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Comparative Study of Mental Health among Male and Female College Students

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Abstract: Introduction: These vital components of cognitive, behavioural, and emotional well-being states to mental health. Public universities mostly stress on students because of financial constraints (Shafiq S, & et al., 2020). The purpose of this investigation was to find out the gender differences on mental health (MH) in the college students.
Method: 130 participants perusing their degree courses in Arts in various colleges of Cuttack and Bhubaneswar of Odisha, India. To find out the significance mean variance among the groups t-test was considered.
Result and Discussion: The analysing data reveals that the Positive self-evaluation ($P>0.05$), perception of reality ($P>0.05$), integration of personality ($P<0.05$), autonomy ($P<0.05$), oriented attitude ($P<0.05$), and environmental mastery ($P<0.05$). The result revealed that male students are differing from female college students such as integration of personality, autonomy, group oriented attitude and environmental mastery. However, in case of positive self-evaluation and perception of reality the result is found to be insignificant.
Conclusion: It is concluded that the male college students are not differing from female college students with regard to positive self-evaluation (PSE) and perception of reality (PSE). Furthermore, concluded that the male college students are differing from female college students such as; integration of personality (IP), Autonomy dimension of MH, group oriented attitude and case of environmental mastery.

Keywords: *Gender; Health; Attitude; Positive self-evaluation.*

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Introduction

Mental health (MH) is the combination of psychological, emotional, and social wellbeing. MH facilitates for better stress management and making choices in different situations. MH is a common term to describe individual relate to opportunities and demands in the life. According to (WHO, 2004) MH is the state of happiness in which the person's understands his or her own abilities. Moreover, MH is strong pillar for the community at large in maintaining in effective well-being (Kumar et al., 2013). MH provides a better health for day to day functioning in life (Macaskill, 2013; Mey & Yin, 2015). Studies conducted by (Bangale & Patnam, 2014; Fernando, 2019) showed significant differences between both the genders in personality of good integration, fair-positive-self- evaluation, and attitude of group oriented. Morab et al., 2014, indicated insignificant results among the groups relation to (MH), (PSE), (IP) and (EM). Sharma (1995) investigated gender and stream wise B.Ed. students on the selected variables of MH and overall MH. Result revealed insignificant differences in the six components of MH and overall MH for B.Ed. students. According to (Arnett, 2000) College going students frequently join full time job. As per the National college health risk behaviour survey held by the centre for disease control and Prevention during the year 1995 it is found that 9.5% of students stated that they had extremely considered trying to suicide and 1.5% of students had mentioned that they had attempted (Kisch et al., 2005). Study conducted by (Blanco et al., 2008) found that mental health problems are common between college students. According to (Vaillant, 2012), the cultural and traditional values do shape how MH and mental illness are conceptualized across contexts.

According to (Eisenberg et al., 2013) survey conducted on 14,175 U.S. students regarding the prevalence and correlated of MH problems had shown that the importance of positive screens score 17.3 % for depression, the percentage for panic disorder was 4.1% and, for generalized anxiety was 7.0%.

Research Studies conducted by (Pedrelli et al., 2015) revealed that becoming familiar with problems characteristic of the developmental stage and students would be able to better serve them.

According to (Auerbach et al, 2018) a rise and severity of mental problems among the students in the recent times around the globe.

Studies conducted by (Shafiq et al, 2020) revealed that public universities students are mostly in stressed because of financial disaster.

Moreover, private Universities students having mentally stress because of uncertainties of online classes and payment of high tuition fees.

Objective

To find out and compare MH of male and female students.

Method

Sample Size

One hundred and thirty college students (Male=60, Female=70, ages were 18 to 25 years) continuing their degree courses in Arts in different colleges of Cuttack and Bhubaneswar, Odisha, India.

Significance

Nowadays, globally all college students irrespective of their gender are facing mental health debacles due to the present situation and many other factors such as academic pressure, peer pressure, time management, examination pressure, financial burdens, career and physical inactivity. Taking into account the present situation the investigator aimed to study the mental health of the participant's which reveals the mental health condition and to recommend suggestions to the college students to overcome the issues related to their MH.

