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Food and Feeding Habit of *Mystus gulio* (Hamilton, 1822) from Meghadrigedda Reservoir, Andhra Pradesh, India

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ABSTRACT

A total of 261 specimens of *Mystus gulio* were examined from June 2023 to May 2024 to assess feeding ecology, seasonal diet composition, and condition indices. Of these, 214 specimens contained food, while 47 had empty stomachs. Insects and crustaceans dominated the diet, followed by algae, molluscan shells, and annelid worms, with notable monthly and seasonal variations. Feeding intensity, expressed through the Gastro-Somatic Index (GSI) and Gut Repletion Index (GRI), peaked during the post-monsoon season, while reduced activity was observed in the monsoon. Condition factor and relative frequency percentage further supported seasonal differences in nutritional status. A strong positive correlation (R = 0.9003) was found between length and weight, indicating steady growth. The study highlights the opportunistic feeding behavior of *M. gulio* and the influence of environmental conditions on its dietary dynamics.

KEY WORDS: Feeding intensity, Season, Gastro-Somatic Index, Gut Repletion Index, Condition factor, Correlation

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INTRODUCTION

The feeding habits of fish species vary across different environments and are influenced by several regional factors such as environmental conditions, prey availability, prey defense mechanisms, and the attractiveness of prey [1]. Food is one of the key factors that supports the metabolic processes of fish and promotes their growth; therefore, any alteration in food sources can significantly impact fish health. Understanding the relationship between fish and their food organisms is essential for predicting and managing fish populations, as well as for assessing their distribution—both of which are crucial for effective fisheries management [2]. Nutrition and feeding directly affect fish growth, reproduction, and health, and also influence their responses to physiological and environmental stressors, including pathogens [3]. Feeding behavior in fish is associated with various factors such as feeding methods, feeding frequency, mechanisms of food detection, and food preferences. Furthermore, competition for limited food resources is inevitable among individuals of the same species that occupy similar ecological niches [4].

Stomach content analysis has become a standard method for studying the feeding patterns of fish, providing valuable insights into their diets and food preferences, which are fundamental to fisheries management. Gut content analysis helps determine a species' diet, feeding habits, and position within the aquatic food web, thereby revealing trophic interactions, competition, and habitat preferences that directly support fisheries management and conservation strategies. However, Lagler emphasized that gut contents only indicate what the fish has consumed and may not represent the full range of its dietary habits [5]. Accurately describing fish diets and feeding behaviors is essential for understanding trophic dynamics in aquatic ecosystems, as fish diets integrate multiple ecological aspects, including behavior, physiological condition, habitat utilization, energy intake, and inter- or intraspecific interactions. In this context, the present study aims to investigate the food and feeding habits of *Mystus gulio* and their relationship with planktonic and benthic communities in the Meghadrigedda Reservoir, with the objective of assessing the reservoir's productivity and its potential as an important fishing ground.

MATERIAL AND METHODS

Fish samples were collected with the assistance of local fishermen using traditional fishing gear, including cast nets and set gillnets. Specimens were preserved in 10% formalin, with additional formalin injected into the gut to arrest further digestion of ingested material [6]. A total of 261 individuals of *Mystus gulio* were collected from June 2023 to May 2024. Monthly collections and analyses were conducted to assess seasonal variations in the dietary composition of the species. All laboratory investigations were performed in the Department of Zoology and Fisheries, Dr. V. S. Krishna Government Degree & P.G. College (A). The stomachs of the specimens were dissected using fine scissors, and the contents were transferred to Petri dishes for examination. Food items were identified under a binocular microscope (magnifications 5× and 10×) and weighed using an electronic balance. The gravimetric method was employed to estimate the percentage composition of the various dietary components [7, 8].

Numerical count method:

Food items were identified by examining portions of the gut contents. The entire volume of each sample was observed under a microscope, and the number of individuals belonging to each food category was recorded along with the total number of food items. The relative percentage composition of each dietary component was then determined. This method follows the procedure described by Hynes [9].

$$\text{Percentage of numerical count } = \frac{\text{Number of individual food item}}{\text{Total number of food items}} \times 100 \ldots\ldots\ldots\ldots\ldots.1$$

K-factor or the condition – It could call it the BMI or health index of the fish. The factor is calculated using the Fulton formula.

