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Possible role of Artificial Intelligence (AI) in enhancing life expectancy by mitigating occurrences of Landslides in hilly areas of district-Uttarkashi of Uttarakhand

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Abstract

Artificial Intelligence (AI) is a technology which simulated the human intelligence processes with the help of computer system and a set of technologies like natural language processing, speech recognition and robotics for problem solving along with pertinent algorithm. It is evident that; mountains and hilly areas are highly prone to many natural disasters like landslides, avalanches, flood, forest fire and earthquakes. Considering the facts, life of people living in hilly habitat is always being full of challenges and because of the same reason migration rate is also very high in these regions. In view of this, application of Artificial Intelligence (AI) based technologies in hills is highly demanding. Therefore, the present article is an attempt to focuse on discussing possible role of AI in safety and betterment of life expectancy in hilly areas of district- Uttarkashi, Uttarakhand by mitigating the occurrences of landslides; one of the most common disasters. Proposed models based on GIS, soft computing and algorithms of Artificial Intelligence as neural networks for Landslide Susceptibility Management (LSM) and early warning system were discussed. Although, besides advanced intervention and new technologies, incidence of landslides and other natural calamities are alarmingin Uttarkashi and other hilly areas of Uttarakhand causing loss of human life and property. Further to understand, due to high cost, unavailability of AI tools and expertise, AI-based alarming system is not very common in these areas. Need of proper discussions and researches for creating awareness regarding all kinds of applications of AI is on top priority research and execution is warranted in current scenario.

Keywords: *Artificial Intelligence, Landslides, LMS, Geology, GIS, Uttarakhand*

Introduction

Human species is believed to be the superior most species in this world mainly due to its best problem-solving abilities, collectively termed as "Human intelligence". During the course of time as a result of the processing of much superior human intelligence, advanced technologies like computer science, information technology, robotics, etc. came in to the existence. These newer technologies are capable of storing huge amount of data and analyzing them in amazingly lightning speed. This has given rise to an *in vitro* form of intelligence, popularly termed as "Artificial Intelligence (AI)". In modern times, AI is being the template for shaping all kinds of basic needs to human beings. In addition to this, AI can be utilized for mitigating the negative outcomes of many natural and human-made disasters either by preventing them through technology or by making early predictions of their occurrences.

Artificial Intelligence (AI) and its algorithm:

Artificial Intelligence (AI) is generally considered the simulation of human intelligence processes with the help of computer system having robust datasets and a set of technologies for solving different kinds of problems. AI is generally utilized as expert systems, natural language processing, speech recognition and robotics. In simple terms, main objectives of AI are to replicate the human intellect in machines and analyze data like humans [www.techtarget.com].

AI is like machine learning; it requires a set of specialized computer hardware, huge amounts of training data, software and programming languages like Python, R, Java, C++ and Julia for training machine to analyze and correlate the data for establishing a pattern to make predictions about future functions [www.techtarget.com]. AI incorporates many basic cognitive skills of human intelligence like learning, reasoning, self-correction and creativity. Though, AI is an expensive technology which requires deep technical expertise and increases unemployment rates by substituting large number of human resources, it is important for making quick prominent changes by automatize various tasks done by humans (Ahmad et al, 2023). These include various kinds of services and quality control.

Hilly areas are generally characterized in two ways; firstly, these are famous for their extraordinary natural scenic beauties comprises of high mountains, valleys, diversity of flora and fauna, peaceful environment and pleasing climatic conditions; secondly, these are being notorious for many natural disasters like landslides, avalanches, flood, forest fire, earthquakes, etc. and human-made disasters like road accidents, insufficiency of basic

facilities like health, education, communication, transportation, etc. Life of people living in hilly habitat is always being full of challenges and because of the same reason migration rate is also very high in these regions. In view of this, application of advanced technologies like Artificial Intelligence (AI) in different areas of life in hilly habitat is highly demanding. Therefore, this article is focused on discussing possible role of AI in betterment of life expectancy in hilly areas of district-Uttarkashi, Uttarakhand by mitigating the occurrences of landslides, one of the most common disasters.

Landslides and mortality

Landslides, usually defined as "movement of mass of rock, earth or debris down a slope" (Chaudhary, 2001), are one of the major natural hazards that adversely affect both human and animal lives and account for enormous damage to properties every year especially during monsoon period (Dai et al 2002). Besides these, landslides also cause destruction to the transportation system and block communication. According to Geological Survey of India (GSI 2009), 0.49 million km2 or 15% of land area of the country is vulnerable to landslide hazard. Out of these 80% is spread over Himalayas, Nilgiris, Ranchi Plateau and Eastern and Western Ghats. According to the report of United Nations International strategy of disaster reduction (UN/ISDR) and Centre for Research on Epidemiology of Disasters CRED for the year 2006, landslide ranked 3rd in terms of number of deaths among the top ten natural disasters (Kanungo 2009).

Geology of Uttarkashi

Uttarkashi is the second largest district of State- Uttarakhand, it spreads out in the physiographic divisions of Rohilkhand plains, Nepal Himalayas, Ganga, Yamuna daob, Siwalik range, Kumaun Himalaya, Dhaoladhar range. Total area of Uttarkashi is 8016 Km^2, mostly drained by major river (s), Yamuna and Ganga. Annual average rainfall observed is 1750.50mm and mean temperature 16°C (GSI 2009).

Prospective role of AI in mitigating landslides and avalanches

Climate change adversely affects weather patterns and increases the risk of natural disasters like landslides. It was found out that occurrence of landslide depends upon a number of factors such as the shape of the terrain, its slope and drainage areas, the composition of soil and bedrock, and environmental conditions like climate, rainfall, hydrology and seismic activity ground motion resulting from earthquakes. Therefore, it is very difficult for human intelligence to analyze all these variables and provide a meaningful landslide susceptibility mapping (LSM; Marcin 2023). In traditional way, geologists have estimated landslide risk of an area by

incorporating abovementioned factors into physical and statistical models (Marcin 2023).

Many geologists also made efforts to classify various regions of Uttarkashi, Uttarakhand on the basis of risk of landslides from very high to very low on the basis of GIS based mapping (Ray and Pandey 2016). In recent times, artificial intelligence (AI) is emerging as a powerful tool with huge amount of information and capability of rapid analysis to help predict and prevent landslide hazards. AI can help to identify potential landslide hazards and provide early warning systems to help prevent them. Unlike human intelligence, AI programs do not take breaks, providing 24/7 services. For refining its predictions, AI also monitors other weather conditions, such as rainfall and temperature. AI models or automated monitoring systems not only help in predicting the occurrence of landslides but also identify landslide prone areas for mitigating the risk either by providing real-time alerts or by formation of barriers and plantation (Marcin 2023). Some of the AI-based landslide susceptibility studies have been conducted.

Kumar et. al. (2017) did their study in the regions of Uttarkashi, Uttarakhand in which landslides are very frequent. They utilized topographical data and integrated that with GIS and soft computing to create a database for making predictions related to landslide susceptibility (Kumar et. al. 2017). Lamsal and Kumar (2020) had designed AI-based Early warning systems (*EWSs*)by incorporating complex information for making predictions in the forms of alarms and warnings related to disaster events like landslides to minimize the damage (Lamsal and Kumar 2020).

Prasad et. al. (2021)evaluated and compared the results of landslide susceptibility mapping (LSM) in the mountainous regions of western India by using six AI models, including random forest (RF), deep boost (DB), stochastic gradient boosting (SGB), rotation forest (RoF), boosted regression tree (BRT), and logit boost (LB). They analyzed 14 landslide triggering factors, such as slope, topographical roughness index, road density, topographical wetness index, elevation, slope length, drainage density, stream power index, geomorphology, rainfall, soil, lithology, lineament density, and normalized difference vegetation index. They found that random forest (RF) model is more effective in LSM (Prasad et al. 2021).

Wang et. al. (2021) demonstrated the AI based study for Landslide susceptibility assessment in hilly areas of Hong Kong. According to them, LSM is the key to mitigate the loss occurs due to the landslide. They described that in three-dimensional real world, landslide is a 3D object not a two-dimensional polygon as seen in maps, an object-wise assessment of

landslide is more logical. They proposed a novel AI-dependent object-based landslide susceptibility assessment method by using 06 different algorithms of AI (Wang et. al. 2021).

Youssef et. al. (2023) had developed an advanced model for predicting landslides by using a type of AI called SNN (Superposable neural network) especially for eastern Himalayan regions. In this model, different layers of networks run simultaneously to analyze complex data to find out the exact responsible factor and timing of landslides (Youssef et. al. 2023).

Summary and conclusion

Considering the facts, in current scenario Artificial intelligence is a most effective tool in counteracting various kinds of adverse impacts of disasters including landslide susceptibility mapping. In future this application of AI will become more pronounced by the incorporation of advanced forms of AI that is "theory of mind" and "self-awareness"[1]. However, occurrence of landslides and other disasters are still very common in Uttarkashi and other hilly areas of Uttarakhand and account for large amount of loss of human life and property. It may be due to lesser availability of abovementioned AI-powered technologies in real world. Possible reasons include high cost, unavailability of AI tools, experts and lack proper knowledge regarding advantages of AI. Therefore, proper discussions and researches are needed for creating awareness regarding all kinds of applications of AI especially in hilly areas. With this approach, we will be able to design AI-based domestic tools with technologies of robotics and LASER not only to predict occurrence of landslides and prevention of hazard but also for laser-guided destruction of falling rocks during landslides.

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Longitudinal distribution of benthic diatom in a central highlands river, the Belan

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Abstract

The river Belan is a north flowing Vindhya tributary of the Tons river of Central highlands ecoregion. Fifteen samples were collected once from December 2021 to August 2022 by scraping of cobble stone upper surface using razor at 5 stations. Total 119 diatom taxa were recorded. The longitudinal pattern of distribution of diatoms, or the arrangement of diatom species along a longitudinal gradient (from the source to the mouth) in rivers or streams, is influenced by several environmental factors. Near the source of a river, nutrient concentrations might be lower, favouring certain diatom taxa. The trends of distributions of taxa varies from Cymbella (8%) <*Nitzschia* (6%)<*Navicula* (5%) <*Achnanthidium* (4%) at stations. Downstream, where nutrient levels may increase due to inputs from tributaries or anthropogenic activities, different species adapted to higher nutrient conditions may dominate. The substrate type in a river, such as the presence of rocks or sediments, can influence the distribution of benthic diatoms.

Keyword: *Belan, Diatom, Anthropogenic activities, Substrate*

Introduction

Diatoms are a type of photosynthetic algae that belong to the phylum Bacillariophyta. These micro-organisms are found in a wide range of aquatic environments, including oceans, lakes, rivers, and damp soils (Collen et al, 2009a). Diatoms are unicellular and have a unique feature that sets them apart from other algae: their cell walls are made of silica (silicon dioxide), forming intricate and often beautiful glass-like structures (Smol & Stoermer, 2010). They play a crucial role in the global carbon cycle, contributing to oxygen production and serving as a primary food source for various aquatic organisms (Ruhela et al, 2017). Diatoms are fundamental to aquatic ecosystems and are a key component of the phytoplankton community (Pandey, 2016). Different species of diatoms are found in different geographical regions and environmental conditions

(Abell et al. 2010). Their distribution can be influenced by factors such as temperature, salinity, and nutrient availability (Tiwari et al, 2023). Overall, diatoms are important organisms in aquatic ecosystems with ecological, environmental, and industrial significance (Darwall et al. 2011). Their unique characteristics, including the silica cell wall, make them valuable subjects of study in various scientific disciplines (Hughes et al, 2012).

Diatoms studies has been done by (Hustedt 1985, Krammer and Lange-Bertalot 1986; Hammer et al., 2001;Lange-Bertalot 2001;Krammer 2002; Werum and Lange Bertalot 2004; Metzeltin et al., 2005;Soininen and Weckström, 2009; Nautiyal and Mishra 2013; Nautiyal et al 2015; Birk et al., 2020;Tiwari et al., 2023,). Longitudinal changes in the diatom communities have been studies all over the world, but some regions of Central India are untouched. Hence, a study was designed to determine longitudinal variation in the diatom flora. Present study was based on the river Belan arising from the Kaimur hill in the Central India.

MATERIALS AND METHODS

The River Belan originates from the Vindhyan ranges in the district of Sonbhadra, Uttar Pradesh, India. It has a length of approximately 156 km and flows in a west-north direction. The river ultimately drains into the River Tons near Chakghat. The River Tons is a tributary of the Yamuna River, and the Yamuna is one of the major rivers in northern India, flowing through several states before joining the Ganges River.

Table 1. Geographical co-ordinates Sampling stations on the river Belan. Acronyms: Rocks (R), Boulder (B), Gravel (G), Pebbles (P), Cobbles (C), Sand (S), Forest (F), Agriculture (Ag), Village (V)

Stations	**S1**	**S2**	**S3**	**S4**	**S5**
Latitude ^{O}N	24°41’45”	24°46’21”	24°54’27”	24°56’32”	25°00’38”
Longitude ^{O}E	82°39’42”	82°33’	82°02’14”	82°56’40”	81°47’11”
Altitude (m)	249	200	119	118	113
Substrate	R- G-P-C	R-B-C-S	S	C-S	C-S
Land use	F	F	F + Ag	Ag	Ag +V
Distance from source	35km	25km	75km	20km	25km

Sampling

The diatom samples were collected at five different stations (S1 to S5) from cobble stony substratum (3 x 3 cm² area) by using razor during the winter, summer and monsoon seasons from December 2021 to September 2022. The collected samples were preserved in 4% formaldehyde solution, then treated with HCl and cleaned by boiling in H_2O_2. Permanent mount were prepared with NAPHRAX and examined

under microscope. The identification made at genus and species level with help of standard key (Sarode& Kamat 1984; Taylor et al. 2007, Karthick et al. 2013).

RESULT AND DISCUSSION

The diatom flora was dominated by Bacillariophyceae followed by Fragilariophyceae and Coscinodiscophyceae. The diatom community was mainly dominated by biraphids (*Navicula,Nitzschia, Achnanthidium, Gomphonema, Cymbella* and *Amphora*), followed by araphids (*Fragilaria*) and centric (*Cyclotella* and *Melosira*). Biraphids also found to be abundant at Himalayan Rivers and Kumaun region (Juttner et al., 1996;Nautiyal and Nautiyal, 1999b; Nautiyal et al.,2004a).The diatom flora of the Belan River was represented by major families namely Achnanthaceae, Fragilariaceae, Naviculaceae, Bacillariaceae.

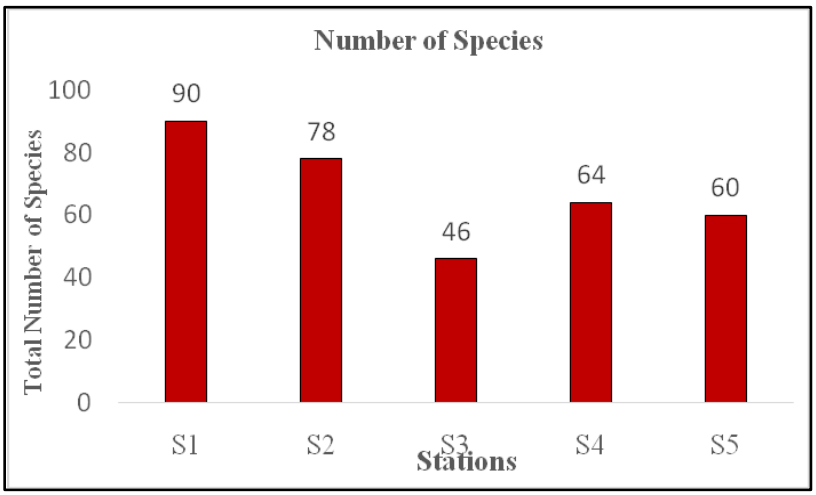

Figure 2. Total diatom species at different stations in the Belan river

Total 28 genera were observed in the study. The species richness varied 90, 78, 46, 64 and 60 at S1, S2, S3, S4 and S5, respectively. (Figure 2). Twenty one genera were common from S1 to S5.The trends of distributions of taxa varies from *Cymbella* (8%)<*Nitzschia* (6%)<*Navicula*(5%)<*Achnanthidium* (4%)at stations. Few (3) genera were restricted to some stations at S1 (*Ecyonema minutum, Ecyonema neogracile, Nitzschia frustulum*), few (No.7) taxa at S4 and S5 (*Denticula elegans, Rhopalodia gibberula, Nitzschia obtuse, Gyrosigma scalproides, Gomphonema parvulum, Gomphonema laticollum, Eunotia bilunaris*). Families like Melosiriaceae, Cymbellaceae and Naviculaceae exhibit no definite pattern of longitudinal variation. The numbers of species in the Naviculaceae were similar from S1 to S5 except S3.

Longitudinal variations occurred in the species-rich genera *Cymbella, Navicula, Nitzschia, Achnanthidium* and *Fragilaria* at S1 and S2 while *Navicula, Nitzschia, Cymbella* and *Achnanthidium* at S3 and S4 and *Navicula, Cymbella, Nitzschia and Achnanthidium*. There was a decrease of species from S1 to S5 (Figure 3). As a consequence of decrease in the number of genera and species, the richness with respect to taxa number was found to decrease from source to mouth (Sundqvist, 2013; Bottin et al, 2014; Dong et al, 2016).