(MH) Inventory

MH inventory prepared by (Jagdish & Srivastava, 1983). Items comprises 56 in inventory and each rated on a 4-point rating scale ranging from always to never with a score of 1 to 4. Inventory comprises of six dimensions such as;

1. Positive self-evaluation - (PSE)
2. Perception of reality- (PR)
3. Integration of personality - (IP)
4. Autonomy-(A)
5. Group Oriented Attitude – (GOA)
6. Environmental Mastery (IM)

Moreover, high score indicates good (MH) and low score indicates poor (MH). The reliability coefficients of different dimensions of MH inventory were found 0.70 and above.

Procedure

Students were informed to come after the college hours in the evening to take part in this study. The questionnaires were distributed to the students and questionnaires were in dual version i.e. Hindi and English. After attempting the questions completely received by the testers and data was recorded carefully.

Methodology table

Variables	Details of the selected variables
Independent (GENDER)	Male and Female
Dependent (M H)	• Positive self-evaluation • Perception of reality • Integration of personality autonomy • Group oriented attitudes • Environment mastery

Source: Authors' own conception

Analysis and Results

The below tables had shown the analysis of data pertaining to this study. Below tables gives the outcomes of MH among the groups by mean, standard deviation and P-Value.

TABLE1, shows the mean difference and P -value among the groups with regard to positive self-evaluation

Group	N	Mean	SD	P-Value
Males	60	24.71	3.45	P> 0.05
Females	70	25.75	3.42	

DF= 128

Source: Authors' own conception

The above Table-1 had shown the mean of the groups on positive self-evaluation. The mean of both genders are found to be (24.71) and (25.75). The SD of the male and female college students are found to be (3.45) and (3.52) respectively. P-Value that is found to be in significant at

0.05 significance level. It means male athletes are not differing from female college students in positive self-evaluation.

TABLE2, shows the mean and P-value of female and male students with regard to perception of reality

Group	N	Mean	SD	P-Value
Males	60	19.95	3.00	P> 0.05
Females	70	20.10	3.45	

DF= 128
Source: Authors' own conception

Table-2 had shown the significance of mean of the groups on perception of reality. The mean of the male and female college students found to be (19.95) and (20.10). The SD of the male and female college students is found to be (3.00) and (3.45). The P-value, which is found to be insignificant at 0.05 significance level. It means male college students are not differing from female college students in perception of reality.

TABLE 3, shows the mean values and P-value among the groups with regard to the integration of personality

Group	N	Mean	SD	P-Value
Males	60	31.50	4.02	P< 0.05
Females	70	29.79	3.99	

DF= 128
Source: Authors' own conception

Table-3 had shown significance of mean of the groups on integration of personality. The mean of the male and female college students are found to be (31.50) and (29.79). The SD of the male athletes and female college students are found to be (4.02) and (3.99) respectively. The P-value is significant at 0.05 significance level. It means male athletes are differing from female in integration of personality.

TABLE 4, shows the mean and P-value of boys and girls regard to autonomy

Group	N	Mean	SD	P-Value
Males	60	14.98	3.12	P< 0.05
Females	70	13.89	2.81	

DF= 128, P<.05
Source: Authors' own conception

Table-4 had shown mean of the groups on Autonomy. The mean of the male and female college students are found to be (14.98) and (13.89). The SD of the male and female college students are found to be (3.12) and (2.81) respectively. The P-value which is found to be significant at 0.05 significance level. It means male college students are significantly differing from female athletes in positive self-evaluation.