Fish condition factor was calculated as: k = 100×TW/L^3 ---------(5)

The condition factor of a fish is regarded as the fitness or relative well-being of the fish and it indicates the general metabolism of the fish.

Gut contents analyses

Each opened stomach was assigned a number of points proportional to its degree of fullness according to an arbitrary 0–20-point scale. In this method, 0, 5, 10, 15 and 20 points were scored for empty, ¼ full, ½ full, ¾ full and full stomachs respectively. Intermediary points were also allotted where necessary according to the proportion of food in the stomach. Stomach contents were sorted out into categories using and analyzed using Relative Frequency (%RF) methods [10, 11, 12, 13].

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$$\text{RF} = \frac{\text{Fi}}{\text{Fi}} \times 100 \text{ ------------------ } 1$$

Whereas, Fi = Frequency of item i; Fi = Frequency of the n^{th} item i.e. number of all Fi. All RF values sum up to 100%. RF is un-weighted by the actual amounts of items in the stomachs but is responsive to the frequency of each in relation to the frequencies of all others [14]. The integrated importance of each food item was then expressed as an Index of Food Dominance (IFD) according to the formula:

$$\text{IFD} = \frac{\text{RF.PP}}{\Sigma\text{RF.PP}} \times 100 \text{ ---------}2$$

Whereas, RF = % Relative Frequency of food item; PP = % Point Percentage

The data have used to calculate the monthly fullness index (FI) to determine the percentage of feeding intensity:

FI = Number of gut with same degree of fullness Total number of gut examined

$$\text{FI} = \frac{\text{Numer of gut with same degree of fullness}}{\text{Total number of gut examined } \times 100}$$

This index ranges from 0-100%. Food items with IFD ≥10% were arbitrarily considered as primary diets; those with IFD between 1-9.9% as secondary diets and those with IFD between 1-9.9% as secondary diets and those with IFD <1% as incidental food items. The use of IFD to establish overall food preponderance is adequate as it incorporates the RF and PP data, thus minimizing the bias characteristic of cases in which results from different analytical methods are independently interpreted [15, 16].

The Gastro Somatic Index (GSI) was calculated to show the trends in the feeding activity of the fish according to the formula [17].

GSI = 100Wf/Wt ----------------- (6)

Whereas, Wf = Weight (g) of food in the gut; Wt = Total weight (g) of the fish

Occurrence method: The number of stomach containing one or more food items were recorded [11]. The number was then expressed as a percentage of all stomach

Points method: In this method, each of the food item was allotted of points on the basis of quantity and all the points gained by different food items were summed up and scale down to percentage to express them in percentage composition of the gut contents of all the fish examined [11, 15, 16].

The Gut repletion index (GRI) was calculated using the formula:

$$\text{GRI} = \frac{\text{Number of non} - \text{empty guts}}{\text{Total number of specimens examined}} \times 100 - - - - - - 3$$

In the point method, the points previously assigned to each stomach were shared among the various contents or food items, taking account of the relative proportions by volume. The mean points gained by each food item were determined.

The mathematical relationship between length and weight was calculated using the conventional formula [17, 18]:

$$W = a\,TLb$$

Where W is fish weight (g), TL is total length (cm), 'a' is the proportionality constant and 'b' is the isometric exponent. The parameters 'a' and 'b' were estimated by non-linear regression analysis [19].