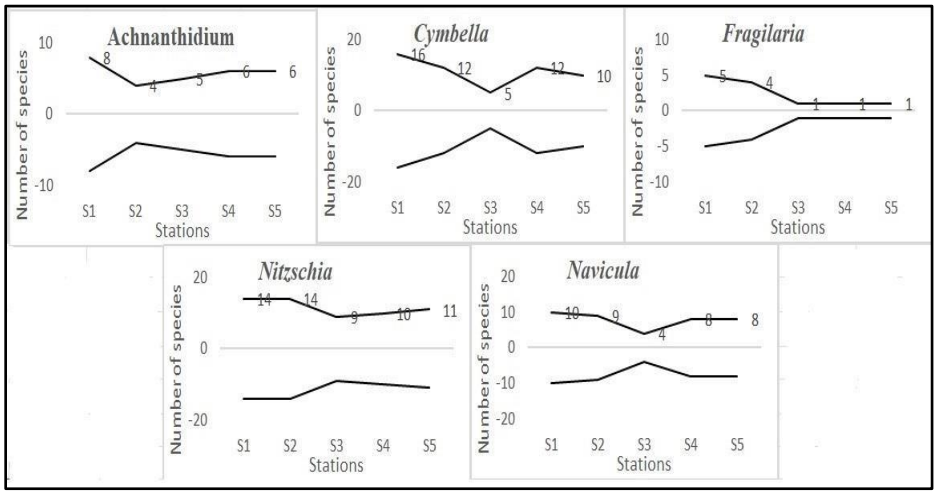

Figure 3 Longitudinal variation of abundant diatom (>5) genera along the river length

Longitudinal gradients in the physical characteristics, especially in altitude and conductivity, greatly influence the richness and substrate heterogeneity attributed to different types of substrate present at stations and density also decreased from S1 to S5 except S5 (Soininen & Weckström, 2009; Nautiyal & Verma, 2009). The upper stretch sites (S1 &S2) come under the forest region was more diverse probably due to the prevailing pristine condition and a lesser degree or no anthropogenic stressors.

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Food and feeding habit of commercially important catfish, *Clupisoma garua* (Hamilton, 1822) from the middle stretch of subtropical the Ganga river, India

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Abstract

Study on food and feeding biology of commercially important catfish, *Clupisoma garua* were performed between the periods from July 2014 to June 2016 from the middle stretch of the Ganga river at Allahabad (now Prayagraj), Uttar Pradesh, India. The fish was dissected to remove the gut from it and the gut was then preserved in 5% formalin. The size of *C. garua* fishes varied from 120 to 446 mm. The gut analysis indicated 81.45% animal matter from total food items in pooled fishes, 78.31% in summer season, 83.79% in winter season and 83.46% in monsoon season of fishes. The gut contents of *C. garua* indicated that the fishes are highly carnivorous. The result showed that Coleoptera constituted of 18.36%, 18.41%, 16.40% and 14.88% share in the gut content of *C. garua* in pooled, monsoon, winter and summer seasons of fishes, respectively. Diptera was the second most choicely food items by *C. garua* which was constituted maximum (17.18%) in summer season and minimum (12.65%) in monsoon season of fishes. The plant matters including diatoms, green algae, blue-green algae and desmids were highest reported 5.72%, 2.58%, 2.15% and 0.21%, respectively in winter season. Present study furnishes baseline information on the food and feeding tendency of *C. garua* which could be useful in formulation of the management and conservation strategies of this species in the Ganga basin.

Keywords: *Clupisoma garua*, Ganga river, food items, Coleoptera, Diptera, commercially important catfish

INTRODUCTION:

Clupisoma garua belonging in Siluriformes order is an important component of riverine and brackish water fisheries (Akter et al. 2019, Bhakta and Sonia 2020). It is preferred by consumers due to availability, deliciousness and nutritive quality (Pathak et al. 2015, Tripathi et al.

2017a, Gopesh et al. 2021). This riverine catfish is available in coastal rivers of neighboring countries (Nahar et al. 2017) and as a dominated species by number (17.62%) from the Ganga river (Dwivedi et al. 2016a, Mayank and Dwivedi 2017). It is also formed sizeable proportion (6.94%) from the Yamuna river (Dwivedi et al. 2016b). A surface feeder this species is uniformly found in the freshwater of India, Nepal, Pakistan, Bangladesh, Myanmar and Thailand (Bhuiyan 1964, Talwar and Jhigran 1991, Dwivedi 2009, 2013, Tripathi et al. 2017b). Freshwater fishes are important and valued property for youth and women employment, income, human food, sport and ornament (Pathak et al. 2014, Tripathi et al. 2015, Dwivedi et al. 2017, 2019, Mayank et al. 2021, Nautiyal and Dwivedi 2019, Kumar et al. 2023). Fishery structure of the Ganga River and its tributaries are in central India make majority of contributions to the nutrition needs and livelihoods of millions of people (Mayank and Dwivedi 2015, 2016, Mayank et al. 2017, Mishra and Dwivedi 2022, Mishra et al. 2023) and other fresh water bodies (Pathak et al. 2015, Pal et al. 2023).

Fishes have become adapted to a wide variety of food items in the feeding (Bowen 1983, Melo et al. 2004, Alam et al. 2020). The success on good scientific planning and management of fish species basically depends on the knowledge of their biological aspects, in which food and feeding habits include a valuable portion (Sarkar and Deepak 2009, Tripathi et al. 2013). Fishes are well designed, especially well for food gathering (Bertrand et al. 2011, Dwivedi et al. 2018). Feeding in some species may require extended periods of time. The amount of food ingested per day and the times of day that feeding is performed depends on many factor (Dorner et al. 2003, Alam et al. 2014). Active predators with their high metabolic rates require more food energy than do sluggish fishes. Daily and seasonal temperature fluctuations affect food intake in most fishes (Brandner et al. 2013, Tiwari et al. 2016). Dietary analysis is broadly used in food web ecology and in designing trophic models of fishes for understanding relationships in the aquatic communities in the composite ecosystems (Alam et al. 2014, Kumar et al. 2022).

The total well being, maximum sizes attained by fishes depend on food supply (Le Cren 1965, Dwivedi and Mayank 2013). An important biological parameter, the fecundity depends upon the supply of food (Nikolsky 1969). The size of the stomach in fishes is closely related to the feeding habit and particularly, to the size of prey. In fishes which swallow large prey or else consume large amounts of food at the same time, the stomach is usually large. The length of digestive tract is also closely related to the type of food. Some species feed mainly in night and are active in day. Peaks of feeding actively occur in morning and evening. Other fishes that depend more on chemical sense can feed effectively in

the absence of light or at night (Deus and Petrere-Junior 2003, Behrens and Lafferty 2007, Schulze et al. 2012). They are observed to be most active in early morning and late evening at dawn to dusk.

The nature of food composition of fish will also throw light on the possible habitats it frequents (Parker et al. 2009, Parnell et al. 2010, Dwivedi et al. 2018). The deviation in the seasonal and diurnal abundance of the favorite food organisms of different fish species in any region may influence the horizontal and vertical movements of the fish stocks (Horpilla et al. 2000, Gonza´lez-Bergonzoni et al. 2016). Hence the exact knowledge of the relationship between the fishes and food organism is essential for the production, conservation and exploitation of the fish stocks from the lotic ecosystem (Rooney et al. 2006, Huss et al. 2013, Tripathi et al. 2013). The food and feeding habit of different fishes vary from season to season and year to year even within a day (Pillay 1953, Royce 1972, Arim et al. 2010) and stock status also impact on feeding nature (Imran et al. 2015, Mayank et al. 2018). The objective of the present study is to give recent data regarding food and feeding habits of *Clupisoma garua* from the middle stretch of the Ganga river at Prayagraj, Uttar Pradesh, India..

MATERIAL AND METHODS

The middle stretch of the Ganga river at Allahabad (now Prayagraj), Uttar Pradesh was selected for the present study. It is a perennial river with high discharge during active monsoon but comparatively very low during summer. Studies were undertaken during the period from July 2014 to June 2016. The fish was dissected to remove the gut from it and the gut was then preserved in 5% formalin. Prior to preservation of the gut, its weight were recorded. At the time of food analysis, the gut was cut open, its food contents was weighed and emptied in Petri dish, and diluted with water for microscopic examination. The food was examined under the binocular microscope (OLYMPUS-CX31 RTSF) following Pillay (1952). Macro organisms were identified individually and counted all organisms present in the gut contents. For examination of micro food items, a drop of homogenized food material was put on a slide and occurrence of various food items was recorded. The procedure was repeated with each sample. Thus, the number of individuals of each food item in the gut has been counted. Different food items were identified by microscopic examination. Qualitative analysis of various food items was done up to order/class and generic level and for the purpose of identification of various food items Needham and Needham (1962), Ward and Whipple (1918) and APHA (1998) were followed.

RESULTS AND DISCUSSION

It is well known that the feeding habit changes with season and different life stages of the fishes especially in case of wild stock. The seasonal variation was also reported in *C. garua* from the Ganga river at Allahabad (now Prayagraj), Uttar Pradesh, India. In the analysis of gut content it was found that the animal matter shared 81.45% of total food content in pooled fishes, 78.31% in summer fishes, 83.79% in winter fishes and 83.46% in monsoon fishes. The gut content of *C. garua* is indicating that the fish is highly carnivorous. The result showed that Coleoptera constituted of 18.36%, 18.41%, 16.40% and 14.88% in the gut content of *C. garua* in pooled, monsoon, winter and summer season fishes, respectively (Table 1). It is most preferred food items. Diptera was the second most choicely food items by *C. garua* which was constituted maximum (17.18%) in summer season and minimum (12.65%) in monsoon season. The highest frequency of Tricoptera was observed to be 3.12% in winter season fishes and lowest in summer season fishes 1.92%. Odonata observed maximum (8.11%) in monsoon season and minimum (5.26%) in summer season which is third most preferable food items by *C. garua*.

The plant matters, includes Diatoms, Green algae, Blue-green algae and Desmids were highest reported 5.72%, 2.58%, 2.15% and 0.21%, respectively in winter season (Table 1). Sand and unidentified matters were dominant in monsoon season. The frogs and rats were also reported in the gut content of *C. garua* from the Ganga river at Allahabad. Small size of fishes were reported in the gut content of *C. garua* with 0.59%, 0.77%, 0.08% and 0.60% in pooled, monsoon season, winter season and summer season, respectively.

Present study was undertaken on *C. garua* from Ganga river at Allahabad. Study indicated clearly that the *C. garua* is a carnivorous fish species in feeding habit. The analysis of stomach contents has been an effective tool to infer about feeding strategies and habits of fish species. *C. garua* is omnivorous in smaller size groups, but with the increase of size it become insectivorous and piscivorous (Tandon *et al.* 1977). Khan (1934) described *C. garua* as carnivorous and reported that it feeds on insects and insect larvae, crustaceans and small fishes. The presence of clotted blood in the gut has also been mentioned. Hora (1937) marked the *C. garua* as a bottom feeder preying on crabs, shrimps, fish, insects etc., small amount of vegetable matter has also found in the stomach.

Table 1 Qualitative and quantitative variations in food and feeding habit of *Clupisom garua* from the Ganga river, India

Food items	Pooled	Monsoon	Winter	Summer
Trichoptera	2.22	1.95	3.12	1.92
Orthoptera	2.18	5.24	1.12	1.66
Odoneta	6.40	8.11	5.83	5.26
Ephemeroptera	3.83	3.13	4.99	3.70
Hemiptera	2.64	4.84	5.37	4.64
Coleoptera	18.36	18.41	16.40	14.88
Plecoptera	3.76	3.49	5.15	3.20
Diptera	15.72	12.65	16.84	17.18
Decapoda	0.41	0.75	0.04	0.33
Malacostraca	1.29	1.39	1.66	0.99
Cladocera	3.24	1.78	4.24	2.77
Copepods	3.89	3.21	5.74	3.42
Oligochaeta	1.06	1.64	0.91	1.06
Megaloptera	1.12	1.45	1.29	0.72
Blattodea	0.35	0.59	0.08	0.31
Mollusca	0.74	0.77	0.81	0.55
Protozoan	1.60	1.80	2.16	1.75
Diatoms	4.66	3.94	5.72	4.70
Blue-green algae	1.48	1.06	2.15	1.49
Green algae	1.81	1.50	2.58	1.61
Desmide	0.09	0.03	0.21	0.07
Rotifers	3.46	2.50	3.67	2.79
Nematode	2.50	2.18	2.95	2.51
Hymenoptera (Ants)	1.71	3.24	0.33	1.18
Mantodea	0.30	0.45	0.42	0.12
Araneae	0.29	0.31	0.17	0.34
Frogs	0.13	0.36	00	00
Rats	0.08	0.16	0.42	0.02
Fish & Fingerlings	0.59	0.77	0.08	0.60
Fish scales & parts	1.65	1.45	00	2.77
Coconut piece (Plant part)	0.19	0.14	0.17	0.24
Grain (wheat)	0.57	0.64	0.42	0.60
Insect body parts	1.79	0.84	00	3.64
Debris	3.76	3.46	2.45	4.77
Sand	0.76	1.09	0.58	0.58
Stones	0.03	00	00	0.07
Bone	0.38	0.75	0.08	0.24
Unidentified	4.81	3.91	1.83	7.30

According to Karamchandani and Motwani (1956) *C. garua* has no selective feeding habit but subsist on anything and everything available in

the habitat. However, it feeds mostly on insects of both aquatic and terrestrial (40.8%), of which later (20.7%) represented Plecoptera (12.2%), Coleoptera (5.2%), Orthoptera (cockroaches, locusts, grasshoppers and mentis-3%), Hymenoptera (ants, bees, wasps-0.1%) and Isoptera (0.2%). The aquatic insects (6.6%), which constituted mostly larvae and nymphs were of the forms diptera (2.4%), coleopteran (1.6%), Ephemeroptera (1.2%), odonata (0.9%), hemiptera (0.4%) and trichoptera (0.1%). The rest 13.5% of the total feed digested was insect matter. The other constituents of the gut contents included fish (3.1%), animal flesh (8.3%), molluscs (1.1%), crustacea (1.1%), algae and fragments of higher aquatic plants (as incidental food -0.7%), debris (mud, sand, stones, pebbles, charcoal pieces- 21.1%) and mucus (23.5%). The high content of mucus might be due to the fish subsisting mainly on insects which are known to stimulate secretion of mucus in the stomach. Active feeding was found during April to June and September to December.

The intensity of feeding of adult *C. garua* like other tropical fishes was affected by the maturation of their gonads. Seasonal fluctuation of the feeding intensity and dietary composition in fishes are influenced not only by maturation of gonads (Shobana and Nair 1980) but also by non-availability of food items in the habitat where the fish dwells (Bhatnagar and Karamchandani 1970). Khan (1972) and Chatterji (1974) also recorded that the fluctuation in feeding intensity in the fishes took place due to maturation of the gonads. Agarwal and Tyagi (1969) regarded *C. garua* as an omnivorous fish. Food contents observed included small fishes, crustacea, and occasionally pieces of plants. Tandon and Coworkers (1977) described *C. garua* as a bottom and marginal feeder. It takes considerable quantities of food of both plant and animal origin.

It may be concluded that the *C. garua* is a carnivorous fish species in feeding habit from the Ganga River at Prayagraj, Uttar Pradesh, India. The result showed that Coleoptera constituted of 18.36%, 18.41%, 16.40% and 14.88% in the gut content of *C. garua* in pooled, monsoon, winter and summer season fishes, respectively. It is most preferred food items. Diptera was the second most choicely food items of *C. garua.*

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Stock assessment of *Gudusia chapra* a non-commercial fish in reverine habitat and their nutro-potential utilization for product development

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Abstract

Population parameters such as growth, mortality, and exploitation rate of *Gudusia chapra* based on the length frequency data of the scoop net (mesh size 0.5-2 cm) catches from middle stretch of the river Ganga at Allahabad were estimated. The length-weight relationship for pooled data was Log W= - 12.913 + 3.0822 log L. The asymptotic length (L∞) and growth coefficient (K) were estimated to be 158 mm, and 0.448year^{-1}, respectively. The total, fishing and natural mortality coefficients were estimated as 3.07, 1.85 and 1.22 respectively while the 'E' was 0.603year $^{-1}$. The recruitment was continuous with one peak per year. The L_c50 was obtained at 69 mm. As per expert and organoleptic testing this fish is suitable for fish product for animal. This fish is also a part of poor people need. The product may be suitable for fish meal, poultry, dog and cat and provide approx. 770.51 Kcal. of energy per 199 gramme of weight.

***Keywords*:** Stock assessment. *G.chapra.* River Ganges. Middle stretch, Virtual population analysis, Fish products

Introduction

The *Gudusia chapra* (Hamilton-Buchanan, 1822), is a pelagic freshwater clupeid fish widely distributed in lotic and lentic waters of Asian countries, particularly in India, Bangladesh Nepal and Pakistan. In India, it is mainly dominated in riverine systems like Ganges, Brahmaputra, and Mahanadi. It also occurs in static water bodies like lakes, ponds, ditches and inundated fields (Ahmad et al, 2007; Debjit and Kaviraj, 2010). It provides major opportunity of fishery of inland fish catch along with Indian major carp (IMCs) and miscellaneous fishes; and designated as an important food fish for middle and lower income class including fishermen community (Vass et al, 2010).

Although several studies have been conducted on the biology of *G. chapra*

with particular reference to ecology (Rahman, 1989), food and feeding habits (Afroz, 2000; Rahman et al, 2008), age and growth (Afroz, 2000), but literature is not available on stock assessment and population dynamics of *G. chapra* in inland water in general and middle stretch of the river Ganga in particular, since riverine health of this stretch has been reported very conducive for development and growth of the resident fishes including *G. chapra* in and around Allahabad, U. P. (Rizvi et al, 2015, 2011; Masud, 2013; Masud and Singh, 2011; CIFRI, 2011, 2007; Vass et al, 2010; Gupta and Tyagi, 1992) . Furthermore, these reports also revealed that there was a continuous decline of inland capture of fishes both in terms of quality and variety from major reverine systems of India including Gangetic river system, and especially in middle stretch of the river around Allahabad centre. Surprisingly, landing of IMCs declined sharply from 1961 to 2007and recent years may be included at this centre, but miscellaneous species are still maintaining their constant contribution (around 48%) in the fishing market of this region (Rizvi et al, 2015, 2011; Masud, 2013, CIFRI, 2011).