TABE-5, shows the mean and P-value with regard to group oriented attitudes among the groups

Group	N	Mean	SD	P-Value
Males	60	26.12	3.53	P< 0.05
Females	70	24.89	3.38	

DF= 128
Source: Authors' own conception

The above table-5, had shown the mean of both the groups on group-oriented attitude. The mean of the male and female college students are found to be (26.12) and (24.89). The SD of the male athletes and female college athletes is found to be (3.53) and (3.38) respectively. The P-value that is found to be significant at 0.05 significance level. It means male college students are differing from female college students on group-oriented attitude.

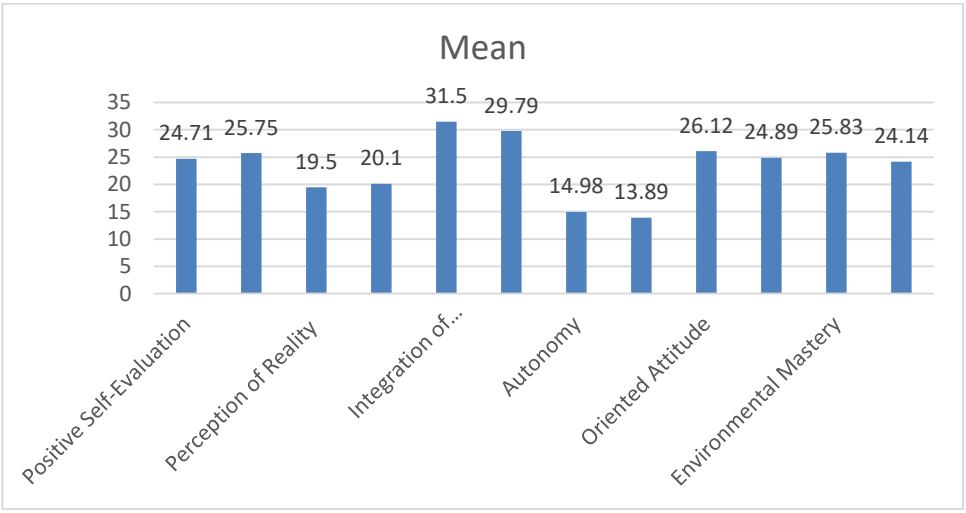
TABLE 6, shows the mean and P-value of environmental mastery among the selected groups

Group	N	Mean	SD	P-Value
Males	60	25.83	3.73	P<0.05
Females	70	24.14	3.87	

DF= 128
Source: Authors' own conception

Table-6 had shown the mean of both the groups on environmental mastery. The mean of the male athletes and female college students are found to be (25.83) and (24.14). The SD of the male and female college students are found to be (3.73) and (3.87) respectively. The P-value which is found to be significant at 0.05 significance level. It means male college students are differing from female college students on environmental mastery.

Graph -1



Source: Authors' own conception

The above graph shows the mean differences among the males and females participants with regard to (PSE), (PR), (IP), (A), (GOA) and (IM)

Discussion

MH inventory-scale was administered to 130 college students to collect the data. Moreover, 't'-test was used to find out the significance differences on different dimensions of MH such as positive self-evaluation (PSE), perception of reality (PR), integration of personality (IP), Autonomy (A), Group Oriented Attitude (GOA), and Environmental Mastery (IM), among male and female college students.

On positive self evaluation (PSE), male college students are not differing from female college students. On the other hand in perception of reality (PSE), male college students are not differing from female college students. Both the groups found to have similar perception of reality. Furthermore, both the groups found to be perception free form need distortion, absence of excessive fantasy and a broad out-look with regard to globe. In integration of personality (IP), male college students are differing from female students. The males found to have more integration of personality compared to female students.

The result showed that in Autonomy dimension of mental health, male are differing from female college students. Male students are found to

have more autonomy compared to female college students, since male students do not depend on others and rely on themselves.

As a result of which male college students are found to have more autonomy compared to female college students.

From the result it is showed that in group oriented attitude, male college students are differing from female college students. Male students found to have more in group-oriented attitude compared to the female college students, because male students get more opportunity to collaborate as compared to the female college students. In case of environmental mastery, it is found that male college students are differing from female college students. Male college students are found to be more in environmental mastery compared to female college students. The result could be because male college students have the capability to work, play, and have the experience to handle the given responsibilities.

