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Assessment of Plankton Diversity with Reference to Monthly and Seasonal Variation in the Godavari River, Andhra Pradesh

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Abstract

The diversity of plankton in the Godavari River was studied from April, 2021 to March, 2022 across six sampling stations: Kunavaram, Rajamahendravaram, Dowleswaram, Kovvur, Tallapudi, and Polavaram to investigate monthly and seasonal variations of planktons in the Godavari River ecosystem. The study revealed significant temporal variations in both phytoplankton and zooplankton diversity, reflecting the ecological responses to changes in nutrient load, water flow, and anthropogenic pressures. A total of 25 phytoplankton species were identified, comprising 12 species of Chlorophyceae (5 families), 9 species of Bacillariophyceae (4 families), 3 species of Cyanophyceae (2 families), and 1 species of Euglenophyceae (1 family). Among these, Chlorophyceae was the dominant group recorded at all stations throughout the study period. Additionally, 26 zooplankton species were recorded, representing 6 groups, 12 families, and 21 genera. These included 8 species of Rotifera, 6 of Cladocera, 5 of Crustacea, 4 of Copepoda, and 1 of Ostracoda, with Rotifera being the most dominant group (30.76%). Monthly and seasonal variations in zooplankton populations were assessed, with the highest density (81.33±7.50 no.l^{-1}) observed during the hot weather season of 2023 at Rajamahendravaram, and the lowest (42.00±4.25 no.l^{-1}) during the South-West Monsoon at Polavaram. The composition and abundance of planktonic communities indicated that the Godavari River supporteda moderately rich and productive aquatic ecosystem. Moreover, the observed diversity patterns establish plankton as valuable bioindicators for assessing water quality and ecological health across different stretches of the river. Continuous monitoring was essential for biodiversity conservation and sustainable river management.

Keywords: Phytoplankton, zooplankton, seasonal variation, diversity, Godavari River

1. Introduction

Rivers play a pivotal role in maintaining ecological balance within aquatic ecosystems and represent one of the most crucial natural freshwater resources supporting human activities for centuries. Historically, many civilizations flourished along riverbanks due to their life-sustaining capacity (Obaidy et al., 2015). Freshwater ecosystems, and particularly riverine systems, are among the most significant landscape features that support both terrestrial and aquatic biodiversity. As highlighted by Kamboj et al. (2017) and Effendi et al. (2016), the dynamic nature of rivers makes it essential to understand their water quality, as they are highly sensitive to a range of developmental pressures.

The Godavari River, the largest monsoonal river in India, spans a basin area of approximately 3.1×10^5 km² and is fed by 25 major tributaries. Globally, it ranks 34th in terms of catchment size and 32nd in terms of water discharge among the world's 60 largest rivers (Ludwig et al., 1996; Gaillardet et al., 1999). It is recognized as the second-longest river in India, after the Ganga, and is often referred to as the "Dakshin Ganga" or the "Ganga of the South." Originating near Trimbakeswar in the Deolali Hills, Nashik (Maharashtra), the river flows for about 1,440 km before entering its tidal zone below Rajahmundry in Andhra Pradesh, encompassing a catchment of 315,980 km² (Jhingran, 1997). In addition to its major tributaries, several seasonal rivulets and streams also contribute to its flow regime.

The Godavari River supports a rich diversity of aquatic life, including phytoplankton, zooplankton, benthic communities, and a variety of fish species. Within this complex food web,