RESULTS AND DISCUSSION

A total of 261 specimens of *Mystus gulio* were analyzed for gut contents. Among these, 214 specimens had food in their guts, while 47 specimens had empty stomachs. The feeding intensity of *M. gulio* was examined during the study period from June 2023 to May 2024. On average, 25.01% of the specimens had their guts one-fourth full, which represented the maximum proportion, whereas only 8.05% of the specimens had completely full guts, which was the minimum proportion observed (Table 1). Seasonal variations in feeding intensity revealed that the highest percentage of full guts occurred during the post-monsoon season, followed by three-fourths full during the monsoon, half and one-fourth full, and nearly empty during the post-monsoon, while empty stomachs were most common in the monsoon season (Table 2). Similar observations were reported by Sudesh and Nandini (2010), who categorized the food items of the species into polychaete worms, insects, crustaceans, molluscs, other items, and non-food materials. The non-food component largely comprised anthropogenic materials such as coconut husk, eggshells, chicken feathers, brick fragments, gravel, and plastic, suggesting accidental ingestion and reflecting the influence of environmental pollution on the feeding ecology of the species [20, 21, 22, 23].

The primary dietary components of *Mystus gulio* were found to be abundant and occurred regularly in the gut. Monthly variations in feeding intensity indicated that insects and crustaceans formed the dominant food items, with the highest occurrence in August (36.0%), the lowest in June (28.0%), and complete absence in September and October. Molluscan shells were most abundant in August (12.5%), least in March (8.0%), and absent in September and October. Annelid worms were recorded at a maximum in April (5.5%) and a minimum in August (2.0%). Microalgae showed the highest contribution in January (13.0%) and the lowest in June (5.0%), while filamentous algae peaked in March (15.0%) and declined to a minimum in June (8.0%). The proportion of digested food was highest in June (30.0%) and lowest in August (15.0%) (Table 3). Previous studies have provided varied accounts of the feeding habits of *Mugil gulio*. David (1963) also emphasized the predominance of small crustaceans, along with the occurrence of fish and plant material such as algae and diatoms [24]. In contrast, Kaliyamurthy and Rao (1972) described *M. gulio* as a carnivore with a strong preference for amphipods, copepods, and other crustaceans, identifying it as a benthic feeder [22, 25, 28, 29, 30].

Seasonal analysis of gut content revealed that insect and crustacean parts were the most dominant food items during the pre-monsoon season (32.0%) and the least during the post-monsoon season (23.88%). Filamentous algae contributed maximally in the pre-monsoon (12.25%) and minimally in the post-monsoon (9.5%), while microalgae were highest in the pre-monsoon (10.0%) and lowest during the monsoon (8.5%). Molluscan shells, which represented the least preferred food category, peaked in the pre-monsoon (9.5%) and declined to their lowest in the monsoon season (8.5%) (Fig. 3). These findings are in agreement with earlier reports. Pandian (1966) noted that the diet of *M. gulio* is dominated by crustaceans (copepods and cladocerans, 55%) and insects (mainly *Chironomus* and *Micronecta*, 40%), with only rare occurrences of prawns and fishes [30]. Similarly, Yusuf and Majumdar (1993) classified *M. gulio* as an omnivorous species with a marked carnivorous tendency, as animal matter constituted 79% of its diet; nauplius larvae and *Brachionus* sp. were the predominant items, and the species was reported as a bottom feeder. Taken together, these studies highlight the dietary flexibility of *M. gulio*, but consistently point to crustaceans, insects, and other benthic organisms as the principal dietary components, with occasional incorporation of plant material and fish remains [25, 26, 27].

In addition to diet composition, seasonal variation in condition indices provided further insights into the feeding ecology of the species. The condition factor (considered analogous to the BMI or health index of fish) was highest in June (2.18) and lowest in March and May (Table 4; Fig. 4). At the seasonal scale, condition factor values were highest in the post-monsoon (1.92), followed by the monsoon (1.66) and pre-monsoon (0.94) seasons (Fig. 5). The relative frequency percentage (RF%) was maximum in December (10.34%) and minimum in September (4.98%) (Table 4; Fig. 4). When assessed seasonally, RF% was equally highest during the pre-monsoon and post-monsoon periods (8.42%), while the monsoon recorded a lower value (6.76%) (Fig. 6). The Gastro-Somatic Index (GSI), which reflects feeding intensity, exhibited peak values in November (17.26), December (14.76), and January (13.67), indicating active feeding

