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Evaluating the parasite infestation and condition factor analysis in Gangetic fishes in the Kanpur region

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Abstract
The Ganga River in Kanpur is India's vital river with a diverse fish population. The present study assessed the parasite fauna and morphological studies of different freshwater fishes of the Ganga River in three sampling sites, Kanpur, Kannauj and Farrukhabad. Forty of each sample of *Channa punctatus* and *Heteropneustes fossilis* were collected from different sampling sites and examined for parasite infection. *C. punctatus* was found to be infected by the protozoan parasite genus *Trypanosoma*. *H. fossilis, was* not infected with any parasite. Length and weight of fish were measured and Condition Factor (K) was analyzed which revealed maximum variation in Kannauj, while Farrukhabad district showed minimal variation in condition factor.
The study found that Kanpur and Kannauj fish species are in good health, whereas Farrukhabad fish species are in poor health, emphasising the importance of monitoring fish health and environmental conditions.

Keywords: Ganga, fish, parasite, condition factor, length-weight relationship

1. Introduction
The Ganga River is the most important in India and harbors rich fish biodiversity (Rao, 2001) [25], a responsive indicator of habitat degradation and environmental degradation. Ganga river water was highly polluted in Kanpur, which can be attributed to direct industrial effluent discharge, sewage discharge, and other pollutants. Fish assemblage is recognized as a responsive indicator of habitat degradation and environmental degradation therefore, freshwater fishes are one of the most threatened groups of animals affected by parasites (Whitfield, 2002) [28]. According to the report of Santy *et al.* (2020) [27], the Ganga River is heavily polluted at the industrial stretch of Kanpur. Eissa (2002) [5] declares that 80% of infection of warm water fishes is caused by parasites, which interfere with the immunity of the organisms and make them more susceptible to parasites. Helminth infection causes a low body weight and high mortality rate (Gautam *et al*., 2018) [7]. Bhaskar and Gupta (2020) [4] claimed that parasites are more sensitive indicators of environmental degradation as compared to hosts. Parasites can significantly affect fish's health, affecting their growth and performance. Fish parasitology is a rapidly growing field in aquatic science, focusing on the health of aquatic life, pollution's impact on fish, and environmental concerns.
The Condition Factor (K) is a crucial indicator in fishery science, particularly in the Ganga River, where pollution from industrial and agricultural waste has led to a decline in fish population and diversity. Human activities cause environmental changes in fish habitats, leading to pollution from fertilizers and pesticides (Martin-Smith, 2005) [17]. The K monitors fish development, feeding patterns, and physiological changes due to food deficiency, tissue damage, or organ failure, assisting in monitoring feeding intensity, age, and growth rates (Maurya *et al*., 2018) [18]. The K also indicates the wellness of fish species, suggesting that heavier fish live in better conditions and suitable aquatic habitats. This affects all living organisms, disrupting behavior, metabolism, and performance. This work investigates the complex interactions of host and parasite and morphological studies for insightful information about the condition factor of fish species in Kannauj, Farrukhabad, and Kanpur.

2. Materials and Methods

The present study assessed the parasite fauna and morphological studies of different freshwater fishes of the Ganga River in different sampling sites. It was carried out in the Department of Zoology at D. B. S. College Kanpur Uttar Pradesh, India

Three different ecological sites were selected and surveyed for fish and studied for the presence of parasites and Condition Factor (K).

2.1 Study sites (Fig. 1, Table I)

1. Kanpur
2. Kannauj
3. Farrukhabad

2.2 Sampling

Live specimens of *Channa punctatus* and *Heteropneustes fossils* were collected from different study sites. The collected fishes were acclimatized to laboratory conditions and investigated for parasites.

Fig 1: Map showing the location of sampling sites

2.3 Parasitological Studies

Fishes were examined for different parasites.

2.3.1 Preparation of blood films

Blood parasites were detected using hanging drop preparations and their contagiousness was noted. Blood smears were made by snipping the tail of a fish and spreading it against a microscope slide. Blood films were smeared, air-dried, preserved in methanol or 10% buffered formalin, and stained for one hour using Giemsa-Eosin-Methylene blue stain and a pH 7.2 buffer. Host specificity also plays a deterministic role in the distribution of parasites. Various characters have been employed to relate the parasites' abundance, mean intensity, as well as prevalence in ecological descriptions. Following Margolis *et al.* (1982) [16], the prevalence, mean intensity, and abundance of infection were computed.