Recent socio-economic studies have identified *G. chapra* as an important food resource and an important source of micronutrients essentially required to prevent hidden hunger among the poor communities (T h i l s t e d, 2003). Hence, there is an urgent need to manage and regulate the small-scale inland fishery of *G. chapra*, for sustainable utilization. However, in recent years population of this fish has alarmingly declined in the rivers and reservoirs (CIFRI, 2011) and its production has been restricted to lakes, ponds ditches, inundated fields and other closed water impoundments (Masud, 2013; Ministry of Environment and Forest, 2009). Therefore, it is essential to assess the population dynamics (stock assessment) of *G. chapra* in the Allahabad water for its sustainable exploitation and management; and to utilize this resource for development of nutritionally rich fish bye – products for human as well as animal consumption.

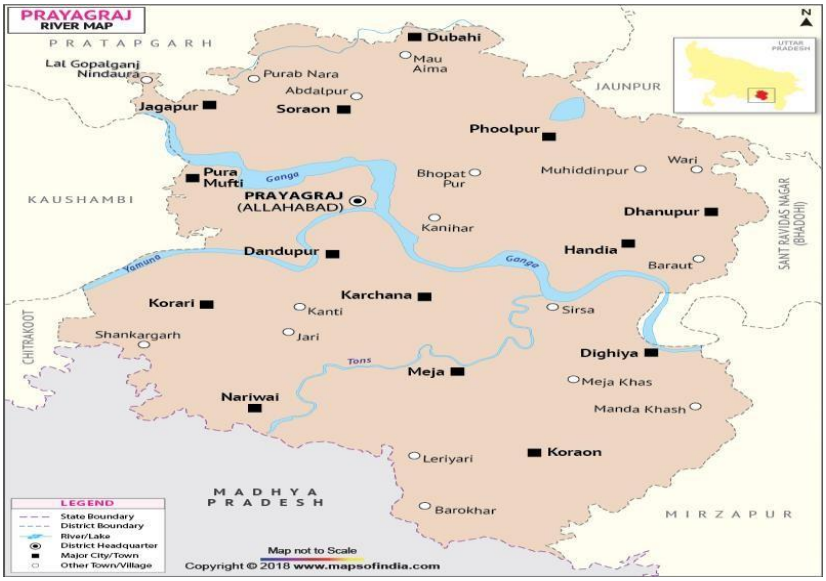
Animal products especially feed product of fish is to provide to the fish, nutritional requirements for good health, optimum growth, optimum yield and minimum waste within reasonable cost so as to optimize profits (Schmittou et al., 1998).

Material and Methods

Study area

Prayagraj is situated at the confluence of rivers Ganges and Yamuna. The study area comprises middle stretch of the Ganga and lower stretch of the Yamuna rivers at Allahabad (Ministry of Environment and Forest. 2009), has seven major fish landing centres (Map-1). The small

fish like *G. chapra* are mainly fished by locally made Farhara jal (1.0-1.5cm mesh size) and Bisari jal (0.5- 2.0 cm mesh size), various types of gill nets, during monsoon and off season respectively at Allahabad waters (CIFRI, 2011).



Map-1. Map of Allahabad showing confluence of two rivers namely Ganga and Yamuna

Data collection: Randomly length frequency data of *G. chapra* was collected twice a week at landing sites of the four main fish markets; Sadiapur, Gaughat, Rasoolabad and Daraganj of Allahabad from January, 2010 to December, 2011. A total of 3427 specimens were collected during the two-year period and the length of the collected fish ranged from 46-150 mm.

Estimation of parameters of population dynamics

The total length of the individual fish was measured (in mm) from the tip of the snout to the end of the distant point of caudal fin. The weight (in gms) of the fish was recorded on the electronic mono-pan balance with 0.1 (g) accuracy in the laboratory. The length frequency was distributed in 10 mm groups and raised to observe the day's catch, monthly catch, and finally annual, catch. FiSAT software (Gayanilo et al, 1996) was used for analysis of various parameters related to population dynamics such as growth, mortality, recruitment pattern, probability of capture, length structured virtual population analysis (VPA) or Cohort analysis, relative yield per recruit as well as biomass per recruit to obtain yield isopleth diagram.

Growth parameters such as $L\infty$ and K were obtained by adopting the

methods of Bhattacharya (1967) and Gulland and Holt (1959). The total mortality coefficient (Z) was estimated by length converted catch curve method by Pauly (1984). The Natural mortality coefficient (M) was obtained by the empirical formula as suggested by Pauly (1980). Mean annual temperature was taken as 26 °C (www: en.wikipedia). Fishing mortality (F) was estimated by subtracting M from Z. Exploitation rate (U) was expressed by the formula: $U= F/Z (1-e^{-Z})$ and Exploitation ratio (E) F/Z by Beverton and Holt (1957).

The probability of capture was determined by backward extrapolating of length converted catch curve. With the help of different exploitation ratio (E) on the X axis and different size at the first capture (by using Lc / L∞ ratio) on Y-axis, values of Y/R were plotted to generate the isopleth diagram. The relative yield per recruit (Y/R) and biomass per recruit (B/R) was estimated by 'knife edge selection' method by Sparre and Venema (1998). The total stock and Maximum Sustainable Yield (MSY) was obtained by the formula: MSY= 0.5×Z×Bv.

The length-weight relationship was determined by the least square method (Zar, 1984) by using the formula:

$$W = a L^b \text{ or its logarithmic form } \text{Log } W = a + b \log L.$$

Commercialization of selected fish

Estimation of nutrition value:

The nutrition value of *Gudusia chapra* has been estimated using standard method with the help of scientists at Central Institute of Fisheries Education, Mumbai. Moisture, total nitrogen was determined by the AOAC (1995) method, Total fat was determined by extracting the moisture free sample with petroleum ether (40-60 ^{0}C) for about five hours using Soxlet Extractor (Schakel et al, 1997).

Organoleptic test:

Organoleptic characteristics of the fish is assessed as per procedure described by Paryam and Pilgrim (1977) as organoleptic evaluation is necessary before developing food products. The organoleptic parameters would be colour, texture, odour and taste.

Product development: After enhancement of protein value of the fish-products by amalgamating phyto- protein, making a Value added fish products for human as well as animal consumption.

For preparation of pelleted fish feed, the equipments, like Sun dryer, Extrude and Packaging machine were used.

Estimation of dosage of fish feed

The amount of feed required per ration can be estimated

= average fish size (weight) x feed rate (%) x total number of fish in the pond.

Results

Fishery

Fish catch of *G. chapra* was found throughout the year. The maximum catch was recorded in the month of July, approximately 400 tonnes and the minimum in the month of December. Fig.- 1

Length – Weight relationship

The length-weight relationship and correlation coefficient (r) obtained for *G. chapra* was parabolic equation as given below:

G. chapra: Log W= - 12.913 + 3.0822 log L r=-0.8348..... Fig. 2

Table 1: Development of fish product for poultry/cat/ dog and fish feed for culture fish with fresh meat of *G. chapra.(Note- Values in table are approximate, as they have been taken from several nutrition sources and personal communications with nutrition experts.)*

Nutrients	Mustard oil	Coconut Powder	Rice bran	Wheat Flour	Corn flour	Pea Flour	Fish
Principal							
Energy (Kcal)	10.16	13.37	74.6	64.65	72.98	16.75	518
Carbohydrates (g)	0.562	0.474	11.72	19.34	15.24	3.125	0
Protein (g)	0.522	0.122	3.16	4.65	1.859	1.075	56
Fat (g)	0.725	1.316	4.92	1.277	0.754	0.05	18
Dietary Fiber(g)	0.244	0.282	4.96	12.82	1.912	1.1	
Vitamins							
Folates (µg)	3.24	0.2	14.8	23.7	46.66	12.62	
Niacin (mg)	0.095	0.02	8.02	4.073	1.964	0.4	
Pantothenic acid (mg)	0.016	0.005	1.74	0.654	0.14	0.025	
Pyridoxine (mg)	0.008	0.001					
Riboflavin (mg)	0.005	0.002	0.06	0.173	0.157	0.025	
Thiamin (mg)	0.016	0.001	0.64	0.156	0.28	0.05	
Vitamin A (IU)	0.62	0		2.7	0.596	160.2	
Vitamin C mg)	0.142	0.08				2.837	
Vitamin E (mg)	0.396		1.16	0.445		0.025	
Vitamin K (µg)	0.108		0.44	0.568	0.003	5.175	
Electrolytes							
Sodium (mg)	0.26	0.2	1.2	0.517	1	0.6	420
Potassium (mg)	14.76	16.4	350.	354.6	59.64	54.25	1000
Minerals							
Calcium (mg)	5.32	0.3	13.4	21.9	28.24	5.4	1600
Copper (mg)	0.01	0.016	0.17	0.299	0.035	0.037	0.1
Iron (mg)	0.18	0.056	4.37	3.171	1.438	0.312	5.4
Magnesium (mg)	7.4	2.2	184.	183.3	21.92	7.8	8.9

Manganese (mg)	0.04	0.028	3.35	3.45	0.105	0.1	0.7
Selenium (mg)	4.16		3.68	23.275	3	0.375	194
Zinc (mg)	0.12	0.028	1.42	2.182	0.351	0.237	6.7
water (g)			1.44	2.969	1.807	15.62	
Ash (µg)	0.36		2.35	1.738	0.315	0.187	
Phosphorus (µg)		2.8	395.	303.9	44.56	23.37	
Phyto-Nutrient							
Carotene β (µg)	0.36						
Fatty Acids							
Total Omega 3s			74.6	50.172		3.8	2370
Total Omega 6s			168	611.89		16.37	210
Essential Amino Acids							
Tryptophan (mg)			25.4	84.83			
Threonine (mg)			131	150			
Isoleucine (mg)			134	145.9			
Leucine (mg)			241.	278.3			
Lysine (mg)			153.	180			
Methionine (mg)			72.2	70.34			
Cystine (mg)			74.8	111.2			
Phenylalanine			149	178.4			
Tyrosine (mg)			97	130.86			
Valine (mg)			208	217.75			

Age and growth

By adopting the Bhattacharya method (Bhattacharya, 1967), seven curves linking were obtained on the basis of monthly mean length of *G. chapra*. Further refinement by Gulland-Holt plot gave L∞ of 158 mm and K of 0.448 year $^{-1}$ (Fig. 3).

Table -2. Estimated energy, value of fish product and composition of ingredients

Content	Composition in gm	Energy/Kcal	Value in Rs.
Fish	100	518	10
Rice bran	20	74.6	5
Corn flour	20	72.98	5
Wheat flour	30	64.65	5
Pea flour	20	16.75	5
Coconut powder	2	13.37	2
Mustard oil	2	10.16	2
Salt	5	0	2
Total	**199**	**770.51**	**36**

The t_o found by von Bertalanffy method (1938) is 0.442 year^{-1}. The VBGF of growth for the species is expressed as: Lt =158 [1-e $^{-0.448}$ (t-0.442)]

From the expression it is found that *G.chapra* grows to the size of 32, 89 and 150 mm at the end of I-III years respectively. During the study, the largest specimen measured was 150 mm. Growth Performance Index (ϕ) was calculated as 4.532 for *G. chapra*.

Mortality

The Z obtained by length converted catch curve and cumulative catch curve method were 3.07 and 7.336 respectively. However, for further estimates, Z of 3.07 by length converted catch curve was taken (Fig. 4). The instantaneous natural mortality (M) estimated by Pauly's empirical formula method was 1.219 year^{-1} for *G. chapra*. Fishing mortality Z-M was calculated as 1.85 year^{-1}. The exploitation ratio (E) was 0.603 and exploitation rate (U) was 0.575.

Table 3 Dosage, pallet size and required energy for the fish, poultry, cat and dog.

Animal	Pallet size mm	Required energy in Kcal	Dosage
Fish (1000)	0.5	2 985 Kcal in a tank for *C. carpio and catla catla*	771.3g
Poultry	0.8	2900	749.35g
Dog	20	700-900	232.55
Cat	10	250 in Adults	65.59

Recruitment of fishes

Recruitment was found to be in one pulse in June- September with a peak in July (19.34%) and September (18.79%) when total 68.49% recruitment took place during these months and a minor pulse of recruitment was noticed from January-May and October to December with a peak in May (11.66%), when the remaining 31.69% of fish were recruited (Fig. 5). The selection of probability of capture gave L_{50} for *G. chapra* as 69 mm by gillnet selection method using mesh size ranged between 0.5 to 2.0 inches (Fig. 6).

Virtual population Analysis

The estimated number of fish in the river, including those lost due to natural mortality and fishing mortality are represented in the cohort analysis. Thus, the number of fish recruited to the fishery in the mid size class of 25 mm was approximately 50776756, their fishing mortality being a meager 0.0003, catch was more than 2 thousand in number. However, from the fully recruited (L50 = 69 mm) size group of 65 mm onwards, the mean fishing mortality was 0.1219 and the current maximum catch was observed at length of 75mm. It is seen that with the estimated yield of 100385 kg, the biomass was 54226.9 kg. The total annual stock estimated from Y/U expression was found to be 174619 kg and the Maximum Sustainable Yield (MSY) was estimated to be 83238kg (Fig. 7).

Commercialization of fish

The nutrition value of *G. chapra* was estimated and given in the Table 1. Organoleptic scoring of *G. chapra* was carried out by a panel of 5

experienced judges who evaluated the organoleptic quality of products of selected fishes having different recipes on a 9 point hedonic scale (in which a score of 5 being on border line for acceptability) and 9 being excellent, 1 being spoiled,

A product was developed in the laboratory of the Institute for fish/ poultry/dog with fresh meat of selected fish and best ratio of other ingredients (such as Mustard oil, Coconut Powder, Rice bran, Wheat Flour, Corn flour, Pea Flour and salt) and their nutritional value are also given in the Table 1.

Estimation of feed of the fish

As per the trial of fish products (fig. 8) developed from fish (meat of *G. chapra*) and others ingredient as mentioned above are observed approximate digestibility. It is found that per day a ration of 15% of its body weight**.**

Note: The fish (example 5 grams) requires food per day, a ration of 15% of its body weight**,**

Amount of feed to be fed per day = 5 grams x 15/100

= 0.75 grams feed per fish per day.

If there are 1000 fish in the pond, then;

= 0.75 g x 1000 fish

= 750 g of feed should be weighed out for the day

Estimation of product value

The estimated value of product is approximately Rs 36 and energy to be provided 770.51 Kcal (approx.)/ 199 gramme of the product are given in Table -2

The size of pallet of any feed for a different animal depends upon their mouth intake. The pallet sizes of product with the same combination of ingredients have been prepared as formula adapted by AAFCO (Association of American Feed Control Officials) 2013. Table -3 showed the pallet sizes and energy requirements of fish, poultry, dogs and cats.

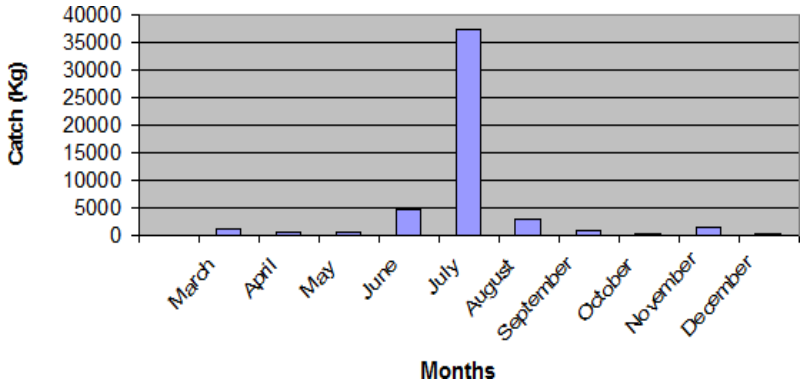


Fig.-1. Estimation of monthly catch of *G. chapra*

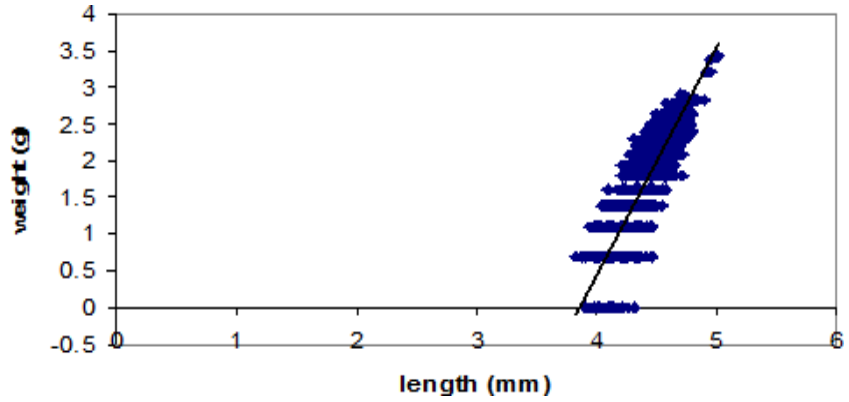


Fig. 2 Linear length-weight relationship of *G. chapra*

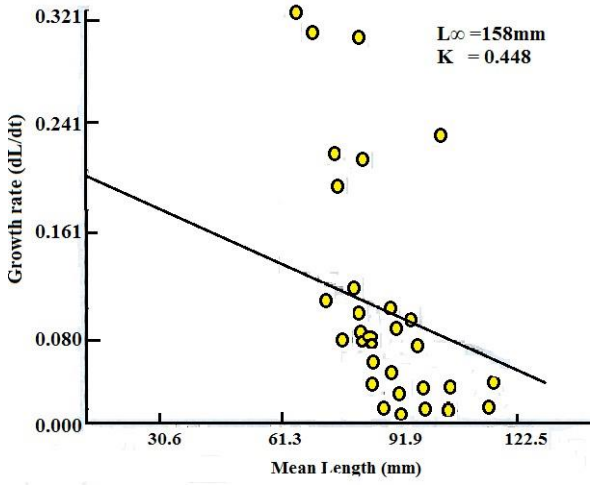


Fig.3. Estimation of growth parameters by Gulland and Holt method for *G. chapra.*

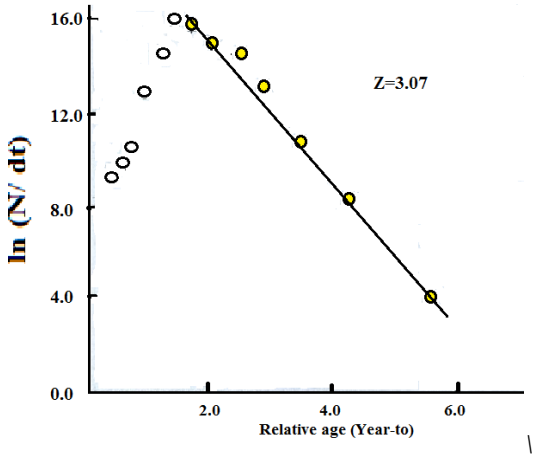


Fig. 4 . Estimation of Total mortality by Length Converted Catch Curve plot for *G. chapra*

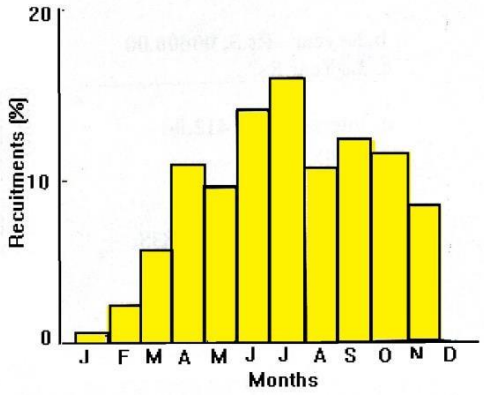


Fig. 5 Recuitment of *G. chapra* in Allahabad water.