associated with higher food availability and nutritional intake. In contrast, the lowest GSI values were recorded in October (2.84) and September (3.49), suggesting reduced feeding activity (Table 4; Fig. 4). At the seasonal level, the GSI was highest during the post-monsoon (12.13), followed by the pre-monsoon (9.41) and monsoon (6.74) seasons (Fig. 7) [17, 18, 31, 32].
The proportion of gut weight to total body weight, expressed as the Gut Repletion Index (GRI), is an indicator of feeding intensity, with higher values signifying frequent feeding or greater food intake relative to body size. In the present study, the GRI reached its peak (100.00%) in June, November, and December, reflecting active feeding, whereas the lowest value (15.38%) was recorded in September, indicating reduced or non-active feeding (Table 4). At the seasonal scale, the GRI was highest during the pre-monsoon (88.09), followed by the post-monsoon (76.78) and the monsoon (70.43) seasons (Fig. 7). Overall, *Mystus gulio* exhibited active feeding throughout the study period, except in October and November 2023, when feeding activity declined (Table 4).
Comparable studies have also emphasized the feeding ecology of related catfish species. Mumthaz et al. (2025) analyzed the gastro-somatic index, relative gut length, gut fullness, feeding intensity, food composition, and index of preponderance, and reported that *M. gulio* is an omnivorous bottom feeder, primarily consuming fish offal, plant matter, filamentous algae, prawns, and polychaetes [33]. Similarly, Khade and Chhaya (2022) observed the feeding habits of *Mystus armatus* and classified it as eury-omnivorous. They further highlighted ontogenetic variation in feeding, noting differences in juvenile and adult diets based on relative gut length (RLG) values. Their findings also demonstrated an inverse relationship between feeding activity and breeding, as well as the influence of food availability and habitat conditions [34]. Comparable observations have been reported by other researchers [25, 35, 36, 37, 38], supporting the view that members of the genus *Mystus* exhibit broad omnivorous feeding habits, with variations influenced by life stage, reproductive cycle, and ecological factors.
In the present study, the mean total length of specimens was highest in May (15.20 ± 2.84 cm) and lowest in August (8.22 ± 1.12 cm). Similarly, the mean total weight peaked in April (19.64 ± 1.65 g) and was lowest in September (14.91 ± 2.62 g). The correlation coefficient (R = 0.9003) indicated a very strong positive relationship between length and weight (Fig. 10 and 11). Comparable findings were reported by Epa Paujiah et al. (2023), who observed length–weight regression values ranging between 0.457–0.975 for males and 0.717–0.977 for females across three estuaries in West Java, Indonesia, suggesting a moderate to strong relationship. Similarly, Begum et al. (2010) and other researchers [39, 40, 41, 42, 43] have highlighted that the length–weight relationship (LWR) serves as a valuable tool in fisheries biology, providing insights into fish health, growth patterns, and population dynamics.

Table 1: Feeding intensity of *Mystus gulio* during the study period

Month	Sample size/	Records on food availability		Food weight (g)	Active feeding		Moderate feeding	Poor feeding		Empty
		Full stomachs	Empty stomachs		Full	¾ full	½ full	¼ full	Trace	
Jun -23	16	16	0	1.88	11.32	19.65	28.85	32.54	7.64	0
July-23	17	14	3	2.05	9.12	22.35	27.45	31.96	9.12	0
Aug-23	25	21	4	2.24	8.45	24.15	28.7	34.56	4.14	0
Sep-23	13	2	11	0.89	0	7.06	14.44	18.25	26.14	34.11
Oct-23	18	3	15	0.75	1.14	8.62	12.85	19.14	28.14	30.11
Nov-23	24	24	0	2.65	14.62	37.24	29.81	17.08	1.25	-
Dec-23	27	27	0	2.57	8.85	35.88	29.74	23.41	2.12	-
Jan-24	21	19	2	2.45	-	4.21	10.12	19.35	29.14	37.18
Feb-24	25	22	3	2.12	-	7.42	13.35	26.44	35.12	17.67
Mar-24	28	25	3	2.08	5.65	18.75	27.66	32.92	14.0	1.02
Apr-24	26	22	4	1.86	12.05	21.17	28.55	23.33	12.55	2.35
May-24	21	19	2	2.25	9.33	24.65	32.45	21.14	9.15	3.28
Feeding intensity	261	214	47	1.98	8.05	19.26	23.66	25.01	14.87	12.57