phytoplankton and zooplankton serve fundamental roles. Phytoplankton, which are among the most vital biological organisms sustaining all life forms, are a key component of riverine ecosystems. As primary producers, they also act as reliable indicators of ecosystem health due to their rapid structural and metabolic responses to environmental changes (Komala et al., 2013; Venkateswarlu, 1969). Phytoplankton occupy the base of the aquatic trophic pyramid, providing the essential foundation for energy flow within the ecosystem (Das and Panda, 2010). Through photosynthetic activity, they transform inorganic nutrients such as nitrates and phosphates into essential organic compounds including proteins and lipids, thus forming the energetic base of the trophic system (Tiwari and Chauhan, 2006; Ishaq and Khan, 2013; Saifullah et al., 2014). Their abundance and structural composition vary seasonally in response to changing ecological conditions, directly influencing water quality and sustainable aquaculture (Joshep and Yamakanamardi, 2011; Akter et al., 2015). Zooplankton, in turn, regulate trophic interactions by transferring energy from phytoplankton to higher consumers. Owing to their short life span, these organisms respond quickly to ecological fluctuations and are reliable bioindicators of aquatic health (Malik et al., 2020). Their population dynamics are governed by several hydrological and physico-chemical parameters such as water depth, current velocity, temperature, pH, dissolved oxygen (DO), biological oxygen demand (BOD), and nutrient status (Alexander, 2012; Lougheed and Vanessa, 1998; Sharma et al., 2018). However, rapid anthropogenic modifications across freshwater systems are increasingly threatening endemic biodiversity (Hillel et al., 2015; Malik et al., 2021). Considering this ecological significance, the study of plankton distribution, diversity, and seasonal patterns in the Godavari River is crucial for multiple reasons: maintaining fisheries resources, assessing water quality, and evaluating the ecological impacts of anthropogenic activities. Hence, the present research focused on evaluating plankton diversity in relation to monthly and seasonal variations in the Godavari River ecosystem.

2. Materials and Methods

2.1. Study area

The plankton diversity of the Godavari River was investigated from April, 2021 to March, 2022 at Kunavaram, Rajamahendravaram, Dowleswaram, Kovvur, Tallapudi, and Polavaram across six sampling stations. The Godavari River, originating near Trimbakeshwar in the Deolali Hills of Nashik, Maharashtra, flowedeastward for approximately 1,440 km across the Deccan Plateau before reaching its tidal limits below Rajamahendravaram, Andhra Pradesh (Jhingran, 1997). After traversing Maharashtra and Andhra Pradesh, the river drains into the Bay of Bengal, about 50 miles downstream from the Dowleswaram Barrage. Rajamahendravaram lies on the river's left bank, where the barrage crosses two midstream islands. Initially constructed as the Dhawaleswaramanicut and later replaced by a barrage in 1985, the structure has a gross storage capacity of 3.12 TMC ft and dead storage of 2.02 TMC ft at 12 m MSL. Downstream of Dhawaleswaram, the river bifurcatedinto two major distributaries-Gautami Godavari (north) and Vasista Godavari (south). Gautami meets the Bay of Bengal 19 km below Yanam, where its further splits into northern and southern branches. The Vasista also dividedinto Vanateyama near Vadalarevu and the main Vasista near Narasapuram. The region between these distributaries forms the fertile Godavari delta, which supportedrich plankton biodiversity.

2.2. Selection of sampling stations

A preliminary survey was undertaken to identify suitable sampling stations along the Godavari River in Andhra Pradesh. Eleven locations were initially surveyed, including Rajamahendravaram, Dowleswaram, Seethanagaram, Ravulapalem, Purushottapatnam, Katheru, Bobbilanka, Kunavaram, Kovvur, and Tallapudi. Based on criteria such as fish abundance and fishing activity, six representative sampling stations were selected: Kunavaram (L_1) (17.573948°N, 81.251645°E-S_1), Rajamahendravaram (L_2) (16.997316°N, 81.769521°E-S_2), Dowleswaram (L_3) (16.964258°N, 81.783943°E-S3), Kovvur (L_4) (17.023706°N, 81.730387°E-S_4), Tallapudi (L_5) (17.125425°N, 81.669358°E-S_5), and Polavaram (L_6) (17.249289°N, 81.647236°E-S_6) (Figure 1). These stations were chosen to represent both upstream and downstream stretches of the river for a comprehensive study of plankton diversity.