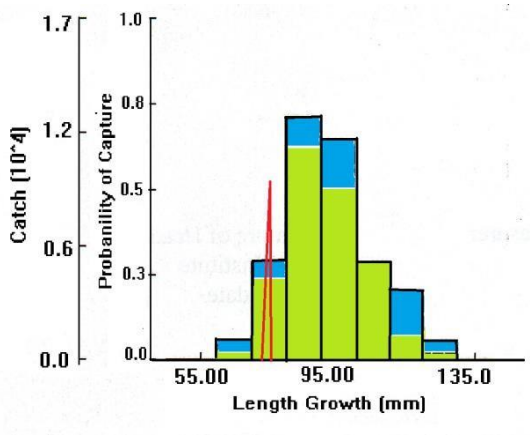


Fig 6. Probability of capture of *G. chapra* in Allahabad water

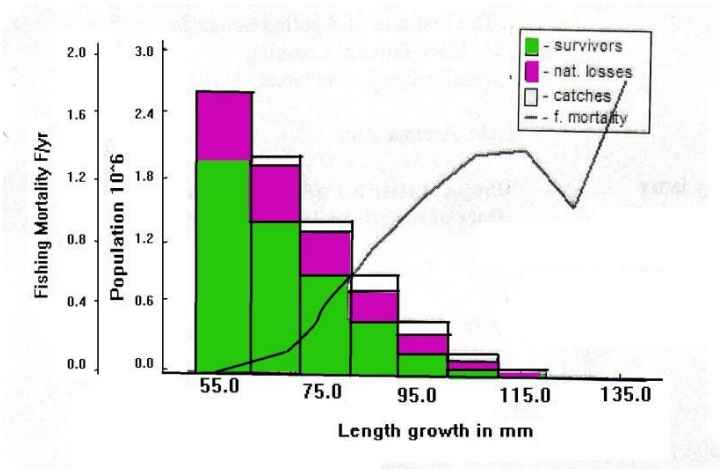


Fig. 7. Virtual Population Analysis of *Gudisia chapra* in Allahabad water

Discussion

It was observed that there was a high degree of correlation between the lengths and weights of the pooled sexes. The value of 'b' close to 3 indicates that the fish grows symmetrically or isometrically, provided its specific gravity remains constant. Therefore, length-weight relationship indicates that the weight of a fish increases more or less proportionately and follows the cube of its length. The isometric growth of fish was tested by a students't' test and found non-significant ($p>0.05$). Similar findings were also reported on other fish like *S. coitor* and *L. labuca* from Allahabad water (Rizvi et al., 2011; Masud, 2013). While Ahamed et al., (2014) were reported that the allometric coefficient b of the length-weight relationship (LWR) of this fish indicated negative allometric growth in males and females, but the analysis of covariance (ANCOVA) showed significant ($p<0.001$) differences in slope and intercept between the sexes.

The growth parameters obtained by the Gulland-Holt plot, ($L\infty$ = 158 mm and K = 0.448) were reasonably good and fell within the 95% confidence limit with other methods and therefore, considered for describing the growth of the species. Ahmad et al., (2007) mentioned that *G. chapra* attained asymptotic length 145mm in Bangaladesh water which is close to the maximum length of *G. chapra* (150 mm) recorded in the present observation.

Rahman and Haque (2006) reported that the annual rates of natural mortality, fishing mortality and total mortality were 1.34, 1.37 and 2.71 year^{-1} in 2003 and 1.37, 1.58 and 2.95 year^{-1} in 2004 respectively in waters of Bangladesh, so it is clearly that fishing mortality was higher than natural mortality on both side ie. India and Bangladesh.

The studies of Rahman and Haque (2006) revealed that the fish were recruited into the fishery twice a year and the fish were harvested at a higher level than the optimum fishing pressure.

Selected fish is found good for making fish product for animals as carnivorous fishes and poultry as well as dog and cat due its morphological and meristic characters having high numbers of spiny ribs and fins and contain higher value of protein, fat and minerals compared to other miscellaneous fishes, although its fresh meat recipes prefer by poor human being.

Feed is one of the major inputs in aquaculture, and the success of fish farming depends primarily on the provision of adequate quantity of nutritionally balanced feed in such a form which may be acceptable to fishes (Santosh et al 2012). Under the present investigation, several diets were formulated using commonly available grains (maize and soybeans), nutritious wastes (entire fish of *G. Chapra*) and a by-product (de-oiled rice bran). Experiments were conducted to evaluate acceptability of different formulated diets by Indian major carp *Catla catla* in artificially made plastic pond. The best combination was found after outcome of the trials, which resulted in a 100 percent increase in growth with this feed over those fed by conventional feed. The cost of the feed was estimated to be around two-thirds of the similar kind of feed, available in the market.

As per AAFCO (Association of American Feed Control Officials) every animal requires energy as per their body's metabolism. Dogs and fish need higher nutrition of protein but poultry (chicken) requires higher energy and minerals for egg and muscle formation. The cat needs less energy requirements due to its long resting period in a day. Table -3 showed that pallet size and energy requirement for the selected animal.

Although, the selected fish eradicate the mal- nutrition of the poor people as reported by earlier researchers but lack of storage facilities, most of the fish catch are not suitable for the human consumption and could also not earn actual income from the fish. Therefore, the developed animal product from un-utilized cheapest fish *(G. chapra)* is very economical as compared to other product available in the national market because ingredients which are used for the development of the product which easily available in local markets, even fish catch also available throughout the years showed by Fig-7 and maximum catch of the fish is recorded approximately 400 t in the month of July. Therefore, estimated value of product is approximately Rs 36 and energy to be provided 770.51 Kcal (approx.)/ 199 gramme of the product are given in Table -3

The study could provide the technology to local people for their employment generation, pollution free environment by utilizing nutritious

waste materials in the fish feed and minimization of incorporating presently practiced grains in fish feed, so that paucity of food grains in developing countries can be partially solved.

Conclusion

The lesser clupeid *G.chapra* forms a fishery throughout the year and the fish appears to be optimally exploited. Being a small fish from the tropical region, it is showing faster growth with high fishing mortality. So it may be concluded that systematic and total knowledge of the present study is given for the first time as the revolutionary idea of employment generation through the commercialization of non-commercial, non- over-exploited and having a good growth rate of miscellaneous fishes, has been planned for making the fish products and utilizing the protein rich plant/ crops of the same area to improve their socio-economic and health status of the poor people.

The present study was also carried out to find out the nutritional quality of fish product developed by *G. chapra*. Results showed that developed product for animal being is a source of high quality protein, carbohydrate, lipids, ash, vitamins, with a well-balanced composition of essential amino acids and fatty acids. The ω-3 and ω-6 PUFAs values were also higher in the product. Hence, consumption of the product is highly recommended for supplementary more nutrition.

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Bird Biodiversity in autumn at SHUATS Campus, Prayagraj, India: A pilot survey

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Abstract

The campus of SHUATS is a haven of abundance of bird species diversity. Birds are a bioindicator of a healthy ecosystem. Birds play an important role in maintaining ecosystems and supporting biodiversity. Birds are also important in plant pollination as demonstrated by sunbirds which participated in cross breeding of flower plants. A survey was done to comprehend the diversity of bird species in the campus in Autumn (September to November 2022). A total of 51 species belonging to 30 families and 15 orders were observed during the survey. The common bird species were Jungle babbler, House crow, Common Myna, Common Tailorbird, Spotted Dove, Asian koel, Sparrow, Blue rock pigeon, Black drongo etc. Based on their feeding habits, they were classified into omnivorous (17 species), followed by Insectivorous (15 species), carnivorous (8 species), granivorous (4 species), frugivorous (4 species) and piscivorous (3 species). According to IUCN Red List data, of all the birds observed, the Egyptian Vulture is endangered, Junglefowl is vulnerable while the other birds are of least concern. The residential status of 37 species are residents while the remaining 14 species are local migratory.

***Keywords**: Autumn, Birds, Campus, Diversity, Habitat, IUCN status*

Introduction

Birds are fore standing species of global biodiversity found in every habitat (Olechnowski,2009) and key indicators of ecosystem health and stress (Taper *et al*.,1995). According to Clements et al (2019) eBird checklist of birds of the world listed a total of 10721 species globally. Whereas, checklist of the birds of South Asia region (2019) records a total number of 1412 bird species, a checklist of the birds of the Indian subcontinent (2019) reports a total of 1392 species and a checklist of the birds of India (2019) reports a total of 1318 bird species were reported. Very few studies have been published on bird diversity from the campuses

of various universities (Jain *et al*.2005;Suthar*et al.* 2017; Edison *et al.* 2016,Singh et al 2018;Hibbin*et al*., 2022). So this study was done in the campus of SHUATS during the months of autumn.

Materials and Methods

Study Area:

The study was conducted in the University campus of SHUATS, Prayagraj, North India (Fig 1.).The study area covers an approximate 900 acres of land area. The study area represents buildings, with an agricultural crop field, horticulture crop field, forest nursery, freshwater pond, cattle yard, cattle pasture, small canal, Yamuna river bank, children park. The university campus consists of more than 1,500 trees, which provide a wide range of habitats for the birds (Hibbin et al., 2022). Also, some areas within the university are quite silent which indirectly promotes bird diversity.

Fig .1 Map showing SHUATS campus (Courtesy: Googol Earth Map.)

Bird survey technique adopted:

- Bird species were surveyed using the line transects method. Line transect sampling involves an observer travelling along a designated line of given length recording the number of birds, nests or other relevant objects (e.g. burrows, droppings and footprints) detected (Buckland *et al.* 2001; Gibbons & Gregory 2006).
- It is based on the theory of walking along a predetermined route at a regular interval to record the birds on or near the line. Open, flat homogeneous habitat was preferred. It was a straight line, not zigzags. Seven line transects were selected for study.
- All transects were approximately 200m.

- The seven transects were:
    - Transect 1: Old men's hostel to girl's hostel.
    - Transect 2: Shepherd hall to college of forestry.
    - Transect 3: College of forestry to horticulture field.

Transect 4: Jacob institute of biotechnology to forestry nursery.

- Transect 5: Backyard of department of animal husbandry to crop research field.
- Transect 6: Residential campus to Yamuna river bank.
- Transect 7: Genetics and plant pathology department to crop research field.

Tools and instruments used for bird survey:

- Camera (Nikon D3500).
- Binoculars.
- Compass.
- GPS.
- Data sheets and a clipboard, notebook, pencils.
- A watch
- A means of moving between plots - walking.
- Appropriate safety and first-aid procedures and gear.
- Google lens.
- ebirds.com
- Avibase bird count, (2022)

Survey periods and time:

- All surveys were carried out in the months of autumn (September to November 2022).
- Surveys were conducted in the morning hours (6.30 a.m. to 9.30 a.m.) and evening hours (3.30 p.m. to 6.30 p.m.) by a single observer (Gajera et.al, 2013).

Bird species identification:

- Recognising a bird species can be a challenging process. Birds are very active and energetic creatures. Quick eye spotting with the help of binoculars are required in order to get possible detail in a short span of time. The birds were identified by fixing eyes on them. Continuous observations were made regarding their movement, specific calls and songs, feeding habits. The general size, shape, distinctive strips and patches of colour including crown strips, eye lines, nape colour, eye arcs or rings and bird bill size were recorded during observation. Wing bars, colour patches, and markings on bird bodies during the stationary

stage or flying stage were recorded. Leg colour, length and caws were also noted in each observation.

- The identification of birds was done with naked eyes and also with the aid of binoculars and cameras.
- Images of birds which could not be identified in the field were captured using a camera and identified with the help of a field guide (Ali 2012 ;Ali and Ripley 1983).
- Observations were confirmed with the help of Avibase bird count (Avibase bird count, 2022.); ebird.com and Google Lens.
- For status of bird species IUCN, (2020) Red list data book was followed.
- Migratory status of birds was followed with the help of Ali 2012 data, where LM- Local migrant, RS- Resident , M- Migrant were listed.
- Residential status was recorded as per Rajashekara and Venkatesha (2015). Where; 0 - 25% of total spices were recorded as rare (Re); 26 - 50% as uncommon (UC); 51 - 75 as common (C); 76 - 100% as very common (VC).

Result and Discussion

The SHUATS campus is situated on the bank of river Yamuna. It is filled with a wide variety of trees, shrubs, flower gardens, crop field, fallow land, cattle pasture, forest nursery, freshwater pond which house many species of birds and also may be one of the major contributing factors for the richness of bird species. (Hibin*et al*,2022).

Bird diversity of SHUATS campus:

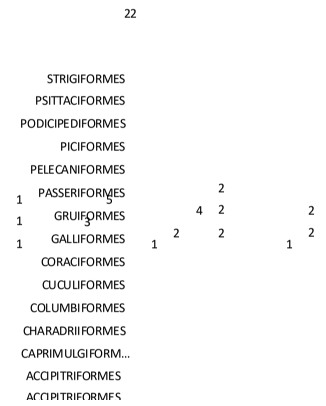
Table 1.depicts checklist of bird species observed at SHUATS campus. A total number of 51 bird species belonging to 30 families and 15 orders were recorded during the study in three months of autumn. The very common bird species were Jungle babbler, Blue rock pigeon, Common Myna, Bank Mana, Black drongo, Spotted Dove, Asian koel, House Sparrow, House crow, etc.

According to IUCN (2020) Red List data, of all the birds observed, the Egyptian Vulture is endangered, Jungle fowl is vulnerable while the other birds are of least concern. (Table 1). According to the occurrence / residential status of birds, 3 rare species were observed viz Egyptian vultures, Jungle fowl, Indian peafowl (Table 1). According to Residential status 37 species of birds are residents while the remaining 14 species are local migratory (Table 1). Figure 1 indicates number of bird species (Order wise) observed at SHUATS campus. 22 bird species belonged to the order Passeriformes about 43% of total.