Prevalence = No. of infected fish/Total no. of fishes examined X 100

2.3.2 Study of parasitemia

Parasites were counted under the microscope. The parasitemia was calculated per 500 RBCs according to Ray and Choudhary (1984) [26].

Mean Intensity = Total no. of parasites/500 RBCs

2.3.3 Photography

The parasites were photographed under metzer-m trinocular research microscope vision plus-5000 tm (supreme).

2.4 Morphological studies

Fishes were measured for Length and Weight and Fulton's Condition Factor (Fulton 1902) [6] was calculated**.**

Condition Factor (K) = W/L^3 X 100

W = Body weight in gm. L = Total length in cm.

3. Result and Discussion

In the present study, forty of each sample of *C. punctatus* and *H. fossilis* were collected from different sampling sites and their weight and lengths were measured and examined for parasite infection. Four *C. punctatus* were found to be infected by the protozoan parasite genus *Trypanosoma*. The frequency index or prevalence of parasites is found to be 10%. The value of the concentration index is 4parasite/500 RBCs. Among the forty samples of *H. fossilis,* no fish is infected with any parasite (Fig. II; Table II).

Trypanosomiasis, or sleeping sickness, is caused by *Trypanosoma*, flagellate protozoa in fish blood cells. These active, long, narrow, flattened bodies exhibit distinctive wriggling movements, and are dimorphic, affecting both small and large fish populations. The organism has an elongated, sinuous body with tapered ends, an acute anterior end transitioning into a free flagellum, and a rounded posterior end. The cytoplasm is granular and lightly stained, and the nucleus can be oval, oblong, or bean-shaped. The free flagellum is well-developed in smaller forms and larger forms (Gupta. 2006) [12].

Gupta and Jairajpuri (1982) [13] described *T. aligaricus* from fresh-water Murrel *Ophicephalus punctatus* Bloch. Gupta *et al.* (2006) [8] conducted hematological research on C. *punctatus* and *H. fossilis* and found 10.6% and 14.6% infection with the dimorphic species *T. saulii* and *T. heteropneusti*. A detailed survey has been published by Gupta (2006) [12] which reported the different species of

Trypanosoma in fish of India. Different reported species of trypanosomes are *T. monomorpha* var. *catlae* (Gupta *et al*., 2000) [10] from *Catla catla*, *T. karelensis* (Gupta *et al*., 2000) [11], *T. artii* (Gupta *et al*., 2002) [9] and *T. heteropneusti* (Gupta *et al*., 2006) [8] from *H. fossilis*. Okpasuo *et al.* (2016) [20] found that out of 102 bagrid fishes, 32 were infected, resulting in a 31.4% parasitic prevalence. The species studied *Bagrus bayad*, *Auchenoglanis monkei*, *A. occidentalis*, *A. biscutatus*, *B. docmac*, *Chrysichthys auratus* and *Clarotes leticeps*.

Female fish had a higher prevalence (42%), and the parasites included monogeneans, nematodes, cestodes, and leeches. The parasites were found in various parts of the fish.

The condition factor of the fishes ranged from 0.75±0.02 to 1.61±0.74**.** *Trypanosoma* infection was also observed by Jarallah (2021) [14] in *Carasobarbus luteus* and *Aspius vorax* fishes. Recently, the first outbreak of *Trypanosoma* was observed in farmed blood parrot cichlids in *Vieja melanura*♀ × *Amphilophus citrinellus*♂) in the Nansha district, Guangzhou, Guangdong province (Zhou *et al*., 2024) [29].

The average lengths of fish species of sampling sites Kanpur, Kannauj, and Farrukhabad are 12.44 cm, 14.65 cm, and 14.74 cm respectively. The average weight of fish species from different sampling sites is 15.70 gm, 43.80 gm and 32.23 gm respectively. The Condition Factor of fish species in Kanpur, Kannauj, and Farrukhabad ranges from 0.90 to 1.43, 0.93 to 1.57, and 0.99 to 1.08, respectively. The maximum variation of condition factor of fish species is found in Kannauj. The Farrukhabad district has observed a minimum variation in the Condition Factor of fish (Fig. II; Table III). Kanpur and Kannauj fish species have higher average condition factor values, indicating good health. On the other hand, the average condition factor of fish species of Farrukhabad shows their poor health status, as they have a lower value in most samples.