Conclusion

The below points is concluded from the present study;

• On positive self-evaluation (PSE), male college students are not differing from female college students.

• In perception of reality (PSE), male college students are not differing from female college students.

• In integration of personality (IP) male college students are differing from female college students.

• In Autonomy dimension of mental health, male are differing from female college students.

• In group oriented attitude, male college students are differing from female college students.

• In case of environmental mastery, it is found that male college students are differing from female college students.

Recommendation

• It is recommended to include physical activities in the daily schedule of the college students.

• Soft skill training modules to be introduced to the college students alone with their daily schedule.

• It is advised to give exposure to the college students for psychological counselling sessions by the professional.

• Supportive and enriched academic environment to be created for the mental health development of the college students.

• Further comparative research on mental health can be done taking different age group of college students in to consideration.

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ANTHROPOMETRY ASSESSMENT OF NUTRITIONAL STATUS OF TRIBAL ADOLESCENT GIRLS OF KEONJHAR DISTRICT, ODISHA

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Date of Receipt: 02.2.2023

Date of Acceptance: 10.4.2023

ABSTRACT

This study was conducted in year 2021 -2022 in Keonjhar district of Odisha, in which 45% of the population belongs to tribal community. The study was conducted in five tribal dominated blocks of Keonjhar (Barispal, Keonjhar, Harichandanpur, Joda, Ghatgaon) among 301 adolescent girls aged between 16 and 18 years. The study revealed that the average height of the tribal adolescent girls was 149.82±2.265 cm, body weight was 39.126±0.022 kg and BMI was 17.43351±1.059 kg m^{-2}. The mean weight, height was found to be less than that of 50th percentile of NCHS standards in every age group. Only 20.6% of tribal adolescent girls were found to be within the normal range of BMI value (18.5-22.9 kg m^{-2}) and the rest 79.4% were underweight (< 18.5 kg m^{-2}) category. The research revealed that there was a statistically significant association between number of family members, family income and socio-economic status with BMI. However, no significant association was found in between age and educational qualification of the respondents with BMI value.

Key Words: Adolescent Girls, Anthropometry, BMI, Nutritional Status, Odisha Tribal Girls

INTRODUCTION

Adolescence is one of the most important and vulnerable period of human life in terms of growth, development and maturation. It is a period of gradual transition from childhood to adulthood which normally begins with the onset of signs of puberty and is characterized by important psychological and social changes, along with physiological changes. WHO has defined adolescents as persons aged 10-19 years. Adolescence period is the transitional phase between childhood and adulthood, characterized by rapid increase in height, weight and hormonal changes resulting in sexual maturation. Owing to sudden and special growth taking place in this phase, the nutritional requirement also increases tremendously compared to preceding years of growth. The nutritional status of adolescent girls is particularly important as being the future mothers they shape the nutritional status of future generation and the community at large (Singh *et al*., 2014).

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In a developing country like India, adolescent girls face serious health problems due to socio-economic, environmental conditions, nutrition and gender discrimination. Increased physical activity combined with poor eating habits and the onset of menstruation contributes to accentuating the potential risk for adolescent's poor nutrition. The tribal societies in India are undisputedly considered to be the weakest sections of population in view of common socio-economic and socio-demographic factors such as poverty, illiteracy, lack of developmental facilities, lack of adequate primary health facilities etc. (Nagamani, 2014) and the tribal girls and women suffer from various nutritional and health issues due to inadequate nutritional intake leading to malnutrition, anaemia, early marriage, early and frequent pregnancy and various socio-cultural practices perpetuating the vicious cycle of undernutrition (Sridhar and Gauthami, 2017). Odisha is the home for the largest number of tribal communities (62 tribes including 13 primitive tribes) of India with a population of 9.59 million constituting 22.8% of the state's total population (Govt. of India, 2011) and 9.19 % of the total tribal population of the country. Tribal people are amongst the poorest and most marginalised population groups experiencing extreme levels of health deprivation.

