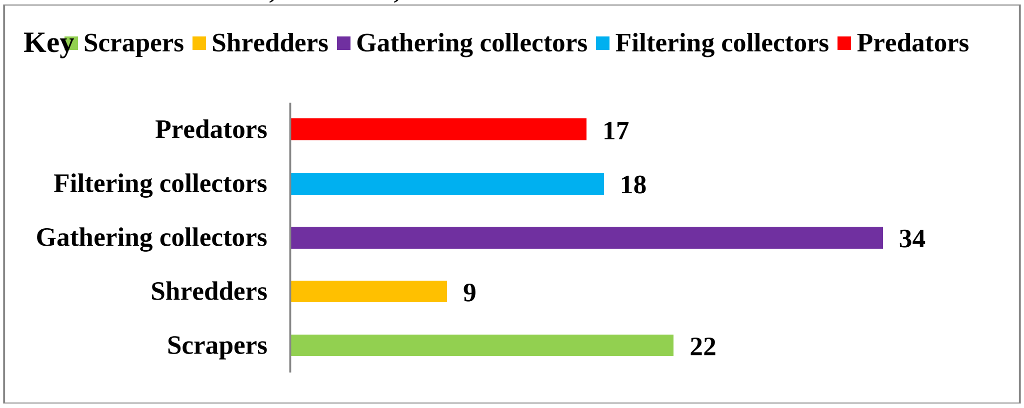


Fig. 5: Trophic Structure of Number of Individual Macroinvertebrates Functional Feeding Groups at Site E, Kano River

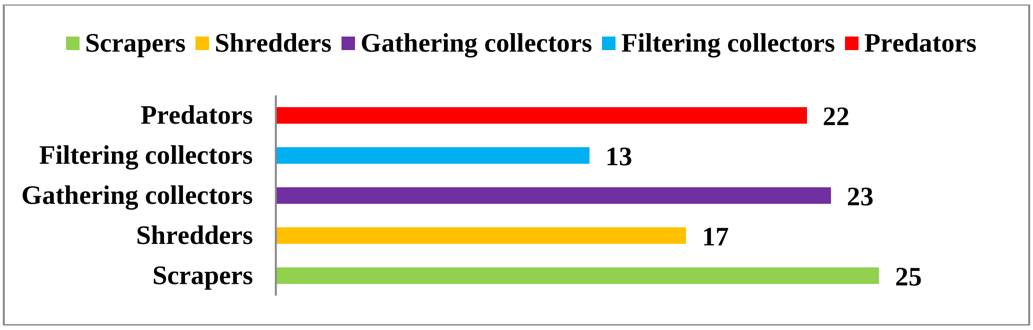


Fig. 6: Trophic Structure of Number of Individual Macroinvertebrates Functional Feeding Groups at Site F, Kano River

Table 1 present a total of 2271which represent 100% abundance of macroinvertebrates species have been identified and five groups of organisms were classified based on the mode of feeding as describe by Rimcheska and Vidinova (2022) and taxa classification was based on Suleiman and Abdullahi (2011). In the heterogeneous physical environment of streams, macroinvertebrates have evolved a diverse array of morphological and behavioral mechanisms for foods exploitation. These were filtering collectors, scrapers, shredders, predators and gathering collectors respectively (Table 2). The distribution of these functional feeding groups in the study sites, could be related to the activities taking place around the sites (Arias *et al.,* 2023). Functional feeding group numerical analyses indicate the linkage between shredders and filtering collectors. Shredders feeding and conversion of Coarse Particulate Organic Matter (CPOM) to Fine Particulate Organic Matter (FPOM) affect the growth of filtering collectors the relation revealed is inverse, this corroborates the findings of Branco *et al*., 2023. Gathering collectors Chironomidae revealed the highest (550 species, 48%) number suggesting the river is polluted due to human activities at the selected studied sites (Prat, 2023). abundance of functional feeding groups, an increase of collector-gatherers was recorded at sites A18% ; B29% ; D32% and 34% in site E, however declined to 23% was observed downstream at site F, this corroborates the findings of Cristina *et al*. (2020). This was followed by the simuliidae filtering collectors exhibited 233 species translating to 20% total abundance. However, other filtering collectors Gammaridae and Oligochaeta expressed equal abundance of 4% respectively and there low number could be due to the absence of preferred feeding host (Barton *et al*., 2023). Overall, scrapers were the most abundant FFG (593 species, 52%) (table 1 and 2) dominated by Hydrophilidae (155 species, 14%), Bitidae (76 species, 6%), Hydrobidae (99 species, 9%), Corixidae (80species, 6%), Hyroptilidae (26species, 3%) and Siplonuridae (157 species, 14%) which similarly corroborate the findings of Benjamin *et al*. (2023). Figure 1 presents trophic structure of individual macroinvertebrate feeding groups at site A. Scrapers formed the base of the structure with 32% followed by predators, 20% of the structure. Gathering collectors were represented by 18% while filtering collectors and shredders were 16% and 14% respectively. The percentage of scrapers was reduced at sampling streams during the sampling period, at sites A 32% having high scrapers and with low fluctuations in sites ranges between 22% to 28%.

Figure 2 presents trophic structure of number of individual macroinvertebrates feeding groups at sampling site B. Gathering collectors formed the highest percentage abundance (29%) followed by 25% of scrapers. Predators in the structure were 18% and shredders 17%. Lowest value in the structure was that of filtering collectors (11%), this is related to the lower number of shredders in the community. Figure 3 presents trophic structure of number of individual Macroinvertebrate Functional Feeding Groups at Site C which represent the first twelve sampling month. Number of macroinvertebrate involved in the structure include scrapers and predators with the highest number (28%) which equals scrapers (28%) in the structure. Higher number of the predators affect the composition and the structure of communities by selectively feeding on some prey and indirectly influencing interactions among prey species and their resources (Paine 1966; Thomas *et al*., 2022). However, successive links of the trophic structure decreases down and was depicted from predators (28%), filtering collectors (18%), gathering collectors (16%) to shredders (10%). Figure 4 presents trophic structure of number of individual Macroinvertebrate Functional Feeding Groups at Site D. This structure point out great differences in number of individual organism at each tropic level and gathering collectors dominated with 32% number the highest in the structure. Scrapers at the base of the structure presented 24%. Predators were 20% and shredders were 15%. Figure 5 presents the number of individual macroinvertebrate Functional Feeding Groups (FFG) from site E in the First twelve sampling months. Number of individual gathering collectors form the highest (34%) followed by 22% number of the scrapers at the base of the structure. Filtering collectors were 18% and predators 17% while shredders were only 9%.

Figure 6 presents the trophic structure of number of individual macroinvertebrate functional Feeding Groups (FFG) at Site F. Scrapers form the base of the pyramid were 25% in number of abundance followed by 23% gathering collectors. Predators presented 22% number and shredders abundance were 17% while filtering collectors formed the lowest individual with 13% in the structure.

CONCLUSION

Kano river streams macroinvertebrates identified were classified into five functional feeding groups based on what they eat and how they obtain their food analysed into numerical structure of trophic bars. The trajectory in the river species diversity revealed site F(414)>A(403)>E(390)>B(372)>C(303)>D(329) . The highest number of chironomidae (550 species, 48%) suggest anthropogenic activities at the study sites. It is therefore recommended that effect of cascading power of the constructed hydroelectric power plant on the distribution and abundance macroinvertebrate communities at the upstream to the downstream of the River Kano should be investigated.

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