Table 2. Seasonal feeding intensity of *Mystus gulio*

Season	Full	¾ fill	½ full	¼ full	Trace	Empty
Pre-monsoon	7.22	16.54	21.25	24.76	11.6	18.63
Monsoon	7.82	19.33	17.42	14.96	15.63	53.59
Post-monsoon	9.01	17.99	25.5	25.95	17.71	6.08

Table 3: Composition of different food items following percentage of point method in the gut content of *Mystus gulio*

	month	Crustacean broken parts	Annelida worms	Molluscan shells	Micro algae	Filaments algae	digested food	Sand and mud
Monsoon	Jun -23	28	2	10	5	10	30	15
	July-23	34	4	12	8	12	20	10
	Aug-23	36	2.5	12	7.5	12	15	15
	Sep-23	0	0	0	0	0	0	0
Post-monsoon	Oct-23	0	0	0	0	0	0	0
	Nov-23	32.5	2.5	7.5	8.5	10.5	18.5	20
	Dec-23	33	4	10	10.5	12.5	15	15
	Jan-24	30	5	12	13	15	15	10
Pre-monsoon	Feb-24	33	5	10	10	12	20	10
	Mar-24	35	4	8	8	15	20	10
	Apr-24	30	5	10	10	12	23	10
	May-24	30	3	10	12	10	25	10
	Average	26.79	3.08	8.45	7.71	10.08	32.21	11.67

Table 4. Relative Frequency, Gastro Somatic Index, Gut repletion index and feeding intensity in *Mystus gulio*

	Month	Length (cm)	Weight (gr)	Sample size/	K-Factor	RF%	GSI	GRI (%)	Feeding intensity
Monsoon	Jun -23	13.8±1.15	19.3±2.41	16	2.18	6.13	7.66	100	Active feeder
	July-23	12.82±1.89	18.42±2.14	17	1.58	6.51	7.78	82.35	Active feeder
	Aug-23	8.22 ± 1.12	16.52±1.87	25	1.58	9.57	8.02	84	Active feeder
	Sep-23	8.62± 1.32	14.91±2.62	13	1.32	4.98	3.49	15.38	Non- active
Post monsoon	Oct-23	10.11±1.78	15.32±1.65	18	1.13	6.89	2.84	16.66	Non- active
	Nov-23	10.53±1.45	16.04±2.54	24	2.61	9.19	17.26	100	Active feeder
	Dec-23	12.04±1.98	16.24±2.13	27	2.2	10.34	14.76	100	Active feeder
	Jan-24	11.89±1.25	18.42±2.47	21	1.73	7.27	13.67	90.47	Active feeder
Pre monsoon	Feb-24	13.18±2.05	18.34±1.98	25	0.94	8.42	11.73	88	Active feeder
	Mar-24	14.27±2.11	20.23±2.12	28	0.92	9.57	9.29	89.28	Active feeder
	Apr-24	14.5±1.78	19.64±1.65	26	0.97	8.42	7.54	84.62	Active feeder
	May-24	15.2± 2.84	21.2±1.84	21	0.92	7.27	9.06	90.48	Active feeder