Keonjhar district of Odisha, which was the study locale has nearly half of its total population i.e. 818,878 (45.4%) as tribals and is one of the tribal concentrated districts of Odisha. Bhuyan and Juang are the two main tribes of Keonjhar and the other tribes were Bathudi, Bhumij, Gond, Ho, Kharwar, Kisan, Kolha(Kol), Kora, Munda, Oraon, Santal, Saora, Sabar and Sounti. The literacy rate among the tribals in males is 44.06% and tribal female literacy rate is 41.56% in Keonjhar district (Govt. of India, 2011). Although several studies on adolescent health and nutritional status have been carried out in India among the general population, there is a dearth of information pertaining to the health and nutritional status among adolescent girls in tribal populations. Hence, the study was conducted to determine the nutritional and overall health status of the tribal adolescent girls in 2021-22.

MATERIALS AND METHODS

Out of the13 blocks of Keonjhar district 5 blocks were selected where the tribal population was high namely Banspal, Keonjhar, Harichandanpur, Joda, Ghatgaon. A total of 301 tribal adolescent girls were selected as the respondent and the data was collected in year 2021- 22. Age of the respondents was between 16 and 18 (non-pregnant, non-lactating) years and considered to the nearest whole number. Keeping the objectives of the study in mind an interview schedule was formulated for recording general and socio-economic information along with anthropometric parameters. Methods of assessment of nutritional status were anthropometric measurement (height (cm) weight (kg) were recorded and Body Mass Index (BMI) was computed. Height of the respondents was measured to the nearest 0.1 cm, using a portable Anthropometry rod. Weight was measured using a digital weighing machine. The respondents were instructed to wear light weight clothes and not to wear foot-wear for more accuracy in weight and height measurement. The formula for Body Mass Index (BMI) prescribed by WHO, weight (kg)/ height (m^2) was used to calculate the Body Mass Index (BMI). Statistical analysis such as arithmetic mean, standard

Table 1. **Socio-economic and demographic profile of tribal adolescent girls (n= 301)**

S.No.	Variables	Number of Respondents	Percentage (%)
1	2	3	4
1	**Age of the Respondents**		
	16 years	116	38.54
	17 years	112	37.21
	18 years	73	24.25
2	**Type of Family**		
	Joint	56	18.60
	Nuclear	245	81.40
3	**Total Number of Family Members**		
	5 or less	40	13.29
	6 – 7	194	64.45
	More than 7	67	22.26
4	**Educational Status of the Respondent**		
	Illiterate	52	17.2
	Primary (Completed Grade5)	149	49.5
	Upper primary (Completed Grade7)	40	13.29
	Secondary (Class 8 to Class 10)	58	19.27
	Higher Secondary	02	0.6
	Graduation	00	70
5	**Marital Status of the Respondent**		
	Married	74	24.6
	Unmarried	227	75.4
6	**Occupation of the head of the family (Modified Kuppuswamy's SES Scale)**		
	Skilled Agricultural and Fishery Workers	15	4.9
	Craft and Related Trade Workers	51	16.9
	Plant and Machine Operators and Assemblers	25	8.4
	Elementary Occupation	210	69.8
	Unemployed	0	0

Table 1 Contd.

Table 1 Contd

S.No.	Variables	Number of the Respondents	Percentage (%)
1	2	3	4
7	**Total Monthly Family Income (Rs.)**		
	Less than Rs. 5000	0	0
	In between Rs. 5001 – Rs 8000	205	58.1
	In between Rs. 8001 – Rs 10,000	79	26.25
	More than Rs. 10,000	17	5.65
8	**Kuppuswamy's Socio-Economic Status**		
	Upper (I)	0	0
	Upper Middle (II)	0	0
	Lower Middle (III)	0	0
	Upper Lower (IV)	107	35.55
	Lower (V)	194	64.45

deviation, percent distribution, and chi-square test of individuals according to different variables. Chi square test was used to evaluate the statistical significance between the variables.