Table 1. Measured maximum and minimum length of *Wallago attu* from the Rapti river, Uttar Pradesh, India

S. No	Order	Family	Scientific name	Common name	IUCN status	Food habits	Migratory status	Residential status
1	Accipitriformes	Accipitridae	*Accipiter badius*	Shikra	LC	Carnivore	LM	C
2			*Neophronpercnopterus*	Eqyptian vulture	EN	Carnivore	LM	Re
3	Bucerotiformes	Bucerotidae	*Ocycerosbirostris*	Indian Grey Hornbill	LC	Omnivore	LM	C
4		Upupidae	*Upupaepops*	Common Hoopoe	LC	Insectivore	LM	C
5	Caprimulgiformes	Apodidae	*Apusnipalensis*	House Swift	LC	Insectivore	RS	C
6	Charadriiformes	Charadriidae	*Vanellusindicus*	Red-Wattled Lapwing	LC	Insectivore	LM	C
7			*Vanellusmalabaricus*	Yellow Wattled Lapwing	LC	Insectivore	LM	C
8	Columbiformes	Columbidae	*Spilopeliasenegalensis*	Laughing Dove	LC	Granivore	RS	C
9			*Columba livia*	Rock Pigeon	LC	Granivore	RS	VC
10	Cuculiformes	Cuculidae	*Eudynamysscolopaceus*	Asian Koel	LC	Omnivore	RS	VC
11			*Centropussisensis*	Greater Coucal	LC	Omnivore	RS	C
12	Coraciiformes	Coraciidae	*Coraciasbenghalensis*	Indian Roller	LC	Carnivore	LM	C
13		Meropidae	*Meropsorientalis*	Green Bee Eater	LC	Insectivore	RS	C
14		Alcedinidae	*Halcyon smyrnensis*	White Throated Kingfisher	LC	Carnivore	RS	VC
15			*Cerylerudis*	Pied Kingfisher	LC	Piscivore	RS	C
16	Galliformes	Phasianidae	*Gallus gallus*	Junglefowl	VU	Omnivore	RS	Re
17			*Pavocristatus*	Indian Peafowl	LC	Omnivore	RS	Re
18	GRUIFORMES	Rallidae	*Amaurornisphoenicurus*	White Breasted Waterhen	LC	Omnivore	LM	C
19	Passeriformes	Dicruridae	*Dicrurusmacrocercus*	Black Drongo	LC	Insectivore	LM	VC
20		Corvidae	*Dendrocittavagabunda*	RufousTreepie	LC	Omnivore	RS	VC
21			*Corvussplendens*	House Crow	LC	Omnivore	RS	VC
22			*Corvuscorax*	Raven	LC	Omnivore	RS	C
23		Nectariniidae	*Cinnyrisasiaticus*	Purple Sunbird	LC	Nectar/ Insectivore	RS	C
24		Passeridae	*Passer domesticus*	House Sparrow	LC	Granivore	RS	VC
25		Alaudidae	*Mirafraerythroptera*	Indian Bush Lark	LC	Granivore	RS	C
26		Cisticolidae	*Priniasocialis*	Ashy Prinia	LC	Insectivore	RS	C
27			*Orthotomussutorius*	Common tailorbird	LC	Insectivore	RS	VC
28		Estrildidae	*Lonchurapunctulata*	Scaly-breasted munia	LC	Granivore / Insectivore	RS	VC
29		Pycnonotidae	*Pycnonotusjocosus*	Red-whiskered Bulbul	LC	Omnivore	RS	C
30			*Pycnonotuscafer*	Red-vented Bulbul	LC	Omnivore	RS	VC
31		Leiothrichidae	*Turdoidesstriata*	Jungle Babbler	LC	Omnivore	RS	VC
32			*Turdoidesaffinis*	Yellow Billed Babbler	LC	Omnivore	RS	C
33		Sturnidae	*Gracupica contra*	Indian Pied Myna	LC	Omnivore	LM	C

35		*Acridotheresginginianus*	Bank Myna	LC	Omnivore	RS	VC
36		*Sturniapagodarum*	Brahminy Starling	LC	Omnivore	RS	C
37		*Microcarboniger*	Little Cormorant	LC	Piscivore	LM	UC
38	Motacillidae	*Motacillamaderaspatensis*	White-browed Wagtail	LC	Insectivore	RS	C
39	Muscicapdae	*Saxicoloidesfulicatus*	Indian Robin	LC	Insectivore	RS	C
40		*Copsychussaularis*	Oriental Magpie robin	LC	Insectivore	RS	C
41	Pelecaniformes	*Bubulcus ibis*	Cattle Egret	LC	Insectivore	LM	C
42		*Ardeaintermedia*	Intermidiate Egret	LC	Piscivore	LM	C
43		*Ardeacinerea*	Grey heron	LC	Carnivore	LM	C
44		*Ardeolagrayii*	Indian pond heron	LC	Carnivore	RS	VC
45		*Ardeapurpurea*	Purple heron	LC	Carnivore	RS	C
46	Piciformes	*Megalaimazeylanius*	Brown-headed Barbet	LC	Frugivore	RS	C
47		*Psilopogonrubricapillus*	Crimson-fronted barbet	LC	Frugivore	RS	C
48		*Psilopogonhaemacephalus*	Coppersmith Barbet	LC	Frugivore	RS	C
49	Podicipediformes	*Tachybaptusruficollis*	Little Grebe	LC	Carnivore	RS	C
50	Psittaciformes	*Psittaculakrameri*	Rose-ringed Parakeet	LC	Frugivore	RS	C
51	Strigiformes	*Athenebrama*	spotted owlet	LC	Insectivore	RS	C



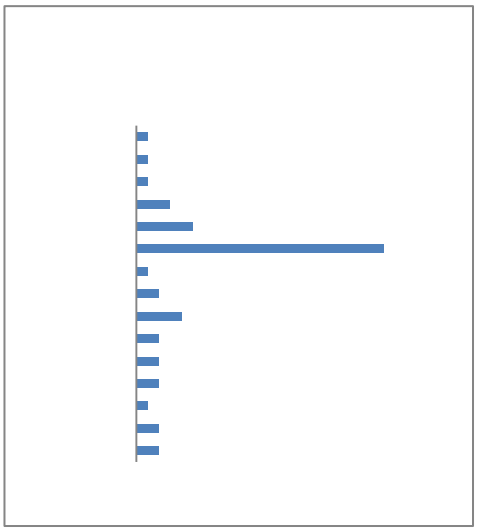


Fig: 1.Number of bird species (Order wise) observed in SHUATS campus

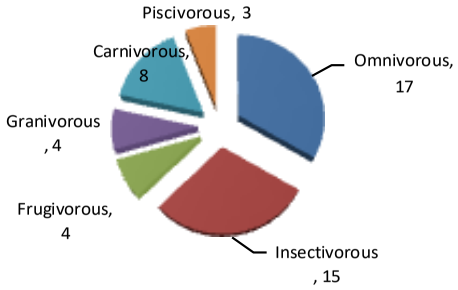


Fig: 2 Number of bird species according to feeding habit observed in SHUATS campus

Based on their feeding habits, they were classified into Omnivorous - 33.33% (17 species), followed by Insectivorous - 29.41% (15 species), Carnivorous -15.68 % (8 species), Granivorous- 07.84% (4 species), Frugivorous- 07.84% (4 species) and Piscivorous- 05.88% (3 species). Due to agricultural crops were cultivated in SHUATS campus 15 species of insectivorous birds are found in the campus.(Fig: 2). Photographs of some bird species were shown in Plate -1, Plate-2 and plate -3

Plate-1:Row 1 (L-R):- Scaly-breasted munia, Red-vented bulbul, House crow.Row 2 (L-R):- Bronzed-winged jacana, , Black Drongo, Red-wattled Lapwing.Row 3 (L-R):- Spotted dove, Ashy prinia, Brahminy starling.Photo by Rajdeepsarkar

Plate-2:Row 1 (L-R):Indian peafowl ,Green bee eater, Row 2 (L-R):RufousTreepie,White Throated Kingfisher,Cattle EgretRow 3 (L-R):Purple sun bird, Greatercoucal, Pied Kingfisher
Photo by Rajdeepsarkar

Plate-3:Row 1 (L-R): Rose Ring Parakeet,Jungle Babbler Row 2 (L-R):Indian Robin, Common Myna Row 3 (L-R):Common Hoopoe, Rock pigeon. Photo by Rajdeepsarkar

Conclusions:

Present study project showed that SHUATS campus has good habits for bird species. A total number of 51 bird species belonging to 30 Families and 15 Orders were recorded during the study in three months of autumn. Study also showed agriculture campus was good for omnivorous and insectivorous birdspecies.

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Maximum size of Helicopter catfish, *Wallago attu* (Bloch & Schneider, 1801) from the Rapti river, Uttar Pradesh, India

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Abstract

The *Wallago attu* fish samples used in this study were gathered from the Rapti River at the a wholesale fish market in Barahalganj, Gorakhpur, Uttar Pradesh, India. Fishes sources were determined on the basis of fishers and vendors. The collection period spanned from March 2023 to November 2023. A total of 149 fish specimens were collected, with lengths ranging from 29.5 cm to 137.8 cm (295 mm to 1378 mm). The fish were captured using various types of nets such as cast nets, drag nets, traps, and hook and line. The weight and length of the fish were accurately recorded using a measuring tape and a digital balance, respectively.

Keywords: *Wallago attu*, Rapti river, Fish market, Gorakhpur, Fishing pressure

Introduction

The Helicopter catfish, *Wallago attu* is a large, ravenous, and predatory catfish belonging to the order Siluriformes and family Siluridae inhabits freshwater environments in several countries including India, Nepal, Pakistan, Sri Lanka, Bangladesh, Burma, Thailand, Vietnam, Kampuchea, Malay Peninsula, Afghanistan, Sumatra, and Java (Talwar and Jhingran 1991, Giri *et al*. 2002, Mirza 2003, Nghia Vo *et al*. 2022). It is known for its unique pectoral fin structure, which resembles a helicopter rotor, leading to its common name. This is a demersal and potamodromous catfish that exhibits quick growth and possesses flesh/muscle with high nutritional quality. The dimensions of fish show variation across different rivers, regions, and ecosystems (Dwivedi and Nautiyal 2010, Imran *et al*. 2015, Dwivedi *et al*. 2017, Gopesh *et al*. 2021). The size of fish is influenced by factors such as food availability, ecological conditions of the ecosystem, fishing pressure and water discharge from water bodies (Chondar 1999, Dwivedi 2009, Rizvi *et al.* 2010, Tiwari *et al*. 2016,

Dwivedi *et al*. 2018, Verma *et al.* 2019). *W. attu* typically measures approximately 2 metres in length and can weigh up to 45 kilogrammes (Talwar and Jhingran 1991). The objective of this study is to document the largest size of *W. attu* found in the Rapti river and establish a database of its measurements in other rivers and lotic water bodies (Example on the basis of published research paper).

Materials and methods

Study Area

The Rapti river is a significant watercourse in Nepal and India. The Rapti river is a perennial river. The river rises from the Mahabharat Range of the Himalayas in Nepal and flows through the Terai area of Nepal and Uttar Pradesh in India. The river originates from a hilltop situated at an elevation of 3500 m. The Rapti river has a total length of around 600 kilometres. The Rapti river travels through the low-lying regions of India until converging with the Ghaghara river downstream of Gorakhpur city, specifically at Kaparwar ghat, Barahalganj road Patana, Uttar Pradesh.

The fish specimens of *W. attu* for this investigation were randomly collected monthly from March 2023 to November 2023. The fish were sourced from several fishermen at the Barahalganj wholesale fish market, situated in the Gorakhpur district of Uttar Pradesh, India. The Barahalganj fish market is situated on the eastern bank of the Rapti river. This fish market is also wholesale fish market for Saryu river. Fishes sources were determined on the basis of fishers and vendors. It functions as the main hub for selling fish caught in the lower part of the river. A total of 149 fish were randomly collected, with sizes ranging from 29.5 cm to 137.8 cm (or 295 mm to 1378 mm), and weights ranging from 135 gm to 11008 gm. The fish's weight and length were precisely recorded using a measuring tape and a digital balance, respectively.

Result and Discussion

The minimum recorded total length of *Wallago attu* was 29.5cm, with a weight of 135 gm. The maximum recorded total length was 137.8 cm, with a weight of 11008 gm (Table 1). A study has documented a new record for the length of *W. attu*, measuring 137.8 cm. The specimen was obtained at the Barhalganj wholesale fish market in the Gorakhpur area of Uttar Pradesh. Currently, this is the largest *W. attu* fish ever captured from the Rapti river in Uttar Pradesh, India. Sarkar *et al*. (2013) found that the largest recorded length of *W. attu* was 57.0 cm in the Rapti river.

The largest known size of *W. attu* was 80 cm, observed along the Ganga River in India (Khan *et al*. 2011). However, Achakzai *et al.* (2013) found that the largest recorded size of *W. attu* from Manchar Lake Jamshoro,

Sindh, Pakistan was 89.3 cm. Hoque *et al.* (2020) reported that the largest recorded size of a specimen from the Dakatia river in Bangladesh was 122 cm. The researchers Yousaf *et al*. (2011) documented the longest recorded length of *W. attu* as 50.2 cm, observed in various locations along the Indus River in Southern Punjab, Pakistan. Currently, the life span of catfish in river ecosystems is superior to that of carp due to their resilient nature (Mayank and Dwivedi 2015, Tripathi *et al*. 2017).

Table 1. Measured maximum and minimum length of *Wallago attu* from the Rapti river, Uttar Pradesh, India

SN.	Minimum length (cm)	Maximum length (cm)
1	29.5	137.8

The largest known size of *W. attu* was 80 cm, observed along the Ganga River in India (Khan *et al*. 2011). However, Achakzai *et al.* (2013) found that the largest recorded size of *W. attu* from Manchar Lake Jamshoro, Sindh, Pakistan was 89.3 cm. Hoque *et al.* (2020) reported that the largest recorded size of a specimen from the Dakatia river in Bangladesh was 122 cm. The researchers Yousaf *et al*. (2011) documented the longest recorded length of *W. attu* as 50.2 cm, observed in various locations along the Indus River in Southern Punjab, Pakistan. Currently, the life span of catfish in river ecosystems is superior to that of carp due to their resilient nature (Mayank and Dwivedi 2015, Tripathi *et al*. 2017).

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A study on the role of corporate social responsibility (CSR) in rural development

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Abstract

Father of the nation Mahatma Gandhi said that the actual progress of India did not mean simply the growth and expansion of urban industrial centres but mainly the development of the villages. Even after 75 years of independence, still, 70 percent of India's population resides in rural areas and depends mainly on agriculture for their livelihood. A large part of the rural population deprives of education, health facilities, basic amenities, infrastructure facilities, hygiene, sanitation, modern technology and so on. So, the growth and development of India cannot be possible by ignoring the rural population. Corporate as a part of society has a responsibility towards them. Corporate Social Responsibility (CSR) is one of the mediums by which a company can do for the betterment of the people. It is the commitment of a corporate to contribute to sustainable development and improve the lives of society. Policymakers and development specialists have recognized "CSR" as a feasible driver for rural development. The present paper attempts to highlight the role of corporate Social Responsibility (CSR) in rural development of India. The paper is mainly focused on holistic view of CSR and recent CSR practices of corporate houses to develop the rural areas.

Keywords- *Corporate Social Responsibility, Sustainable Development, Holistic Rural Development, CSR programmes.*

Introduction

Globally, the concept of CSR has evolved and now encompasses the economic, legal, ethical, and discretionary responsibilities of rganizations, business ethics usually focuses on the moral judgments and behaviour of individuals and groups within organizations. Generally CSR means those activities taken by the business with the purpose of welfare of society. CSR is understood as being the way through which corporate maintains equilibrium of economical, environment and social imperatives. An ideal CSR has both ethical and philosophical dimensions, particularly in India where there exists a wide gap between sections of people in terms of income and standards as well as socio-economic status. CSR is regarded as vehicle through which companies give something back to the society.

India lives in it villages and country's vast population is based on agriculture for living. Agriculture covers almost one-fifth of the gross domestic product in India. The Government has planned several programs pertaining to Rural Development in India to increase the growth of agriculture. Rural development seeks to change the socio-economic structure of the rural community. As far as rural areas are concerned CSR is considered very important. Simply social responsibility implies that the responsibility that government, corporation, organization or individual has towards society. Corporate must realize that to uplift the downtrodden society, government alone will not be able to succeed in its endeavour. Basically India stays in its villages. The statement is valid even today literally from all the perspectives. The concept of rural development is quite ample and far-reaching as the major part of State's population is living in rural areas.

India is a country of villages as 70 percent of India's population lives in rural areas, still these villages are underdeveloped due to poverty, unemployment, hunger, illiteracy, ill health, inadequate infrastructure, high mortality rate, etc. Neglecting the development of rural areas can give rise to degradation and depletion of rural population's welfare as well as harmful for the business and the society. Therefore, it is necessary to provide adequate and quality social services and minimum basic needs for economic growth and social justice but these are not only the responsibility of the government. It also needs more participants to be involved in the process of rural development. Thus Corporate Social Responsibility (CSR) is considered a significant motivating factor for the corporate house to work for the rural development which will help them to enhance the image of their business.

Corporate Social Responsibility (CSR)

The term CSR is very wide and complex and has different meanings. The EC defines CSR as "the responsibility of enterprises for their impacts on society". To completely meet their social responsibility, enterprises "should have in place a process to integrate social, environmental, ethical human rights and consumer concerns into their business operations and core strategy in close collaboration with their stakeholders".

The Companies Act 2013 states CSR as every company, private limited or public limited, which either has a net worth of Rs 500 crore or a turnover of Rs 1,000 crore or net profit of Rs 5 crore, needs to spend at least 2% of its average net profit for the immediately preceding three financial years on corporate social responsibility activities. According to Infosys founder, Narayan Murthy, "social responsibility is to create maximum shareholders value working under the circumstances, where it is fair to all its

stakeholders, workers, consumers, the community, government and the environment." From the above definitions, it is clear that:

- The CSR approach is integrated with the core business strategy for addressing socialeconomic impacts of businesses.
- CSR needs to address the well-being of all stakeholders and not just the company's shareholders.

Thus, the meaning of CSR reveals the ethical behaviour that an organization exhibits towards its internal and external stakeholders and simultaneously it represents the responsibility of an organization towards the environment and society in which it operates. Therefore, it is very necessary to understand and study how corporate enterprises are working on CSR initiatives and what effects it gives to the rural side of India.

Rural development is quite a broad term, but it essentially means a plan of action for the development of rural areas which are lagging in socio-economic development. It usually refers to the way of enhancing the quality of life and financial well-being of individuals, specifically living in remote areas.

Material and Methods

The researcher in his research formulated that, CSR activities improve a company's image when consumers attribute sincere motives, are ineffective when sincerity of motives is ambiguous, and hurt the company's image when motives are perceived as insincere [1]. [2] Author studied that firms had different motives/reasons for reporting the different attributes of CSR. Researcher [3], suggested that society values, new business opportunities, reduced regulatory interventions, customer satisfaction, firms' reputation, and better stakeholder relationship are acting as different driving forces that are motivating business firms for the implementation of CSR initiatives. [4] The Bi-dimensional model suggested by the researcher to understand the impact of CSR. In [5], authors formulated that Investment in CSR initiatives vary according to the firm size. According to [6] the major reasons for involving CSR practices by companies are to create and maintain a favorable corporate image where companies should be viewed as social organizations and in terms of CSR practices, community involvement is higher than the other categories of CSR in his research. Authors in [7], found that roads, pollution and power are the major concern of corporate CSR activities as compared to least concern area which is communication and education. The above work and findings of different scholars at different points of time entail that they have rightly observed the CSR practices and

performance of companies in India. Further, the proposed research will help us to conclude the answer to the following questions:

- Does the company consider rural people as stakeholders?
- What CSR initiatives being taken for rural development?
- What are the challenges of CSR programs on socio-economic development of rural population in India?
- What suggestions are needed for accelerating CSR initiatives?

1. To study the CSR status in rural India.
2. To study and understand the CSR initiatives being taken by companies for rural development.
3. To study the challenges faced by CSR in rural India.
4. To make suggestions for accelerating CSR initiatives.
5. To study various CSR practices done by leading organizations in Rural Development.
6. To examine sector wise CSR initiatives take by corporate houses to provide basic services to the rural community for development.