According to Olurin and Aderibigbe (2006) [21], when b = 3, the fish grows isometrically, resulting in an optimum shape. When the value of b is less than 3.0 the fish experiences negative allometric growth. However, when the value of b is more than 3.0 the fish grows following the positive allometric growth pattern. Studies by Kumar *et al.* (2014) [15] found 'b' values ranging from 2.54 for *Wallago attu* to 3.2 for *Channa punctatus*, with a mean 'b' value of 2.99 across all species. The 'b' values indicated positive allometric growth for *H. fossilis* (3.05) and *C. punctatus* (3.2). Basak and Hadiuzzaman (2019)[3] discovered a significantly significant link between the length and weight of *Kalibaus* fish, indicating favorable environmental conditions in the reservoir. The mean condition factors (1.396, 1.310, and 1.367) and growth coefficients (2.97, 2.95, and 2.93) indicated that the fish were doing well. Based on the observations of Asadi *et al.* (2017) [2] Shahrbijar River in Guilan Province, Iran shows less than one condition factor and is not suitable habitat for *Cobitis keyvani* but it presents an appropriate habitat for other species, *Barbus c*yri, *Capoeta gracilis*, *Alburnoides eichwaldii*, *PseudoRasbora parva*, *Ponticola cyrius* and *Acanthalburnus microlepis*. Nazek *et al.* (2018) [19] studied the length-weight relationship and condition factor of fish from the Eastern Mediterranean city of Tripoli-Lebanon and observed that all captured fishes exhibited negative allometric growth and tended to be thinner, but the relative condition factor fluctuated and showed a state of well being for these fishes.

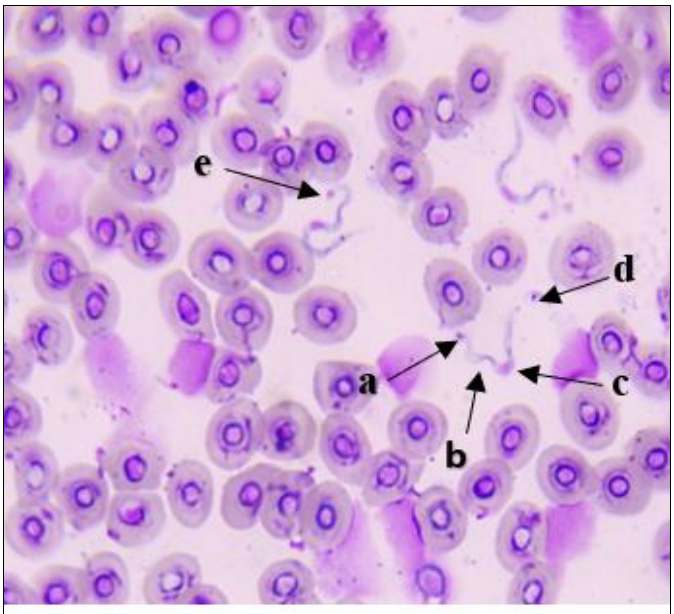
Prakash (2022) [23] discovered a similar average condition factor for *C. punctatus* across seasons at Balrampur, Uttar Pradesh, India. The values are ≥1 for non-polluted sites and ≤1 for polluted sites. The development patterns were isometric, and the condition factor values demonstrated that the reservoir is an appropriate habitat for farming. Similarly, Pathak *et al*. (2022) [22] discovered that *Aphanius dispar* and *Salmostoma bacaila* had negative allometric growth, *Cirrhinus mrigala* had isometric growth, and *Labeo rohita*, *Mystus gulio*, and *Systomus sarana* had positive allometric growth. *Oreochromis mossambicus*' development was approximately isometric (b ≈ 3). They showed a clear linear association between length and weight. Ragheb (2023) [24] calculated the length-weight relationship in thirty-three fish species from Egyptian Mediterranean waters off Alexandria, and found that 20 had an isometric growth pattern, 10 had negative allometric growth, and only three had positive allometric growth. Abdan *et al*. (2024) [1] studied *Keudawah* (*Rasbora* sp.) fish from its native place Krueng Lanca of Aceh Province, Indonesia and observed negative allometric growth (both males and females), with b values ranging from 2.307 to 2.962 (for males) and 1.731 to 2.669 (for females).