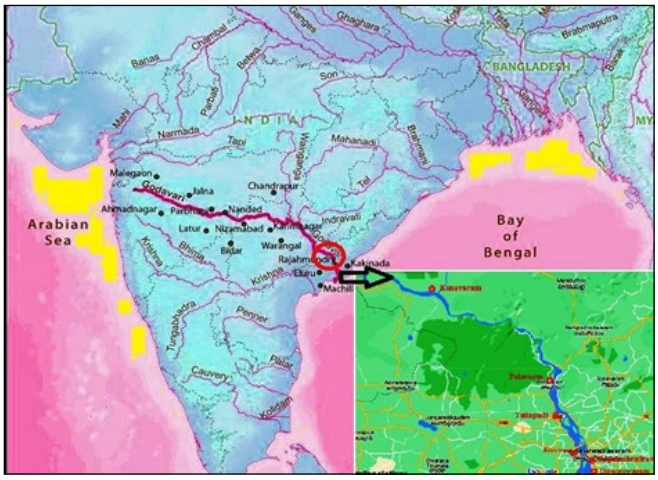

Figure 1: Map showing the sampling stations along the Godavari River

2.3. Collection and preservation of plankton

Zooplankton samples were collected using a plankton net with a mesh size of 50 µm. Sampling was conducted between 8:00 am and 10:00 am. A total of 100 l of surface water was filtered through the net, and the concentrate was transferred into 100 ml plastic containers. Samples were preserved in 5% formalin containing 2–3 ml of glycerol and Lugol's solution (Dussart and Defay, 1995). Replicate samples were collected using a 50 l bucket and passed through a 50 µm bolting silk plankton net. The filtrate was immediately transferred to

100 ml plastic bottles and preserved in Lugol's solution at a 1:100 ratio. All preserved samples were brought to the laboratory for identification. Zooplankton were systematically identified using standard taxonomic keys (Edmondson, 1959; Kasturirangan, 1963; Pennak, 1968; IAAB, 1988; Patil, 2000; Altaff, 2004; Witty, 2004).

2.4. Identification of plankton

Phytoplankton and zooplankton composition was examined using a Binocular Biological Microscope. For zooplankton analysis, both qualitative and quantitative, a Sedgwick-Rafter (S-R) counting cell was used. The S-R cell is a specialized slide measuring 55 mm in length, 20 mm in width, and 1 mm in depth, with a total capacity of 1 ml. Each of its 1000 fields holds 0.001 ml. Plankton identification was carried out using standard taxonomic references by Ward and Whipple (1959) and Prescott (1962).

2.5. Statistical calculation of plankton

The total number of zooplankton present in a litre of water sample was calculated by using following formula:
N=n×V / v Where,
N=Total no. of zooplankton/ lit of water filtered,
n=Number of zooplankton counted in 1 ml plankton of sample,
v=Volume of concentrate plankton sample (1 ml),
V= Volume of total water filtered through (L). Then the same was converted to numbers / litre.

3. Results and Discussion

3.1. Phytoplankton identified in Godavari River

The collection of phytoplankton was done monthly from February, 2022 to July, 2023 from six specified landing stations. During the investigation period, a total of 25 phytoplankton species have been observed from all sampling stations, including 12 species of Chlorophyceae in 5 families, 9 species of Bacillariophyceae in 4 families, 3 species of Cyanophyceae in 2 families and one species of Euglenophyceae in one family (Table 1 and 3 and Figure 2, 3 and 4). Chlorophyceae was found to be the dominant category of algae noticed at all six landing