Research Methodology

The nature of this study is descriptive. The top nine CSR projects for rural development by nine corporate are taken for this study. Secondary sources have been used to accomplish the objectives as mentioned earlier. The data have been collected with the help of books, journals, websites, articles, newspapers, etc.

Corporate initiatives towards rural development

There are numerous ways the corporate serve the society. They account for financial aid to providing services of basic nature. Few areas of rural scenario are discussed below where various initiatives are taken to develop them.

Health

Hemophiliacs Education and Transformation (HEAT) project started by ONGC in collaboration with Hemophilia Federation India (HFI) to take curative action for the Children with Hemophilia (CwH) through educating them. The HFI will identify country wise 1000 CwH that are in age group of 5 to 18 years and are below poverty line and fund will be provided by ONGC to run the project. **Infosys** has made a foundation and constructed Hospitals and Rest Rooms (*Dharamshalas)* at various hospitals in country such as built a Infosys Super- Specialty hospital at

Sassoon Hospital in Pune, constructed a *Dharmashala*at Kidwai Memorial Institute of Oncology in Bangalore, Built a hospital for tribes at H.D. Kote, in the southern Indian state of Karnataka, Donated high-tech surgical equipment to hospitals in Mysore, Bijapur, Bellary and Hubli in Karnataka, Donated money to SPARSHA toward conducting screening camp for knee-related issues among retired school teachers and many more initiatives are taken by Infosys in the field of Health.

GlaxoSmithKline (GSK) with a NGO Institute for Indian Mother & Child (IIMC) committed towards good maternal and child health in rural areas of West Bengal by educating mothers and providing various primary medical facilities to pre, neo and postnatal care for mother and her child to avoid various deformities in delivery like premature babies etc. It also provides supplementary nutritional mixed diet to all pregnant or weaning mothers along with newborn baby to care against malnutrition diseases of children. It has ultimately help in reduction of maternal mortality rate (MMR) by training Traditional Birth Attendant (TBA) for safe child birth. IIMC till now covered 950 villages to cater 300 mothers and 26000 children. GSK has also initiated a *Tribal Welfare Projects* in PethTaluka, Nashik, Maharashtra through its Rural Health Development Organization and charitable trust GraminAarogyaVikasSanstha (GAVS) for their upliftment. It provides support for education, health, transport, malnutrition etc.

Tata Medical Center (TMC) a renowned Cancer institution of country at Kolkata offering care and medical service to the cancer patients and their kin where as in west Tata Memorial Hospital (TMH) Mumbai, practicing a huge Cancer patients. Patients from north, east and also from Bangladesh came to TMC and here 50% of beds are reserved for those who are unable to bear the cost and other 50% beds are subsidized. Other charges are covered by charitable funding.

Tata Steel Rural Development Society (TSRDS) a society of Tata Steel works on three principles Emphasizing Prevention, Curative Services and Promotion to awareness about health and hygiene. Various clinics are opened in Jharkhand and Jamshedpur which tries to cater Tuberculosis, Contraception and HIV-AIDS. As per its principle TSRDS is not giving everything free but make a village health fund and every visitor of clinic pays a sum of Rs. 2 in to a box. So far Rs. 290,000 has been collected; this amount of money is used back for the community.

Livelihood

GlaxoSmithKline (GSK) a British Pharmaceutical Company initiated a Sustainable livelihood program through a Livelihood Training Centers

named *YuvaParivartan*in PethTaluka of Nasik in Maharashtra to impart skill training such as in the field of computer, tailoring, nursing, beauty, agricultural etc. to make youths more employable and reduce the labour migration. Approximately more than 2500 youths are trained so far and most of them are currently employed.

TATA a giant India based Multinational Corporation has so far ran numerous social welfare programs in the rural as well as urban areas like a group company **Tata Consultancy Services**(TCS) started a program *Maitree*which focus on imparting training and skill development to the visually impaired. They established an *Advanced Computer Training Centre* (ACTC) where these differently able sections are taught practical application of learned skill and knowledge in the corporate field.

Apart from this, **Tata Motors** also initiated vocational training program through cooperative societies to the women and youth in computers and farm development, special program for women with the help of *self-help group* (SHGs) concept in vocational trades like tailoring, weaving, beautician and technical training such as motor mechanics and electricians etc.

Tata Chemicals Society for Rural Development (TCSRD) aid in generating livelihood for women of rural areas through a handicraft development project started in 2002 in Okhamandal village of Gujarat with a group of 25 rural women that is now grown as empowering brand as *Okhai*. This is promoted through SHGs and women are trained with various business techniques like teamwork, marketing, quality, production, redesigning of Okhai products and costing etc. Currently 14 villages and more than 450 women have accounted benefit from it.

Citi India, for the economic growth and development of those remote hill rural areas of Uttarakhand where agriculture activities are very peculiar, has collaborated with a NGO Appropriate Technology India (AT India) that actually works for mountain communities to start a Sustainable Livelihoods for Rural Producers Program that is empowering peoples specially women in various other rural produce such as sericulture, horticulture and cultivation of organic species and augment them to make sustain their micro enterprise

Education

Infosys Foundation promotes primary education in underprivileged children with global partnership through establishing libraries and other infrastructural facilities. It founded more than 50,000 libraries in rural schools in Karnataka where more than 50,000 sets of books were given to rural schools of Andhra Pradesh, Karnataka, Odhisha and Kerala costing

8000 to 10,000 per set apart from this it also setup more than 10,150 libraries in rural government schools also. Infosys foundation is having collaboration with *Center for Environment Education* (CEE), Bangalore, to give orientation to the teachers of science and environment. It also provides scholarship to the meritorious PhD students at Gulbarga University, Karnataka. **Forbes Marshall** supports fun preschools launched in 1999, named as *Gammatwadis*which prepares young children for formal schooling. They also partnered with the local municipal authorities to expand the service training programs for more than a hundred Balwadi teachers. They also joined with an NGO named *Akanksha*which involved in teaching and supporting children by giving them a strong educational foundation, self esteem and values, and help them plan a steady livelihood as a step towards improving their standard of living. They also contributed to create motivational centers called *PrernaKendras*for children from municipal schools and activity centers or study hall facilities called *Balbhavans*at their Welfare Centre and support to the 'School Library Project' are some of the other programs they are involved with to ignite young minds, build self esteem and inculcate values for a socially responsible community.

Tata Consultancy Services take initiatives to improve adult literacy condition. Tata Consultancy Services (TCS) came up with a *Computer Based Functional Literacy (CBFL) programme*in Beeramguda village in Medak district of Andhra Pradesh. CBFL is a e-learning system to help illiterates adult to speak the language and learn the skills of reading, writing and arithmetic. TCS core competency in software development to develop CBFL software for *National Literacy Mission (NLM)* for conducting research. The CBFL method uses the combination of graphic patterns and audio patterns leads to recognition, retention and recall of words. Primers developed by the NLM often supplement the programme.

Agriculture

Tata Hitachi Construction Machinery (THCM) conducts various agricultural based training programmes in the villages to enhance their efficiency and productivity as well as income. THCM helps the villagers to start cultivation on their barren land and for creating water harvesting structures to store rain water to increase water availability for house hold and other activities like pisciculture, duck farming, vegetable farming etc. Under THCM‟s *lift irrigation project* in the Hurling village, they provided pipes and cable connection, which has enabled the villagers to bring 30 acres of land under multiple cropping as well as they provides good variety of high yielding hybrid seeds to farmers for vegetable cultivation.

Zuari Agro Chemicals Limited demonstrated Low cost Drip Irrigation System at Succor, Bardez Goa. The cost of installing Drip system can be recovered in just two crop rotations. Zuari Agro Chemicals Limited also explained about the special fertilisers which is favorable for cultivation with drip irrigation. *Zuari has collaborated with Department of Agriculture and Karnataka Govt. and Pesticide Manufacturers Association* to educating farmers on safer use of pesticides and how pesticides should be handled safely so that it could not harm to human and environment. They organizes campaign on 11th November in which 15 farmers were organized for meetings in different parts of Yadgir, Gulbarga, Raichur, Bidar, Bagalkot and Bijapur districts where farmers highlighted important points during these meetings related to Safety Measures in handling pesticides, precautions to be taken before purchase, advantages of sourcing products from authorized dealers.

ITC's Livestock and Animal Husbandry Programmefocus rural communities which is primarily based on the aim to strengthen and improving rural livelihood through both farm and non-farm activities. Theprogramme including genetic improvements of cattle through artificial insemination to produce high-yielding crossbreed progenies and upgrade to high-yield livestock and form co-operatives to market their milk as well as ITC trains and equips technicians to provide an integrated package consisting of artificial insemination, cattle health and nutrition, pregnancy and post-natal services right at the farmer's doorstep. They established over 256 *Cattle Development Centers* (CDCs) covering more than 10,500 villages for providing artificial inseminations, vaccination and nutrition services.

Community Development

ONGC movement 'PURA' (Providing Urban Amenities to Rural Areas) initiated to avail urban amenities to rural areas which provide gas-based power from isolated & idle gas wells in each state where ONGC produces Oil & Gas and availability of isolated gas like Tripura, Assam, Andhra Pradesh, Tamil Nadu, Gujarat. In this project ONGC partnered with NABARD for Soft loan & entrepreneurial development, TERI for Project study & development, Wartsila for power generation, Thermax for cold chain.

Tata Tea's Power of 49 campaign aims to empower and educate India‟s women voters. The initiative highlighted that women form approximately 49 percent of the electoral base. The mission is to create 100 million informed voters as well as by using every platform to aware and connect large numbers of women voters. Tata‟s another initiative is Tata Tea‟s extremely successful *Jaago Re campaign*; launch in 2007 has initiated

social change by awaring with actual human rights and duties as a citizen of India.

Infosys Rural Development goal is an initiative taken for the well-being of people living in rural areas to ensure sustainable development for which the *Infosys Foundation* working with local administration for constructing roads, providing drainage systems and electricity, and rehabilitate facilities for victims from tsunami, earthquake, cyclone, drought -affected areas. The Foundation has donated more than INR 40 crore to the projects such as awareness campaigns on hygiene, sanitation, vocational training and entrepreneurship.

Results and Discussion

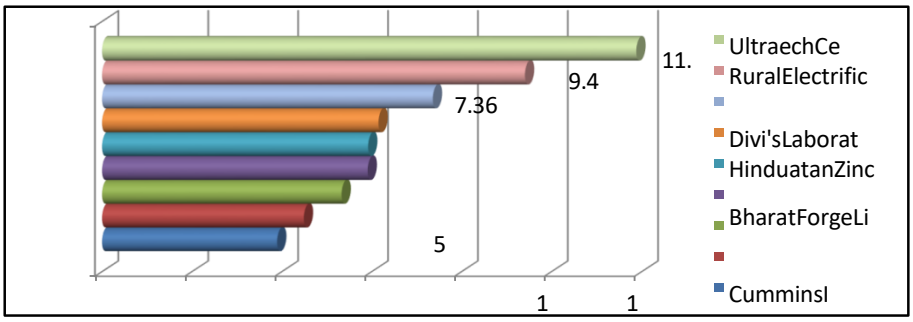
Thus, from the study it can be concluded that the business houses in India can play a major role in the process of rural development by grooming basic areas of rural services and sectors like employment, health, agriculture, education, and community development etc.

Hence, Corporate houses need to run more and more CSR programme which empower rural India and led it in mainstream. Rural development is vital not only for the majority of the population living in rural areas but also for the overall economic and social development of the India. So corporate should focus on it as much as possible.

Some of the **suggestions** to corporate for rural development are as follows:-

- ❖ Fulfil basic needs and facilities of villagers.
- ✞ Make smart villages instead of smart cities for the development of the nation.
- ✞ Establish new firms or industries in remote areas, so it employs villagers.
- ✞ Provide vocational training to villagers.
- ✞ Start a program that develops a skill in the villagers.
- ✞ Construct schools, hospitals, toilets, training centres, etc, for villagers in remote areas. ❖ Start a village improvement awareness program.

Name of the Company	Name of the Initiative	Sub Thematic Area	Total Expenditure on the Project (in Crores)	Total Prescribed CSR in 2020-21 (inCrore)	Actual CSR Spent in 2020-21 (in Crore)
Rural Electrificatio n Corporation Limited	Rural Development Project	Rural Development/ Community Development	9.41	144.32	147.75
OilIndia Limited	Construction of roads and bridges	Rural Development/ Community	7.36	49.12	105.25
Ultratech Cement Limited	Rural Development Program	Development, Rural Livelihood Rural Development/ Community Development	11.88	73.27	120.68
Divi's Laboratories Limited	Village Development	Rural Development/ Community Development, RuralInfrastructure	6.15	31.88	34.35
Hindustan ZincLimited	Community Assets Creation	Rural Development/ Community Development, Rural Infrastructure	5.92	196.5	214.0305
BharatForge Limited	Village Development	Rural Development/Community Development, Rural Livelihoods, Rural Infrastructure	5.91	22.53	18.3800
Hindustan Unilever Limited	Project Prabhat	Rural Development/ Community Development	5.33	161.7	165.08
Chambal Fertilisers & Chemicals Limited	Project Saakar	Rural Development/ Community Development, Rural and Education Infrastructure	4.49	19.58	19.65
Cummins India Limited	Rural Development Projects	RuralDevelopment	3.8955	16.0848	16.0848



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Studies on vermitechnology in biodegradable waste management

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Abstract

Vermicomposting is the organic waste conversion method that uses cow dung and earth worms to naturally create compost from organic waste; now-days high in demand. Recently, vermitechnology is extensively employed in the management of biodegradable solid waste. The elemental analysis demonstrated higher amounts of readily available nutrients, such as carbon (C), nitrogen (N2), phosphorus (P), potassium (K), calcium (Ca), and magnesium (Mg) were found in vermicompost derived from trash. The present study demonstrated two different earthworm species were used to assess the effectiveness of vermicompost development. These wastes include animal manure and waste papers from the industrial, agricultural, and residential sectors. Three different species of earthworms, including Eisenia fetida and Eudrilus eugeniae, were used in this investigation. Earthworms are utilized in the vermicomposting process, which turns organic waste into a substance that resembles humus. Numerous researchers worldwide have discovered that vermicompost typically has a richer nutritional profile than conventional compost. Vermicompost is made from waste materials and has a higher concentration of readily available nutrients like carbon, nitrogen, phosphorus, and potassium was demonstrated.

***Keywords*:** Vermitechnology, recycling , biodegradable organic waste .

Introduction:

Vermicompost is a nutrient, microbes and plant growth promoting rich organic substance that enhances crop yield and maintains soil heath. This organic fertilizer is implicated in the control of greenhouse gas emissions from agricultural soil compared to inorganic fertilizer, which promotes it. Sustainable crop production could be achieved using vermicompost because the obstacles bedevilling continuous cropping are reduced through the application of vermicompost to the soil. It enhances the biological and physicochemical properties of the soil. This vermicompost-induced soil biology and condition improvement led to an increase in crop

productivity. Also improved in the presence of vermicompost, is plant nutrient uptake and vegetative growth. This is perhaps due to its contributions to the increase in soil organic carbon, water holding capacity, aeration, and soil porosity (Haque and Biswas, 2021; Liu et al., 2020; Wang et al., 2018).Over the past century, the issue of soil waste has received considerable critical attention globally (Wei et al., 2022). Proper management of solid wastes is mandatory and need urgent action for the persistence and appropriate functioning of societies (Bui et al., 2020). Poor waste management is contaminating the biosphere including oceans, rivers and seas; thereby causing flooding, obstructing drains, transmitting diseases through vector breeding, elevating respiratory problems via airborne particles created from waste burning, harming animals by consumption of waste unknowingly and a major demise in economic development by diminishing tourism (Desa, 2012, Sharma et al., 2020). The addition of composted organic wastes to croplands frequently results in an increase in soil productivity that cannot be attributed to mineral fertilizers alone. This so-called "organic matter effect" implies that plant growth can be influenced by processes other than the simple provision of nutrients (Galli et al. 1992).

Review of literature:

Considerably more research has been done on the qualities of the material that earthworms create after consuming organic matter and the technique by which they do so than on stabilized casts in comparison to compost and synthetic fertilizers, Orozco (1996). Eisina fetida grows at its fastest pace when the temperature is 30 degrees Celsius and the moisture content is 85%. The temperature at which the majority of cocoons hatched was 20^{o}C, which was thought to be the ideal growth temperature for this worm (Edwards & Bates, 1992).