1: *Heteropneustes fossilis*

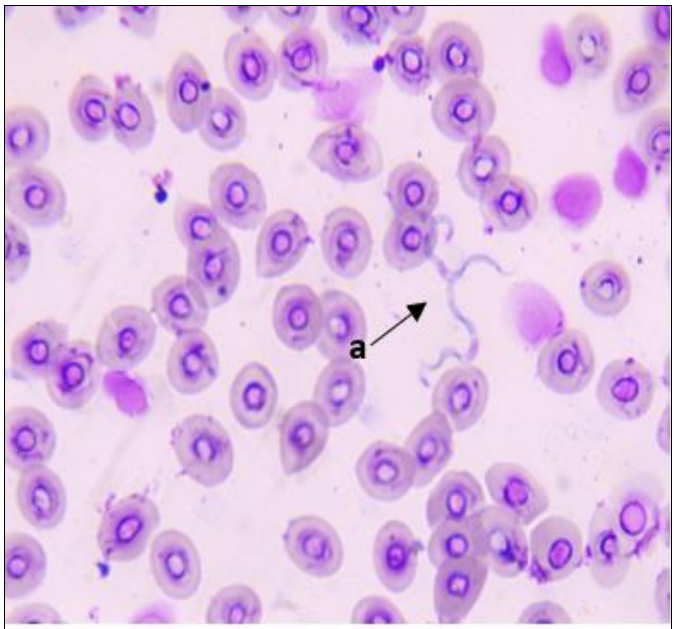
2: *Channa punctatus*

3: Measuring the length of fish

4. Measuring the weight of fish



5. *Trypanosoma* a protozoan parasite
a. Anterior end; b. Undulating membrane; c. Nucleus; d. Posterior end; e. Kinetoplast



6. *Trypanosoma* a protozoan parasite
a. Three parasites together

Fig 2: Photographs showing the fish, morphological analysis and Trypanosoma parasite

Table 1: Sampling sites: Geographical coordinates and site occupied

Sampling sites	Geographical coordinates	Site occupancy
Kanpur	26◦ 26’ 59.7228’’ N, 80◦ 19’ 54.7356’’ E	Fishing market
Kannauj	27◦ 3’18.6804’’ N, 79◦ 55’ 5.0988’’ E	Village and fish market
Farrukhabad	27◦ 23’ 13.3764’’ N, 79◦ 35’ 17.2572’’ E	Village and fish market

Table 2: Parasite distribution in fishes *C. punctatus* and *H. fossilis*

	Parasite recovered			
	Trypanosoma			
Hosts	**No. of fish examined**	**No. of fish infected**	**Prevalence or Freq. Index (%)**	**Mean intensity or Conc. Index (Parasite/500 RBCs)**
Channa punctatus	*40*	*4*	*10 %*	*4*
Heteropneustes fossilis	*40*	*Nil*	*Nil*	*Nil*

Table 3: Condition Factor (K) at different sampling sites

Sampling sites	Average length (cm.)	Average weight (gm.)	Condition Factor (K)
Kanpur	*12.44*	*15.70*	*0.90 – 1.43*
Kannauj	*14.65*	*43.8*	*0.93 – 1.57*
Farrukhabad	*14.74*	*33.23*	*0.99 – 1.08*

4. Conclusion

The present study investigated the prevalence of parasite infection in two fish species, *C. punctatus* and *H. fossilis*, collected from different sampling sites. *C. punctatus* were infected with the protozoan parasite genus *Trypanosoma* with a relatively low level of parasite infection. The absence of parasite infection in *H. fossilis* suggests that this species may have a lower susceptibility to parasite infection or inhabit an environment with lower parasite loads. A comprehensive study was also conducted to assess the condition factor of fish species in three different sampling sites: Kanpur, Kannauj, and Farrukhabad.

The condition factor, a crucial indicator of fish health, was calculated based on the length and weight of the fish species. The average lengths of fish species varied significantly across the three sampling sites. Kannauj recorded the highest average length of 14.65 cm, followed by Farrukhabad with 14.74 cm, and Kanpur with 12.44 cm. Similarly, the average weights of fish species also showed variations, with Kannauj recording the highest average weight of 43.80 gm, followed by Farrukhabad with 32.23 gm, and Kanpur with 15.70 gm.

Overall, the study highlights the importance of monitoring parasite infection in fish populations, particularly in *C. punctatus*, to ensure the health and well-being of these species. The average condition factor values for Kanpur and Kannauj were higher, indicating the good health status of the fish species. However, the average condition factor value for Farrukhabad was lower comparatively, suggesting a poor health status of the fish species in this region. The study's findings have significant implications for fisheries management and conservation efforts.

The differences in condition factor between the three sampling locations imply that environmental elements including habitat, food availability, and water quality might affect the fish species' health. Monitoring and controlling these environmental conditions are essential to ensure the sustainability of fish populations in these areas.

The study provides valuable insights into fish species in Kanpur, Kannauj, and Farrukhabad, emphasizing the need for long-term fish population sustainability. It recommends further research on length-weight relationships and condition factors for fisheries management and population dynamics.

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6. Conflict of interest: Authors have no conflict of interest.

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