Table 1: List of phytoplankton species and their class, family and genus

Sl. No.	Class	Family	Name of algae
1.	Chlorophyceae	Scenedesmaceae	*Scenedesmus arcuatus* (Lemmerman)
2.			*Scenedesmus bijugatus* (Turp.) *Kuetzing* var. *gravenitzii* (C. Bernard)
3.			*Crucigenia quadrata* (Morren)
4.		Chlorellaceae	*Chlorella vulgaris* (Beyerinck)
5.		Oocystaceae	*Oocystis irregularis* (Petkof) Printz
6.			*Selenastrum minutum* (Naegeli) Collins
7.			*Kirchneriella lunaris* (Kirch.) Moebius
8.			*Tetraedron pusillum* (Wallich) W.et.G.S.west
9.			*Tetrastrum heteracanthum* (Nordst.)Chod
10.		Zygnemataceae	*Spirogyra crassa* Kutetzing
11.		Desmidaceae	*Cosmarium pseudobroomei* Wolle.
12.			*Closterium Diana* var. *arcunatum*. Ehr
13.	Cyanophyceae	Chroococaceae	*Chroococus limneticus* Lemm.
14.			*Microcystis aeruginosa* Kuetz.
15.		Oscillatoriaceae	*Oscillatoria chalybea* (Martens.) Gom
16.	Bacillariophyceae	Naviculaceae	N*avicula pygmaea* Kuetz
17.			*Navicula rhynchocephala* Kuetz. Var. *Elongata* Mayer
18.		Nitzschiaceae	*Nitzschia tryblionella* Hantzsch v. *levidensis* (W.Smith) Grun.
19.			*Nitzschia filliformis* (W. Smith)
20.		Surirellaceae	*Gyrosigma kuetzingii* (Grun.) Cleve
21.		Fragilariaceae	*Fragilaria pinnata* Her. F. *surotunda* Mayer
22.			*Fragilaria intermedia* Grun.
23.			*Rhopalodia gibberula* (Ehr) O. Muell
24.			*Synedra ulna* (Nitz.) Ehr.
25.	Euglenophyceae	Euglenaceae	*Euglena gracilis* Klebs