Fig: 1Feeding intensity of *M. gulio*

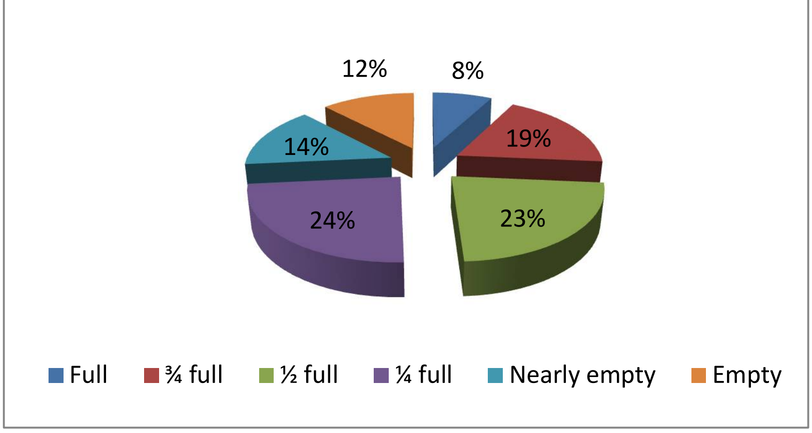


Fig: 2. Seasonal feeding intensity

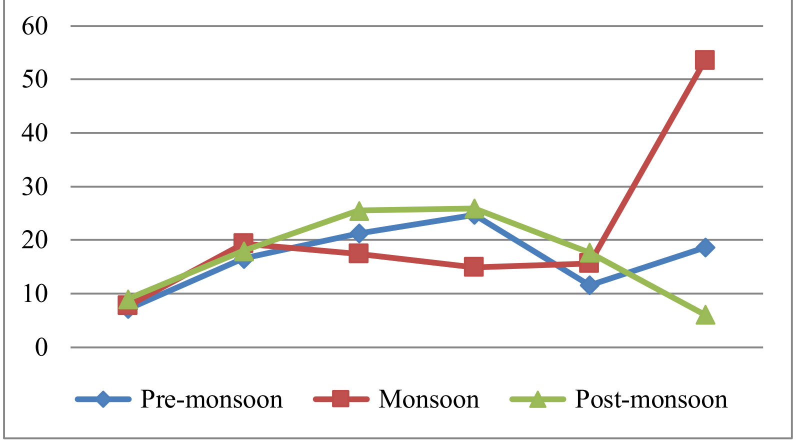


Fig: 3. Seasonal food items petcentage in the gut content

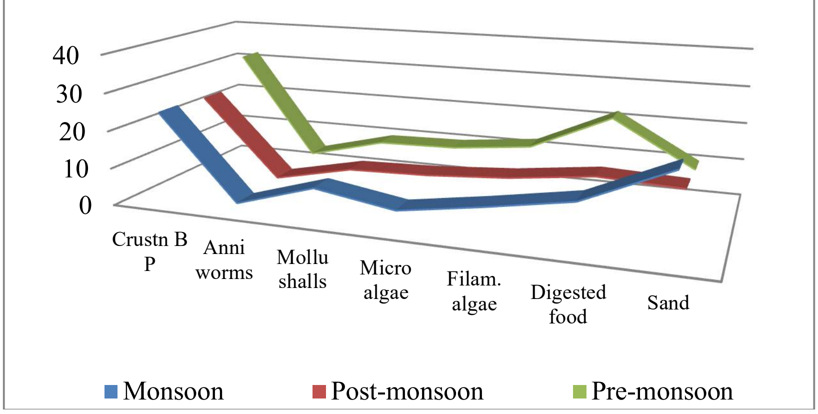


Fig: 4. K facyor and RF%

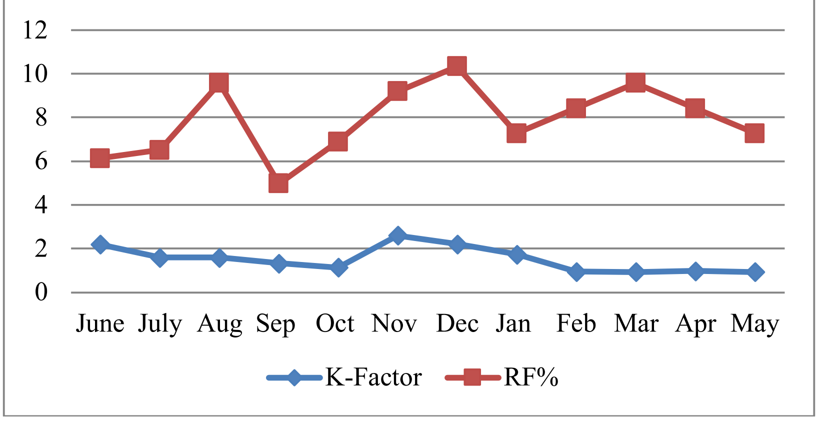


Fig: 5. Seasonal K Factor

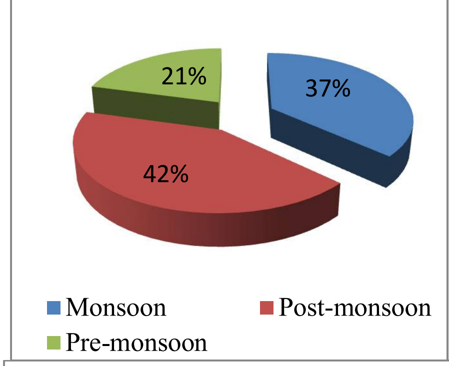


Fig: 6. Seasonal RF %

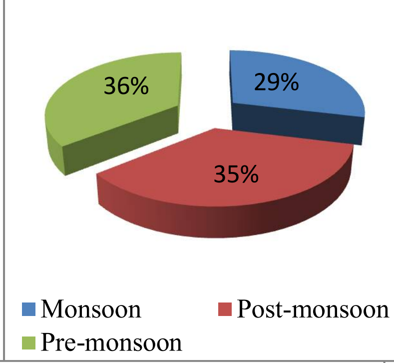


Fig: 7 Seasonal GSI

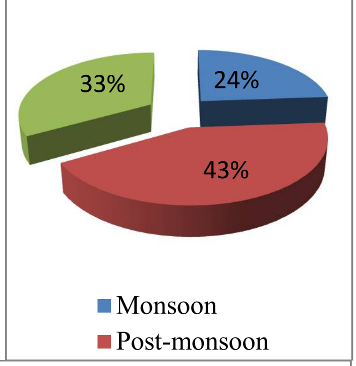


Fig: 8. Gastro Somatic Index, Gut repletion index in *M. gulio*

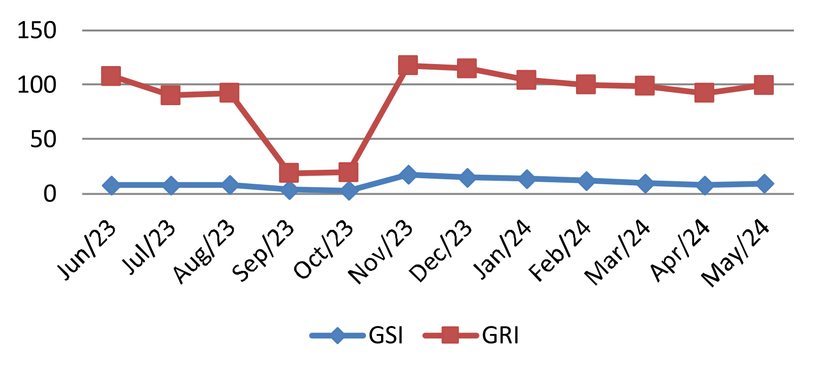


Fig: 9. Seasonal GRI

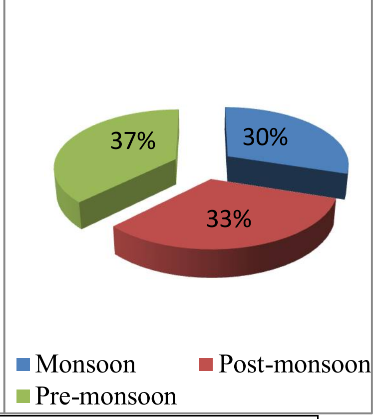


Fig: 10 Length- Weight relationships

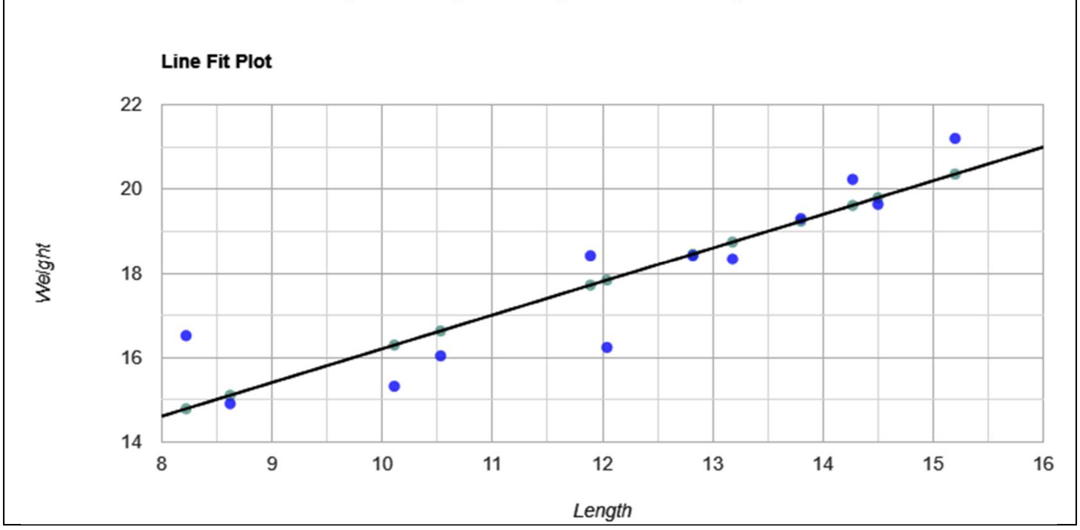
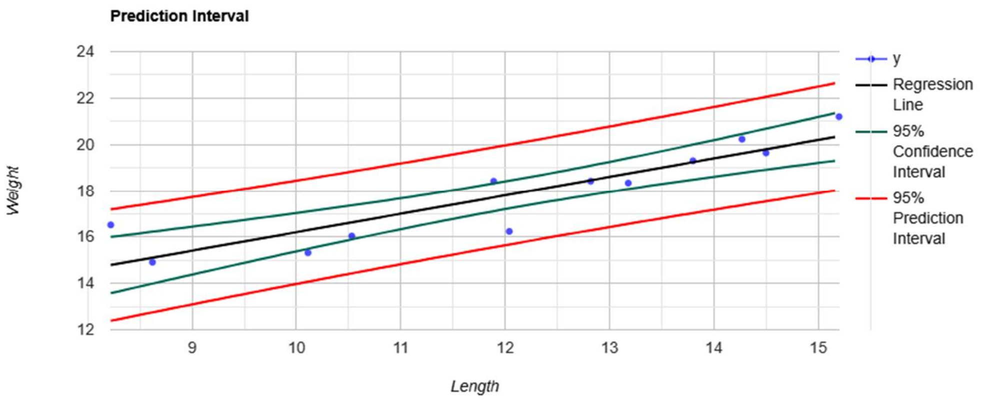


Fig: 11: Regression Linear relationship line



CONCLUSION