Sodium, Pottasium, and Calcium mineralized throughout this process. Worms process organic matter (OM) most effectively at temperatures between 15 and 25oC and between 70 and 90% of moisture content. Worms perish at temperatures above 35oC. To achieve better outcomes and faster processing times, different materials are combined before processing. Worms can only withstand a certain amount of toxicity. The best results are achieved when employing raised beds, where feedstock is added at the top and castings are collected at the bottom through mesh floors. Eisina fetida is the most widely utilized earthworm. The process of the “Bioxidation and stabilization of organic materials involved by the joint action of earthworms and mesophyll micro-organism is known as vermicomposting earthworms create is rich in macro and micro nutrients, vitamins growth hormones , enzymes including lipase , amylases ,

cellulose and chitins as well as immobilized microorganism even after they are expelled from the worms the enzymes keep breaking down orga nic materials (Barik et.al.2011). It has been deconstructed to be effective in processing wastes water and sewage sludge, brewery materials, paper wastes, urban leftovers food and animal wastes and horticultural residues from dead plants from processed potatoes (Dominguez, Edwars 2004). Animal, plants and urban settlement wastes are the three primary categories of organic wastes that are good conditions for vermicomposting (Thomas et.al.,2012). When earthworms transforms soil nutrients in to forms that plants can access more easily such as soluble nitrate , calcium , exchangeable , phosphorous , potassium , ammonium nitrogen and magnesium vermicompost can be added to deficient soils (Edwards and Bohlen 1996). According to (Gopal et.al.,2013). Vermicomposting enhance soil health and fertility by contributing major and micronutrients, organic matter and compounds that promote plant growth in addition to enhancing soil stracture all type of organic wastes can be disposed of safely, effectively and affordable and vermicompost a highly helpful products is produced (Gajalakshi et.al.,2013). By using earthworms and microorganisms to interact vermicomposting involves the bio- oxidation and stabilization of organ ic wastes (Dominguez &Associates 2004). Vermicompost is the enrichment adds nutrients to the soil that chemical fertilizer do not (R.D. Kale et .al.,1998). The rapid rate of urbanizations and population growth has a commensurate impact on the amount of garbage generated which causes the per capita land area to steadily decline according to a study (M.K.Awasthi et al.,2014). Organic wastes make up 46% of all soil wastes, generated worldwide additionally the procedure requires additional fuel which renders is unsuitable at times (R. Singh et.al.,2018). Recycling rates are higher in industrialized countries than in developing once because of improved wastes segregation technique processing technology and collecting system (T.S.Bixler el al.2019). It is known as Verm filtration when vermicompost is utilized to used wastes water , Verm filtration is generally understood to be a liquid state vermi-conversion process in which wastes passes over a bed of infected earthworms and vermicompost or soil utilized as filter bed materials (K.samal et.al.,2018). About 700 million tones of organic wastes , including leaves , husk sawdust , steam ,bark flowers and other materials are thought to be produced annually in India (Alok et.al.,2010). Vermicompost has a high concentration of essential nutrients both macro and micro , which are easier for plants to absorb and more soluble as well as microorganism and plants growth regulators (Bhayar & Bhide 1996). It also includes helpful soil microorganism that are great growth boosters such as mycorrhizal, fungi and bacteria that fix nitrogen (Gopi 2017). Using 3R programs redue , reuse and recycle- as an alternative to

conventional wastes management technique has been suggested as a way to take a sustainable approach ti the environment (Shekdar 2009). Leaf litter may be successfully turned in to vermicompost by numerous researchers who then utilize it on a variety of crops either on its own or in combinations with inorganic or biofertilizer (Pozp et .al.,1998). Technology advancements in wastes management systems population expansion and consumption patterns are only a few of the socioeconomic political and environmental issue that have a big impacts (Zaman A.U.2013). Instead of treating or discarding the trash directly the "Zero Wastes" approach may involve using organic residues from municipal industrial and agriculture wastes as resources (Misselbrok et.al.,2012). Vermicompost generally out perform regular compost in term of physical nutritional and biochemical aspects (Pramarik et .al.,2007). In addition vdermicomposting as opposed to composting , produces two beneficial products – earthworms biomass and vermicompost and requires less processing time (Sim et al.,2010). In order to eliminate pathogens and stabilize sewage sludge a straighforword and reasonably priced technique is needed for its treatment and application following naturies recycling process composting is an efficient "ZeroWaste" method for handiling organic wastes one benefit of composting is that it produces naturas fertilizer as a by product and it's a safe way to treat trash with high nutritional content through the use of various earthworms species the natural process of organic wastes decomposition by saprophytic microorganism can be quadruplrd this technique is called vermitechnology tons of kitchen trash can be developed in a more effective cheap , and environmentally beneficial way with vermicompost vermiculture is the raising of worms for this purpose whereas vermicomposting is the result of vermicomposting economic advantages include the conversion of biowastes that ends up in landfills the removal of biowastes from the wastes stream a decrease in the contamination of other recyclables the creation of recyclables the creations of low skill jobs locally and strigh forwaed technology which makes vermicomposting beneficial for under developed africultural area (Appelhof 1993). Agro industrial wastes can be transformed in to value added products using vermicomposting an intentive biotechnology that can be used to improve soil fertility and stracture in organic farming (Garg,Gupta 209). Earthworms are frequently described as naturies ploughmen and formers pale , because of their activities in ingesting organic matter , breaking it up and combining it closely with mineral particles to create aggregates earthworms play a critical role in the creations of soil (Saranraj et al.,2012).

Thus to eliminate pathogens and stabilize sewage sludge a straight forward and affordable technology for its treatment is needed (J.A. Anand et

.al.1995). Life cycle assortment (L.C.A.) studies and cost benefit analysis indicate that more vermicomposting is a more appealing choice than land filling an d cremation and they are gathered at the bottom of the filter treated water (Hosseinzadehb et .al.,2018). Since organic wastes are biodegradable they can be broken down by variety of microorganism during the earthworms are added to organic waste and over time they transform the wastes in to humus a dark odorless substance known as vermicompost. Organic process decompose spontaneously biological in an aerobic environment during the composting process (Sim EYS el al.2010). the conversion of organic debris in to nutrient –rich fertilizer and soil conditioner is often acknowledged to occur through biological process like composting and vermicompost (ZamanAU 2013).

Materials and Methods:

- Vegetable debris
- Cattle dung
- Floral waste
- Paper waste
- Earthworms (Eisenia fetida, Eudrilus eugeniae)

Methods: In this, cemented pots of sizes 16-inch height x 14-inch diameter, each of capacity 10kg, with small holes at the bottom were used. Small pebbles were placed in these pots followed by spreading a shallow layer of sand of approximately 1 cm. On this layer, 1 kg cow dung was added and then 40 earthworms were introduced in each pot. After adding 5 kg of following substrates separately: grass, wheat straw, saw dust, neem leaves, bagasse in these pots the mixture was covered with big dried leaves and wire mesh. The experiment was set up in duplicate for each substrate. The composting mixture was allowed to stand for 15 days by sprinkling water every 2-3 days. After turning, further incubation was allowed till another 15 days. A set up without earthworms was taken as control. After successful trial run in pots the experiments were set up in pits for the production of vermicompost.(Rachna Kapila et.al).

Collection of earthworms : The earthworms collected from Dr.Rajendra Prasad Central Agriculture University Pusa, Samastipur, 848125, Bihar, India

The earthworm selection is Eudrilus eugeniae, Eisenia fetida.

Collection of Kitchen wastes/paper wastes: The kitchen waste collected from (Farm science center) piprakothi motihri Bihar 845429

Methods: In this, cemented pots of sizes 16-inch height x 14-inch diameter, each of capacity 10kg, with small holes at the bottom were used. Small pebbles were placed in these pots followed by spreading a shallow layer of sand of approximately 1 cm. On this layer, 1 kg cow dung was added and then 40 earthworms were introduced in each pot. After adding 5 kg of following substrates separately: grass, wheat straw, saw dust, neem leaves, bagasse in these pots the mixture was covered with big dried leaves and wire mesh. The experiment was set up in duplicate for each substrate. The composting mixture was allowed to stand for 15 days by sprinkling water every 2-3 days. After turning, further incubation was allowed till another 15 days. A set up without earthworms was taken as control. After successful trial run in pots the experiments were set up in pits for the production of vermicompost (Rachna Kapila et.al).

Conclusion:

One of the most significant features of compost made by earthworms is that it is entirely organic earthworm have the ability to break down waste materials quickly producing a stable nontoxic material with a nice structure, that may be used as a soil conditioner for plant growth and has the potential to be highly valuable economically, one of the naturally occurring products of vermicomposting is a substance that has multiple benefits for plants the nutrients found in earthworm are by for the biggest advantage. An alternative for biodegrading solid waste is to use an integrated method that combines both composting and vermicomposting and composting improves disease control and yields organic fertilizer more quickly than any of the separate procedures could. Comparison to compost and commercial fertilizers, vermicomposts also had a lower risk of causing salt stress. Because of this organic fertilizer – an alternative to chemical fertilizers are becoming more and more significant in the agriculture industry.

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Seraikella Chhau Dance: A Cultural Heritage of Eastern India

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Abstract

Seraikella Chhau, a traditional dance form from Jharkhand, is a cultural mosaic blending martial skills, folk traditions, and creative expressions. Originating from old customs, tribal ceremonies, and regal legacies, it is a prestigious classical dance style. The dance's complex composition, featuring dynamic movements and elaborate masks, costumes, and makeup, is significant culturally and preserving local mythology. Despite adaptations, challenges persist in its preservation.

In the context of eastern India, Seraikella Chhau is very significant culturally, even beyond its aesthetic appeal. By maintaining old mythology and promoting community identity through its immersive performances, it acts as a guardian of local narratives.

This short communication cum discussion paper aims to provide a deeper understanding of Seraikella Chhau's cultural legacy, highlight its significance in the current cultural environment, and promote ongoing initiatives for its preservation and broader recognition.

Key words: Seraikella Chhau, elaborate masks, aesthetic appeal, local narratives.

Introduction

Seraikella Chhau, an ancient form of Indian classical dance, resonates with a profound legacy that traverses the corridors of time, echoing the cultural ethos of centuries past. Its genesis can be traced to the illustrious precincts of the princely state of Seraikella, nestled in the heart of eastern India. Rooted in a tapestry of rich traditions, this dance form has entrenched itself as an indelible emblem within the intricate socio-cultural fabric of the region.

Dating back through the annals of history, Seraikella Chhau emerges as a testament to the artistic ingenuity and cultural prowess of its origins. It encapsulates a confluence of influences, drawing from indigenous tribal rituals, martial arts, and the opulent heritage of princely courts. Its evolution over the ages has been shaped by the fusion of these diverse elements, moulding it into a distinctive and revered art form.

In the broader panorama of Indian culture, Seraikella Chhau stands as a beacon of artistic expression, offering a captivating glimpse into the nuanced and intricate dance traditions that have flourished across the country. Its geographical roots in eastern India have imbued it with a regional flavour, yet its artistic resonance transcends boundaries, captivating audiences with its grace, vigour, and storytelling prowess.

Moreover, beyond its artistic grandeur, Seraikella Chhau holds an eminent position in the cultural landscape of India. It serves as a repository of historical narratives, cultural symbolism, and community identity, encapsulating tales of valour, folklore, and the essence of the region's ethos.

As this research progresses, it aims to unravel the historical tapestry of Seraikella Chhau, exploring its origins, evolution, and the amalgamation of cultural influences that have contributed to its prominence. This introductory overview sets the stage for a comprehensive exploration, seeking to delve deeper into the nuances of this revered dance form, unveiling its intrinsic beauty and profound significance within the cultural heritage of India.

Historical Background

Delving into the historical roots of Seraikella Chhau involves tracing its evolution and the myriad influences that have contributed to its unique identity:

Origins and Early Development:

Seraikella Chhau finds its genesis intertwined with the ancient tapestry of eastern India's cultural heritage. Historically, its roots can be traced back to the tribal heartlands, where it was intrinsically linked with rituals, ceremonies, and storytelling practices within these communities. Its earliest incarnations were deeply embedded in the rituals and folklore of the indigenous tribes, serving as a medium for expressing their tales of heroism, mythological narratives, and celebrations of nature's rhythms.

Fusion of Influences:

Over time, Seraikella Chhau underwent a transformative journey, assimilating diverse influences that shaped its evolution. The amalgamation of martial arts, folk traditions, and the patronage of the princely courts during different epochs contributed significantly to its development. The infusion of elements from martial practices, characterized by swift movements, precision, and athleticism, lent a dynamic vigour to the dance form, distinguishing it from conventional classical dances.

Evolution into Performance Art:

The evolution of Seraikella Chhau from its ceremonial and ritualistic roots into a structured performance art was a gradual process. The patronage of the princely state of Seraikella played a pivotal role in refining and codifying the dance form, transforming it into a stylized art that embraced storytelling, elaborate choreography, and thematic presentations. This transition marked a significant shift, elevating Seraikella Chhau from a local tradition to a recognized and revered classical dance form.

Influential Figures and Transmission:

Throughout its evolution, notable gurus, artists, and custodians have played crucial roles in preserving and transmitting the legacy of Seraikella Chhau. These custodians, often belonging to hereditary lineages, passed down the nuances, intricacies, and essence of this dance form through generations, ensuring its continuity and authenticity.

Contemporary Context:

In contemporary times, Seraikella Chhau continues to thrive as a cultural treasure, embracing innovation while staying rooted in its traditional essence. Its presence on national and international platforms not only showcases its aesthetic appeal but also reinforces its relevance and resilience in a rapidly evolving cultural landscape.

This segment of the research paper aims to unearth the multifaceted journey of Seraikella Chhau, unravelling the intricate threads of its historical evolution, influences, and transformations. It highlights the dance form's transition from tribal rituals to a refined performance art, embodying a rich tapestry of cultural heritage and artistic expression.

Elements of Seraikella Chhau

Movements and Techniques:

Distinct Movements: Seraikella Chhau is renowned for its unique and intricate movements, characterized by a harmonious blend of fluidity and precision. Performers execute a diverse range of steps, jumps, spins, and poses, each contributing to the storytelling aspect of the dance. The choreography often mirrors the dynamism of martial arts, emphasizing agility, grace, and strength.

Gestures and Expressions: The language of gestures and facial expressions in Seraikella Chhau is highly nuanced. Every movement is imbued with symbolic meaning, conveying emotions, narratives, and characterizations. Performers skilfully utilize mudras (hand gestures) and facial expressions to articulate the essence of the story, creating a captivating visual narrative.

Footwork and Postures:

The footwork in Seraikella Chhau is intricate and rhythmic, complementing the accompanying music. Performers utilize a variety of foot positions and steps, seamlessly transitioning between them to create a dynamic and visually engaging performance. Graceful postures, often inspired by natural elements and mythological motifs, further enhance the aesthetic appeal of the dance.

Music and Instruments:

Traditional Instruments: The music of Seraikella Chhau is an integral part of its performance, providing a rhythmic and melodic backdrop to the movements. Traditional instruments like the dhol, shehnai, flute, and dhumsa are commonly employed. Each instrument contributes to the overall ambiance, enhancing the narrative and emotional depth of the performance.

Rhythms and Beats: The dance is intricately woven with rhythmic patterns that synchronize with the footwork of the performers. The beats and tempo of the accompanying music are carefully coordinated with the dance, creating a symbiotic relationship between movement and sound. This synchronization not only adds vibrancy to the performance but also reinforces the narrative structure.

Storytelling through Music: In Seraikella Chhau, music is not merely an accompaniment but a co-storyteller. The compositions are designed to evoke specific moods, accentuate dramatic moments, and convey the essence of the narrative. The interplay of music and dance serves as a powerful medium for cultural storytelling, preserving the rich oral traditions of the region.

Costumes and Makeup:

Elaborate Costumes: The costumes worn by Seraikella Chhau performers are elaborate and visually striking. Inspired by traditional motifs and mythological themes, these costumes play a crucial role in character portrayal. The use of vibrant colours, intricate embroidery, and traditional jewellery adds a visual spectacle to the performance, enhancing the overall aesthetic appeal.

Masks and Makeup: Masks are a distinctive feature of Seraikella Chhau, serving as a transformative element for performers. These masks, often crafted with intricate detailing, represent characters from mythology, folklore, or the cultural history of the region. The use of makeup further accentuates facial expressions, enabling performers to embody and convey the emotions of their characters more vividly.

Symbolism in Attire: Each element of the costume, from the colour of the attire to the design of the accessories, carries symbolic significance. These symbolic elements contribute to the narrative and help the audience interpret the characters and themes portrayed during the performance.

This examination of movements, music, and costumes in Seraikella Chhau underscores the art form's holistic approach, where each element collaborates to create a rich and immersive cultural experience.

Cultural Significance

Preservation of Cultural Narratives: Seraikella Chhau stands as a custodian of cultural narratives, embodying the collective heritage, myths, and legends of eastern India. Through its performances, this dance form perpetuates stories passed down through generations, preserving the region's rich folklore, historical events, and cultural ethos. Each movement, gesture, and musical note becomes a vessel for carrying forward these narratives, ensuring their continuation in a dynamic and captivating manner.

Celebration of Tradition and Heritage: Within the context of eastern India's traditions, Seraikella Chhau acts as a living repository of cultural heritage. Its performances often depict tales of valor, love, mythology, and societal customs, allowing audiences to connect with and celebrate the essence of their roots. By showcasing traditional themes and historical episodes, Chhau becomes a conduit for reviving and honouring the region's cultural legacy.

Fostering Community Identity:

Community Participation and Inclusivity: Seraikella Chhau is deeply woven into the social fabric of communities in eastern India. It serves as a platform for communal participation, where artists, musicians, costume makers, and storytellers collaborate, fostering a sense of belonging and shared identity. The involvement of local communities in preserving and promoting Chhau reinforces a collective ownership of the art form, strengthening ties among individuals and communities.

Transmission of Values and Social Cohesion: Through its performances, Seraikella Chhau communicates cultural values, ethics, and societal norms. The stories portrayed often carry moral lessons, historical anecdotes, and teachings, serving as a medium for imparting wisdom and reinforcing social cohesion within communities. The shared experience of witnessing Chhau performances cultivates a sense of unity, forging connections among diverse members of society.

Cultural Resilience and Identity Assertion: In the face of evolving societal landscapes, Seraikella Chhau represents a form of cultural resilience. It asserts the identity of eastern India's communities, especially amidst modernization and globalization. Its continued practice and preservation assert the importance of indigenous traditions, ensuring their visibility and relevance in contemporary times.

As a Conclusion I can say that, Seraikella Chhau's cultural relevance within eastern India transcends mere entertainment; it serves as a vital vessel for cultural preservation, community cohesion, and the assertion of regional identity. Its performances, steeped in tradition and symbolism, resonate deeply with audiences, fostering a profound connection to the collective heritage and values of the region. As a dynamic repository of cultural narratives and a unifying force within communities, Seraikella Chhau remains a cornerstone of cultural identity and continuity in eastern India.

Evolution over Time

Adaptation to Modern Contexts: Seraikella Chhau, while deeply rooted in tradition, has demonstrated resilience by adapting to contemporary contexts. Its evolution has seen innovative choreographic approaches, fusion with other art forms, and engagements with modern themes without compromising its fundamental essence. This adaptability has allowed Chhau to remain relevant and accessible to diverse audiences.