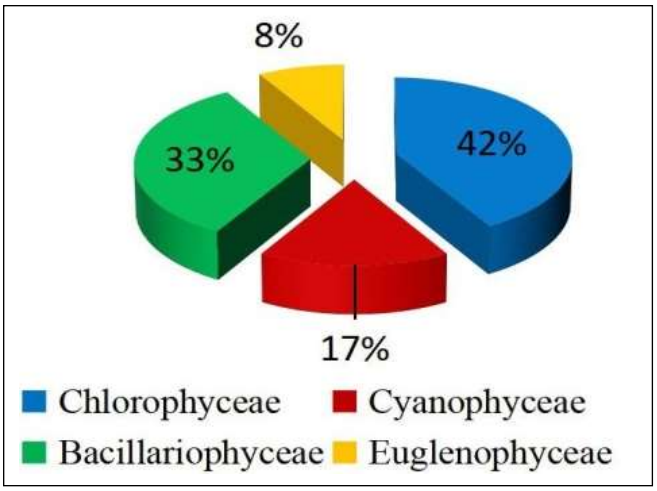

Figure 2 Family-wise percentage composition of phytoplankton

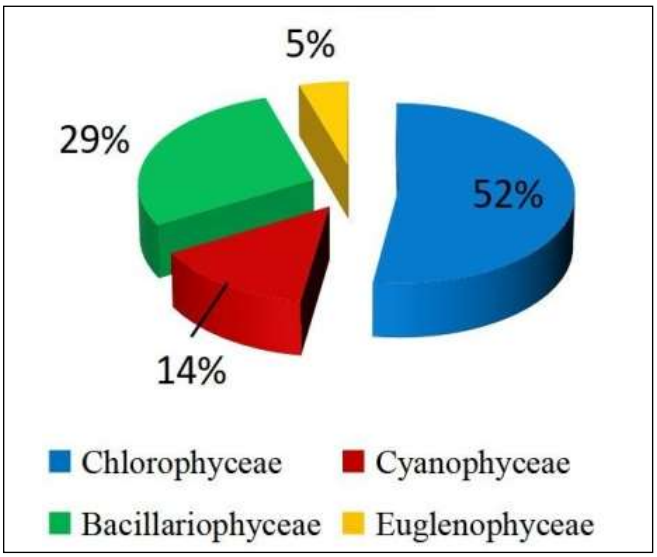

Figure 3: Genera-wise percentage composition of phytoplankton

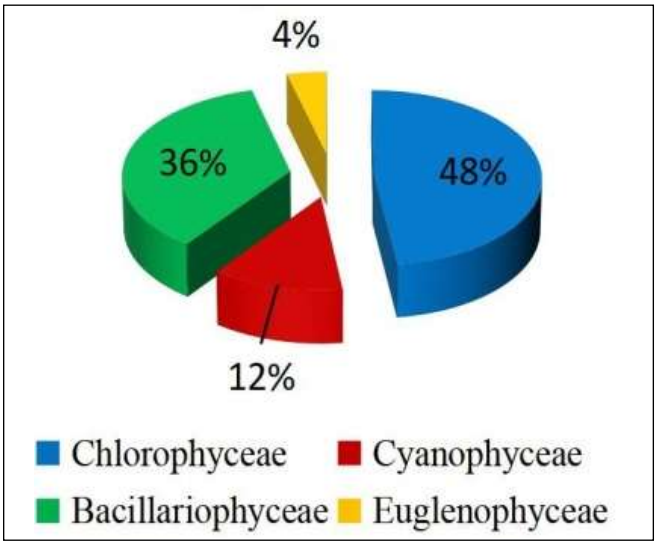

Figure 4: Species-wise percentage composition of phytoplankton

stations throughout the sampling period.The occurrence of phytoplankton communities in the Godavari River was examined at six landing stations (Table 2). The abundance of species was recorded higher at Dowleswaram (L_3) and Rajamahendravaram (L_2). The most prevalent population status was common followed by sporadic, abundant, very abundant and rare. Chlorophyceae taxa was found to be dominating with 11 genera in comparison to other plankton throughout the research period at all landing stations (Table 4). With 9 genera, the Bacillariophyceae was the second most common dominating group observed. During the hot weather period, the class Cyanophyceae was represented by three genera and three species. One genus was found in class Euglenophyceae. In general, planktonic algae were less abundant in the Godavari River.

The current investigation documented a comprehensive assemblage of 25 species, which were classified into 12 families and 21 genera across four distinct classes: Chlorophyceae, Cyanophyceae, Bacillariophyceae, and Euglenophyceae. The dominance of Chlorophyceae was observed throughout all six landing points over the duration of the experiment. A comprehensive enumeration of phytoplankton species in the Godavari River has yielded a total of 25 observed species. Among them, 12 species belong to the Chlorophyceae class, 9 species were classified under Bacillariophyceae, 3 species fall inside Cyanophyceae, and a single species was designated as Euglenophyceae. In a previous study conducted by Nalawade and Bagul (2020), a total of 35 phytoplankton taxa were observed in the Godavari River near Nashik City. In contrast, Sharma et al. (2015), a total of 27 phytoplankton taxa were documented from the Dogarwadaghat of river Narmada.In the current investigation, it was observed that Chlorophyceae emerged as the predominant group, encompassing a total of 13 genera and 12 species. The genera that were frequently observed include Scenedesmus, Chlorella, Selanastrum, and Spirogyra. Similar Chlorophyceae dominance was reported in the upper areas of Godavari River (Ghorade et al., 2014; Nalawade and Bagul, 2020; Barwant and Sanap, 2020) in Narmada River (Sharma et al., 2015) and in Cauvery River (Uthirasamy et al., 2021). Throughout the designated study period, a notable prevalence of *Scenedesmus bijugatus* was identified across the majority of the sample stations. Additionally, the abundance of Chlorella vulgaris, *Oocystis irregularis*, and *Spirogyra crassa* was documented in a significant number of the sampling locations.

During the study period, the class under consideration emerged as the second greatest dominant group. The assemblage consisted of a total of nine distinct species, which were classified under six different genera. The genera frequently documented within this class include *Navicula, Nitzschia, Fragilara*, *Gyrosigma, Synedra*, and *Rhopalodia*. It was note worthy to mention that Navicula abundance was observed at all of the sampling points. Ghorade et al. (2014) in the Godavari River, Barwant and Sanap (2020) in the

Table 2: Phytoplankton species identified during the study period from six sampling stations