The present study on the feeding ecology of *Mystus gulio* revealed clear seasonal variations in diet composition, feeding intensity, and condition indices. Insects and crustaceans constituted the dominant food components, with notable fluctuations across months and seasons, while molluscan shells and annelid worms formed minor dietary elements. Seasonal shifts in microalgae and filamentous algae further highlighted the species' flexible feeding strategy. Condition factor, relative frequency percentage, gastro-somatic index, and gut repletion index all demonstrated post-monsoon peaks, indicating enhanced feeding and overall health during this period. The strong positive correlation between length and weight further confirms the species' consistent growth pattern. Overall, *M. gulio* exhibited active feeding behavior throughout the year, with reduced intensity during the monsoon months, reflecting the influence of environmental conditions and food availability on its feeding dynamics.

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DECLARATION

The methodology was collaboration between all authors, PA, PJK and KRR who contributed to the completion of this work and also carried out the habitat of the wild flora. The final manuscript was read and approved by the writers.

COMPETING INTERESTS

Authors have declared that no competing interests exist

Ethical approval

This study was conducted according to international ethical standards set by the Institutional Animal care and Use Committee

Consent to participate

Not applicable as commercial gear operating reservoir, the local men and women were involved in the sampling study.

Data availability statement

The authors confirm that the data used to support the findings of this study are available within the manuscript.

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