Artistic Innovations: The evolution of Seraikella Chhau has witnessed artistic innovations, including experiments with new storytelling techniques, integration of modern music influences, and collaborations with contemporary choreographers. These endeavors have expanded its artistic horizons while staying rooted in its foundational elements.

Current Status and Challenges:

Preservation Efforts: Despite its enduring legacy, Seraikella Chhau faces challenges in its preservation and transmission. Efforts by cultural organizations, government initiatives, and dedicated practitioners aim to document, teach, and promote Chhau across generations. Workshops, training programs, and institutional support play pivotal roles in safeguarding its legacy.

Socioeconomic Challenges: Economic constraints and changing societal dynamics pose challenges to the sustainability of Seraikella Chhau. The lack of financial support, limited infrastructure, and diminishing patronage can hinder the cultivation and professionalization of Chhau artists, impacting its continuity.

Preservation and Promotion Efforts:

Educational Initiatives: Educational institutions, cultural academies, and community-driven initiatives play crucial roles in preserving Seraikella Chhau. They offer training, workshops, and educational programs to nurture young talent, ensuring the transmission of knowledge and skills to future generations.

Cultural Advocacy and Awareness: Advocacy campaigns, cultural festivals, and international collaborations serve as platforms for promoting and showcasing Seraikella Chhau on regional and global stages. These initiatives raise awareness about its cultural significance and garner support for its preservation.

Digital Outreach: Embracing technology, efforts are underway to leverage digital platforms for archiving, promoting, and disseminating information about Seraikella Chhau. Online resources, documentaries, and social media campaigns widen its reach and engage wider audiences.

The evolution of Seraikella Chhau stands as a testament to its adaptability and resilience in the face of changing times. While grappling with challenges, concerted efforts by various stakeholders aim to preserve, promote, and revitalize this cultural treasure. Despite the hurdles, the fervent dedication to safeguarding its legacy ensures that Seraikella Chhau continues to thrive, bridging the past with the present and nurturing a legacy for the future.

Influence on Contemporary Dance Forms

Choreographic Inspirations: Seraikella Chhau's impact on contemporary dance forms is notable in its influence on choreography. Elements such as intricate footwork, expressive gestures, and storytelling techniques have found resonance in modern dance. Choreographers worldwide draw inspiration from Chhau's dynamic movements, incorporating its rhythmic patterns and thematic richness into their creations.

Cross-Pollination of Styles: The fluidity of Seraikella Chhau's evolution has allowed for cross-pollination with diverse dance genres. Fusion performances, where Chhau merges with contemporary, ballet, or other traditional dance forms, showcase the versatility and adaptability of Chhau, contributing to a vibrant tapestry of global dance aesthetics.

Cultural Exchanges:

International Collaborations: Seraikella Chhau's participation in international festivals, collaborations with artists from different cultural backgrounds, and joint productions have facilitated cultural exchanges. These interactions expose Chhau to diverse audiences, fostering a mutual appreciation of artistic traditions and creating dialogues that transcend geographical and cultural boundaries.

Global Appreciation: The global diaspora has played a crucial role in spreading awareness about Seraikella Chhau. Performances on international stages, participation in cultural exchange programs, and collaborations with foreign artists contribute to a broader understanding of the art form. This not only elevates Chhau's visibility but also fosters a sense of cultural diplomacy.

Contribution to the Global Artistic Landscape:

Diversity in Artistic Expression: Seraikella Chhau contributes to the global artistic landscape by adding diversity to the spectrum of dance forms. Its unique blend of martial arts, folk traditions, and classical elements offers a distinctive flavour that enriches the global dance vocabulary. This contribution fosters a global appreciation for the richness of cultural diversity in the arts.

Cultural Preservation and Awareness: Seraikella Chhau's presence in global artistic forums contributes to the preservation of cultural heritage. By engaging with audiences worldwide, it serves as an ambassador for Indian cultural traditions, reinforcing the importance of safeguarding and celebrating the world's cultural tapestry.

Seraikella Chhau's impact on contemporary arts extends beyond its regional roots, influencing dance forms and cultural exchanges on a global scale. As a source of inspiration for choreographers and a catalyst for cross-cultural understanding, Seraikella Chhau contributes significantly to the ever-evolving and interconnected world of contemporary arts. Its journey from the traditional heartlands of eastern India to international stages showcases the power of dance as a universal language that transcends borders and fosters cultural harmony.

Conclusion

Seraikella Chhau, with its roots tracing back centuries, embodies an enduring legacy that encapsulates the essence of eastern India's cultural heritage. Its evolution from tribal rituals to a refined classical dance form has stood the test of time, reflecting the resilience and adaptability of cultural traditions.

The exploration of Seraikella Chhau unravels its profound cultural significance within the socio-cultural tapestry of eastern India. It serves as more than a mere dance form, acting as a repository of historical narratives, folklore, and communal identity. Its performances preserve and transmit cultural values, embodying the ethos of the region.

The research underscores the imperative need for continued preservation and appreciation of Seraikella Chhau. Despite its cultural richness, the dance form faces challenges such as economic constraints, limited resources, and changing societal dynamics. Efforts towards its preservation, including educational initiatives, advocacy, and technological outreach, are crucial for safeguarding its legacy.

In conclusion, the exploration of Seraikella Chhau illuminates its enduring legacy, cultural significance, and the imperative need for sustained efforts in its preservation and appreciation. As a custodian of cultural heritage and a vibrant artistic expression, Chhau's continued existence and recognition are essential not only for eastern India but also for the global appreciation of diverse cultural traditions. It beckons for a concerted commitment to safeguarding this cultural gem, ensuring that future generations inherit and cherish this invaluable part of India's cultural mosaic.

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The comparative study of nature in the poetry of William Wordsworth and Sumitranandan Pant

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Abstract

This abstract delves into the profound exploration of nature in the poetry of two eminent poets from different cultural backgrounds and time periods – William Wordsworth, a leading figure of the English Romantic movement in the late 18th and early 19th centuries, and Sumitranandan Pant, a prominent Indian poet of the 20th century. Both poets share a deep affinity for nature, yet their expressions and perspectives exhibit distinctive cultural and philosophical nuances. The works of William Wordsworth are emblematic of the Romantic era's celebration of nature and its profound influence on human emotions and spirituality. Wordsworth's poetry often reflects his fascination with the sublime aspects of the natural world, portraying the serene beauty of landscapes and the impact of nature on the human psyche. Through his concept of 'Nature as Teacher,' Wordsworth emphasizes the therapeutic and moralizing influence of nature on the human soul. In contrast, Sumitranandan Pant, a stalwart of Hindi literature, draws inspiration from the diverse and spiritually rich landscapes of India. His poetry exhibits a seamless blend of traditional Indian philosophy and modern sensibilities. The study aims to provide a comprehensive understanding of how these two nature poets, despite their differing backgrounds, share a universal appreciation for the intrinsic beauty and transformative power of the natural world in their respective literary traditions.

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Keyword: *Nature, Emotions, Wordsworth and Sumitranandan Pant*

Introduction

Nature has long served as a wellspring of inspiration for poets, allowing them to explore the profound connections between the human spirit and the natural world. Two poets who exemplify this symbiotic relationship with nature in their works are William Wordsworth and Sumitranandan Pant. Despite the geographical and cultural differences that separate them – Wordsworth hailing from the picturesque Lake District in England and Pant from the serene landscapes of Himalayan foothills of

India – both poets share a common passion for capturing the sublime beauty and transformative power of nature in their verses.

William Wordsworth, a prominent figure in the Romantic literary movement of the 18th century, is renowned for his celebration of nature's influence on the human mind and soul. His poetry often reflects a deep sense of communion with the natural world, emphasizing the healing and rejuvenating aspects of the outdoors. Wordsworth's magnum opus, "Lines Composed a Few Miles Above Tintern Abbey," encapsulates his belief in the transcendent and spiritual qualities of nature, laying the foundation for a poetic tradition that values the inherent connection between man and the environment.

On the other side of the globe, Sumitranandan Pant, a leading figure in Hindi literature and one of the prominent pillar of the Chhayavad along with Prasad, Nirala and Mahadevi Verma during the 20th century, echoed similar sentiments in his exploration of nature through poetry. Pant's verses are imbued with a profound sense of the sacredness of the natural realm, drawing inspiration from the Himalayan landscapes of his native Uttarakhand. His works, such as "Gunjan" and "Yug-Pravah," showcase a deep ecological consciousness and a poetic vision that seeks to harmonize the human experience with the rhythms of nature.

In this exploration of the two nature poets, William Wordsworth and Sumitranandan Pant, we will delve into their respective backgrounds, thematic preoccupations, and poetic techniques. By juxtaposing their diverse cultural contexts, we aim to unravel the universal threads that bind these poets together in their shared reverence for nature's timeless allure and its transformative impact on the human spirit.

Nature's Muse: A Poetic Exploration of the Treatment of Nature in Wordsworth's Poetry

William Wordsworth, a luminary of the Romantic era, was an ardent advocate for the profound connection between humanity and the natural world. His poetry stands as a testament to the transformative power of nature, offering an intricate and emotionally charged depiction of landscapes, seasons, and the inherent beauty found in the simplicity of the natural realm. In exploring the treatment of nature in Wordsworth's poetry, we delve into a realm where the poet elevates nature to a muse, a source of inspiration, and a spiritual guide.

Nature as a Living Presence:

Wordsworth's poetry is infused with a deep sense of animism, portraying nature not as a lifeless backdrop but as a living, breathing entity with its own spirit and vitality. In works such as "Lines Composed a Few Miles

Above Tintern Abbey," he describes nature as a "presence" that dwells in the mind, offering solace and wisdom. This treatment of nature as a dynamic force highlights Wordsworth's belief in the inherent divinity and interconnectedness of all living things.

The Impact of Place and Landscape:

Wordsworth had an acute sensitivity to the influence of specific places and landscapes on human emotions and experiences. The Lake District, his beloved home, features prominently in his poetry. In "I Wandered Lonely as a Cloud," he immortalizes the beauty of a field of daffodils, and in "Tintern Abbey," he reflects on the enduring impact of the picturesque scenery on the human psyche. Through vivid descriptions and emotional resonance, Wordsworth elevates nature to a sacred space that shapes and molds the human spirit.

Celebrating the Seasons:

The changing seasons serve as a recurring motif in Wordsworth's poetry, symbolizing the cyclical nature of life, growth, and renewal. In "Lines Written in Early Spring," he muses on the beauty of nature's rebirth, expressing a sense of hope and optimism. Each season, according to Wordsworth, carries its unique charm and lessons, contributing to the continuous evolution of the natural world and its influence on the human soul.

Emotional Responses to Nature:

Wordsworth's treatment of nature extends beyond mere description; it encompasses the emotional responses and spiritual revelations triggered by natural encounters. The sublime beauty of a sunset, the tranquility of a babbling brook, or the awe-inspiring grandeur of a mountain peak become catalysts for profound introspection and heightened emotional states. Wordsworth captures these experiences in verses that evoke a range of sentiments, from joy and wonder to contemplation and awe.

Nature as a Teacher and Moral Guide:

In Wordsworth's poetry, nature is not only a source of aesthetic pleasure but also a teacher and moral guide. The natural world, in its simplicity and purity, imparts valuable lessons about life, morality, and the interconnectedness of all living things. In "The Tables Turned," Wordsworth suggests that nature possesses a wisdom that surpasses the intellectual pursuits of urban life, encouraging a return to a simpler, more authentic existence.

William Wordsworth's poetry is a celebration of nature in all its glory – a nuanced exploration of the profound connection between humanity and

the natural world. Through vivid imagery, emotional resonance, and philosophical reflections, Wordsworth elevates nature to a role of unparalleled significance, portraying it as a muse, a source of inspiration, and a guiding force that shapes the human experience. As readers immerse themselves in Wordsworth's verses, they embark on a journey that transcends the physical landscape, inviting them to reflect on the timeless beauty and spiritual richness found in the embrace of nature's enduring embrace.

Nature's Symphony in Sumitranandan Pant's Poetry: An Artistic Ode to the Natural World

Sumitranandan Pant, one of the foremost poets of modern Hindi literature, left an indelible mark with his profound and emotive verses that intricately weave together the beauty of nature and the human experience. His poetry is a celebration of the sublime, where the natural world emerges as a muse, a metaphor, and a source of profound inspiration. In exploring the treatment of nature in Pant's poetic compositions, we unearth a rich tapestry that not only captures the scenic grandeur but also delves into the intricate relationship between humanity and the natural world.

Nature as a Cosmic Force:

Pant's poetry transcends mere description; it transforms nature into a cosmic force, an entity that pulsates with life and energy. In works like "Gunjan," he often personifies nature, attributing human qualities to the elements. The wind whispers secrets, the river murmurs tales, and the mountains stand as timeless sentinels. Pant's treatment of nature as a living, breathing force underscores his belief in the interconnectedness of all existence.

Seasonal Rhythms and Metaphors:

The changing seasons play a pivotal role in Pant's poetic universe. Each season becomes a metaphor for the diverse facets of human emotion and experience. In his renowned poem "Kala," he masterfully captures the essence of autumn, weaving it into a poignant metaphor for the withering of youth and the inevitable passage of time. Pant's meticulous attention to the seasonal rhythms reflects a deep understanding of nature's cyclical patterns and their symbolic resonance in the human journey.

Ecstatic Communion with Nature:

Pant's verses often depict a deep, almost ecstatic communion with nature, where the poet immerses himself in the sensory richness of the natural world. In "Rangbirangi," he revels in the vibrant colors of the landscape,

describing the interplay of light and shadow in a mesmerizing dance. This treatment of nature reflects Pant's belief in the therapeutic and rejuvenating power of immersing oneself in the beauty that surrounds us.

The Symbolism of Landscapes:

The landscapes in Pant's poetry transcend mere settings; they become symbolic realms that mirror the emotional terrain of the human soul. Mountains, rivers, and forests are not just geographical features but metaphors for the challenges, joys, and complexities of life. The Himalayas, in particular, hold a special place in Pant's works, serving as a symbol of eternal beauty and spiritual transcendence.

Harmony of Man and Nature:

Pant's treatment of nature goes beyond its aesthetic appeal; it encompasses a profound philosophy of harmonious coexistence between humanity and the natural world. In poems like "Gramya," he extols the virtues of rural life, emphasizing the symbiotic relationship between man and nature in agrarian landscapes. Pant envisions a world where human activities are in harmony with the natural order, fostering a sense of balance and interconnectedness.

Sumitranandan Pant's poetry stands as a testament to the enduring bond between humanity and nature. Through his eloquent verses, he paints a vivid portrait of the natural world, infusing it with spiritual depth, metaphorical richness, and a deep sense of interconnectedness. Pant's treatment of nature goes beyond the physical; it delves into the metaphysical, inviting readers to contemplate the profound beauty and wisdom inherent in the landscapes that surround us. In the poetic realm of Sumitranandan Pant, nature becomes a sacred text, a canvas for the human soul to explore and understand its own existence in the grand tapestry of the universe.

A Comparative Study the treatment of Nature in the Poetry of William Wordsworth and Sumitranandan Pant:

Nature has been a perennial source of inspiration for poets across cultures and epochs. Two poets who have left an indelible mark on the canvas of nature poetry are William Wordsworth from the English Romantic tradition and Sumitranandan Pant, a prominent figure in Hindi literature. Despite the cultural and temporal differences between them, both poets share a profound love for nature, which reflects in their works. This article aims to delve into the comparative study of nature in the poetry of Wordsworth and Pant, exploring the thematic similarities and stylistic differences that characterize their respective approaches.

Thematic Similarities:

1.Spiritual Connection with Nature: Wordsworth and Pant both depict nature as a spiritual force that nurtures the soul and provides solace. Wordsworth's famous lines, "Nature never did betray the heart that loved her," and Pant's emphasis on nature as a spiritual teacher echo this sentiment.

Pantheistic Views: Both poets exhibit pantheistic tendencies, viewing nature not merely as an external entity but as a manifestation of the divine. Wordsworth's pantheism is evident in his belief that nature is a living, breathing entity, while Pant often personifies nature in his verses, attributing divine qualities to it.

Celebration of Simple Pleasures:

Both Wordsworth and Pant find joy in the simplicity of nature, celebrating the beauty of everyday scenes. Wordsworth's "Lines Composed a Few Miles Above Tintern Abbey" and Pant's "Panchvati" both encapsulate the poets' admiration for the ordinary yet profound aspects of the natural world.

Stylistic Differences:

Cultural Context:

Wordsworth's poetry is deeply rooted in the English countryside, reflecting the landscapes of the Lake District. On the other hand, Pant draws inspiration from the diverse geography of India, incorporating elements of the Himalayas, rivers, and forests into his verses. This cultural divergence shapes the imagery and symbols employed by each poet.

Language and Form:

Wordsworth, writing in English, employs a language that is rich in simplicity and accessibility. His poems often follow traditional English poetic forms. In contrast, Pant, writing in Hindi, utilizes the rhythmic patterns of Hindi poetry, infusing his verses with a distinct cadence. The linguistic and formal disparities contribute to the unique aesthetic experiences offered by their works.

Social and Political Dimensions:

While both poets predominantly focus on the beauty and transcendental qualities of nature, Pant occasionally incorporates socio-political themes into his poetry. His verses reflect concerns about the plight of the underprivileged and the impact of industrialization on the environment, providing a broader societal context compared to Wordsworth's more individualistic perspective.

Conclusion:

The poetry of Sumitranandan Pant and William Wordsworth stands as a testament to the enduring allure of nature and its profound impact on the human spirit. Both poets, despite cultural and linguistic disparities, contribute to the Romantic tradition by portraying nature as a source of inspiration, spirituality, and harmony. Through their unique stylistic approaches, Wordsworth and Pant invite readers to embark on a poetic journey that celebrates the timeless beauty and transcendent qualities of the natural world, fostering a deep connection between humanity and the environment.

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