Name of algae	L_1 Kunavaram	L_2 Rajamahendravaram	L_3 Dowleswaram	L_4 Kovvur	L_5 Thallapudi	L_6 Polavaram
Scenedesmus arcuatus	S	C	C	C	S	C
Scenedesmus bijugatus	S	VA	VA	VA	A	A
Crucigenia quadrata	R	C	C	S	R	S
Chlorella vulgaris	A	A	A	C	S	C
Oocystis irregularis	C	A	A	A	A	VA
Selenastrum minutum	R	R	C	S	S	S
Kirchneriella lunaris	C	C	S	S	S	C
Tetraedron pusillum	S	S	C	C	C	C
Tetrastrum heteracanthum	S	R	S	C	C	S
Spirogyra crassa	A	A	A	S	S	A
Cosmarium pseudobroomei	S	C	C	R	C	R
Closterium Diana var. *arcunatum*	C	S	C	R	C	S
Chroococus limneticus	S	C	S	S	S	S
Microcystis aeruginosa	C	A	A	C	S	A
Oscillatoria chalybea	C	C	C	A	C	C
Navicula pygmaea Kuetz	A	A	A	C	A	C
Navicula rhynchocephala	S	VA	VA	S	C	VA
Nitzschiatryblionella	R	A	A	R	R	C
Nitzschia filliformis	S	C	C	S	S	S
Gyrosigma kuetzingii	R	S	S	C	S	S
Fragilaria pinnata						
Var. subrotunda	C	A	A	S	C	C
Fragilaria intermedia	C	A	C	S	C	A
Rhopalodia gibberula	S	C	S	S	S	R
Synedra ulna	S	C	C	S	C	C
Euglena gracilis	C	VA	A	VA	A	C

Table 3: The number and percentage composition of families, genera and species under various classes

Sl. No.	Classes	Families		Genera		Species	
1.	Chlorophyceae	5	41.66	11	52.38	12	48.00
2.	Cyanophyceae	2	16.66	3	14.28	3	12.00
3.	Bacillariophyceae	4	33.33	6	28.57	9	36.00
4.	Euglenophyceae	1	8.33	1	4.76	1	4.00
	Total	12	100.00	21	100.00	25	100.00

Godavari River, and Uthirasamy et al. (2021) in the Cauvery River have also documented Bacillariophyceae as the second most prevalent category.

The Cyanophyceae class, sometimes known as Myxophyceae, was comprised of three genera and three species. The Godavari River exhibited a prevalence of Oscillatoria and Microcystis as the dominant species. The level of blue-green algal diversity seen in the Godavari River was found to be lower in comparison to the Narmada River (Sharma et al., 2015), the Cauvery River (Uthirasamy et al., 2021), and the Godavari River (Nalawade and Bagul, 2020). The class was exclusively comprised of a single species, Euglena gracilis. Euglenoids were observed with regularity at all sampling points. A study conducted by Sharma et al. (2015) documented the presence of a similar species near the Narmada river.

Table 4: Phytoplankton population status at various stations

Landingstations	Very abundant (%)	Abundant (%)	Common (%)	Sporadic (%)	Rare (%)
Kunavaram (L_1)	0 (0%)	3 (12%)	8 (32%)	10 (40%)	4 (16%)
Rajamahendravaram (L_2)	3 (12%)	8 (32%)	9 (36%)	3 (12%)	2 (8%)
Dowleswaram (L_3)	2 (8%)	8 (32%)	10 (40%)	5 (20%)	0(0%)
Kovvur (L_4)	2 (8%)	2 (8%)	7 (28%)	11 (44%)	3 (12%)
Tallapudi (L_5)	0 (0%)	4 (16)	9 (36%)	10 (40%)	2 (8%)
Polavaram (L_6)	2 (8%)	4 (16%)	10(40%)	7 (28%)	2 (8%)

Multiple euglenoids were documented in the Godavari River (Barwant and Sanap, 2020), and Cauvery River (Uthirasamy et al., 2021a). During the designated study period, the presence of the class Dinophyceae was not documented. However, Dixit and Sharma (2019) provided evidence of the existence of dinoflagellates in the Gomti River. The population state of phytoplankton exhibitedvariability across all six sampling points. The fluctuations in population size might be ascribed to factors such as nutrient availability (Borse et al., 2000), temperature (Philipose, 1960; Kumar and Dutta, 1991), and environmental variability (Hynes, 1970).

3.2. Zooplankton identified in Godavari River

During the present study, 26 zooplankton species belonging to 6 groups, 12 families and 21 genera were recorded in the six sampling stations of Godavari River (Table 5). The zooplankton include 8 species of rotifer, 6 species of cladocera, 5 species of crustacean, 4 species of copepod and 1 species of ostrocoda. Apart from that, embryonated eggs and fish larva were also recorded. In this investigation, the more dominant group of species (30.76%) recorded was under rotifera (Table 6). Monthly and seasonal fluctuations in zooplankton populations were studied and the data were shown as average values in different locations. The seasonal variation in zooplankton population density (no. l^{-1}.) at the six selected landing stations of Godavari River were recorded from February, 2022–July 2023. The highest zooplankton were recorded as 81.33±7.50 during hot weather period-2023 at Rajamahendravaram and the lowest was recorded as 42.00±4.25 in South-West Monsoon-2023 at Polavaram. The seasonal zooplankton dominance followed as:

Hot weather>Winter>North-East Monsoon>South-West Monsoon.

The average zooplankton density was found to be as highest at Rajamahendravaram followedby Dowleswaram, Kovvur, Kunavaram, Tallapudi and Polavaram (Table 7). The present investigation documented a total of 26 zooplankton species, which were classified into 12 families and 21 genera, within the Godavari River. The findings of the present investigation revealed that Rotifer species accounted for 30.76% of the total population in the Godavari River. Previous studies have also documented the prevalence of rotifer dominance, as indicated by multiple authors (Ankathi and Piska, 2009; Negi and Negi, 2010; Negi and Mamgain, 2013; Patil and Ghorade, 2013). The study conducted by Maria-Heleni et al. (2000) examined the variety of zooplankton in the Aliakmon River in Greece. The researchers found that the river exhibited a greater number of species, with a total of 79 species identified.

Dutta et al. (2004) conducted a comprehensive survey of freshwater zooplankton diversity in the Jammu region, documenting a total of 51 species. In their study, Mohan and Priyadarshinee (2022) documented the presence of 31 distinct species of zooplankton in Kumaraswamy Lake, located in the state of Tamil Nadu. In comparison to the findings of Negi and Mamgain (2013) and Patil and Ghorade (2013), which examined zooplankton populations in the Tons River in Dehradun and the Godavari River, Maharashtra respectively, it was observed that there were lower levels of zooplankton.

Negi and Mamgain (2013) documented the presence of Ciliophore and Porifera, which were not observed in the present investigation. The highest reported density of zooplankton during the hot weather season of 2023 in Rajamahendravaram was 81.33±7.50 no. l^{-1}, while the lowest density (42.00±4.25 no. l^{-1}) was observed in Polavaram during the South-West Monsoon of 2023. In their study, Jaybhay and Madlapure (2006) observed a range of 23 to 43 zooplankton per liter at various stations within Parola dam in Hingoli. Ningule and Gaike (2014) recorded that the total number of zooplanktons varied from 28 to 47 no. l^{-1} at Arni-Sangvi reservoir. Similar higher zooplankton density from Godavari River Water (Maharashtra) was earlier reported as 102 to 103 no. l^{-1} (Negi and Mamgain (2013)) and 103 no. l^{-1} (Patil and Ghorade, 2013). In the current study, the seasonal zooplankton dominance in the Godavari River was as follows:

Hot weather>Winter>North-East monsoon>South-West monsoon.

Singh (2013) observed the largest zooplankton abundance (168–220 no. l^{-1}) during the winter season, while the lowest abundance (114–155 no. l^{-1}) was recorded during the summer season in the Gomati River of Lucknow. Negi and Mamgain (2013) observed that the highest density occurred during the northeast monsoon season in October, while the lowest density was recorded during the southwest monsoon season in July in the Tons River of Utarakhand. This finding differed significantly from the results obtained in the present study.

Table 5: Zooplankton recorded during the present study

Sl. No.	Groups	Family	Species
1.	Copepoda	Diaptomidae	*Cyclops* sp.
2.			*Diaptomus pallidus* (Herrick, 1879)
3.		Cyclopidae	*Mesocyclops edax* (Sars, 1914)
4.			*Nauplius larva*
5.	Cladocera	Daphnidae	*Daphnia pulex* (Leydig,1860)
6.			*Cerodaphnia quadrangular*
7.			*Ceriodaphnia reticulata*
8.			*Moina micrura* (Kurz, 1874)
9.			*Moina brachiata* (Jurine, 1820)
10.		Chydoridae	*Alona affinis*
11.	Ostracoda	Cypridiidae	*Cypris* sp.
12.	Rotifera	Brachionidae	*Brachionus calyciflorus* (Pallas, 1766)
13.			*Brachionus diersicornis* (Daday, 1883)
14.			*Brachionus quadridentata* (Hermann, 1783)
15.			*Keratella cochlearis* (Gosse, 1851)
16.			*Keratella tropica* (Apstein, 1907)
17.		Lecanidae	*Lecane lunaris* (Ehrenberg, 1982)
18.		Synchaetidae	*Synchaeta* sp (Ehrenberg, 1832)
19.		Testudinellidae	*Filinia terminalis*
20.	Crustaceans	Decapoda	*Zoea larvae*
21.		Insecta	*Nymphs*
22.			*Damsel fly Nymph*
23.			*Dragon fly Nymph*
24.			*Mosqito larvae*
25.	Fishlarvae	Pisces	Embryonated eggs
26.			Fish larvae

Table 6: Percentage composition of various zooplankton taxa in Godavari River

Group	Family (%)		Genus (%)		Species (%)	
Copepoda	2	16.66	4	19.04	4	15.38
Cladocera	2	16.66	3	14.28	6	23.07
Ostracoda	1	8.33	1	4.76	1	3.84
Rotifera	4	33.33	6	28.57	8	30.76
Crustaceans	2	16.66	5	23.80	5	19.23
Fishlarvae	1	8.33	2	9.52	2	7.69
Total	12	100.00	21	100.00	26	100.00

A decrease in the abundance of zooplankton during the monsoon season was found, which could be attributed to higher levels of turbidity and increased water current velocity (Kobayashi et al., 1998). The current analysis suggested that the differences in zooplankton density among sample stations and seasons mightbe influenced by abiotic factors (Maria–Heleni et al., 2000), as well as nutrient availability (Negi and Mamgain, 2013; Khanna and Ishaq, 2013).

Table 7: Average seasonal variation in zooplankton density (nos. l^{-1}) at six landing stations of Godavari River

LandingStations	Winter period, 22	Hot weather period, 22	South-West Monsoon, 22	North-East Monsoon, 22	Winter period, 23	Hot Weather period, 23	South-West Monsoon, 23
Kunavaram	62.25±5.82	67.66±5.29	52.35±4.83	55.00±4.75	55.00±5.50	63.5±5.50	48.00±4.35
Rajamahendravaram	71.5±6.54	79.00±6.55	56.25±5.25	62.55±6.25	67.00±6.50	81.33±7.50	58.5±5.20
Dowleswaram	67.00±6.45	75.33±7.02	55.00±5.64	60.84±6.75	64.00±5.49	77.33±7.45	54.33±5.50
Kovvur	66.45±5.84	72.00±6.24	54.5±4.52	57.21±5.50	58.00±5.85	68.33±7.25	51.00±4.85
Tallapudi	54.22±5.25	67.35±5.42	53.25±4.50	59.5±5.25	54.55±5.25	64.25±6.5	47.82±4.92
Polavaram	56.66±5.63	66.00±5.88	48.42±4.35	55.00±4.85	53.00±5.50	59.25±4.50	42.00±4.25

4. Conclusion

The study on the Godavari River revealed 25 phytoplankton and 26 zooplankton species, with *Chlorophyceae* and *Rotifera* as dominant groups. Seasonal fluctuations showed maximum diversity in hot weather and minimum during the South-West Monsoon, highlighting the influence of hydrology and nutrients. Plankton proved to be reliable bioindicators of water quality and ecological health. Continuous monitoring is crucial for biodiversity conservation, sustainable fisheries, and effective river ecosystem management.

5. Further Research

While the present study captures monthly and seasonal variations, long-term monitoring across multiple years is essential to understand the influence of climate change and extreme weather events on plankton dynamics and river ecology.There is scope to evaluate the spatial variation in plankton communities in relation to point and non-point sources of pollution, such as agricultural runoff, industrial discharge, and urban sewage entering the river at various sites.

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