RESULTS AND DISCUSSION

Table 1 depicts the demographic profile of the respondents who fell under different category of age groups, type of family, number of members in family, monthly family income, educational status, marital status of the respondents. Socio – economic details of family members were assessed by using Modified Kuppuswamy's SES Scale (Saleem, 2020). All the respondents belonged to Hindu households.

A total of 81.4% of the respondents were from nuclear or extended families and 18.6% belonged to joint families which showed the decreasing joint family system among the tribal population. Similar results were reported by Nanda and Dhar (2017), Santhanam and Maheswari (2022). Highest number of respondents were of 16 years age (38.54%) and the mean age was 16.85 years. Majority of the respondents (64.45%) had 6-7 members in the family and 22.26% had more than 7 members in their family. Santhanamand Maheswari (2022) reported that majority (51%) of household had family members in between 5 – 7. Nanda and Dhar (2017) in their study on nutritional status of adolescent girls of Dongria Kondh tribe found that the 70.97% households had 7-9 members in the family.

A total of 49.5% of the tribal adolescent girls had education up to primary level. 13.29 % had educational qualification up to upper primary and 19.27% had secondary educabon. 17.2% of the respondents were illiterate. As per the Census

of India (2011). Keonjhar district had tribal female literacy rate of 41.56% with a gender gap of 22.5. Odisha Economic Survey 2019-20 indicated that the enrolment percentage of tribal girls in elementary education is decreasing year by year since 2016-17.Santhanam and Maheswari (2019) reported that the same type of result *i.e.*, majority 51% of the respondents had education till middle school. Sridhar and Gauthami (2017) in their study reported that majority of the subjects (41.2%) had education up to primary school, 22.8% less than primary school, 6.4% up-to high school and 25.9% were illiterates.Financial issues, negative attitude of parents who were themselves illiterate, early age marriage, linguistic barriers, unwillingness of parents to spare the labour force and allow the girl child to school for education are some of the reasons for low enrolment rate and high dropout rates of tribal girls.In context of marital status, 24.6% of the respondents were married and 75.4% were unmarried and the mean age of married tribal adolescent girls was found to be 17.2 years. Sridhar and Gauthami (2017) reported that 41.4% of the respondents had conception by the age of 17. Early age marriage is one of the major causes for malnutrition, anaemia, maternal and neonatal mortality among the females.

Majority (69.8%) of the respondents were from the household where the head of the family had elementary occupation (agricultural labours, labours, collection of forest amenities, marginal farmers). Fathers of 8.4% of respondents worked in the mining factories. 16.9% respondents' family head was engaged in trade of local alcoholic drink known as 'Handia', and goat, poultry farming utilising the poverty funds provided by the Government. Only 4.9% respondents were from the family where the head of family were skilled agricultural farmer. Jana and Ghosh (2015) in their study on socio-economic conditions and quality of life in the tribal areas of Orissa with special reference to Mayurbhanj District found that the majority of the tribals (Mean 48.3) were earning their livelihood as agricultural labourer followed by other workers.

Two-third of the respondent's family had monthly income in between Rs. 5000 – 8000 per month and only 5.65% family had monthly income more than Rs.10,000. Devi and Patil (2019) found that 31.2% of the tribals had monthly income in-between Rs.5000 – Rs.10,000. Mallick *et al.* (2021) in their study on the living standards of the Kandha people in Kandhamal District of Odisha reported that majority (29.25%) of the tribal household had a monthly income in between Rs. 5000 – 7000. Illiteracy, geographical isolation, ignorance about using modern techniques makes the tribal economy still marginalised.George *et al.* (2022) in their study found that 32.2% of the respondent's parents had monthly income between Rs.4810 and Rs. 8009. Modified Kuppuswamy's SES Scale (Saleem,2020) revealed that 64.45% of the respondents' family belonged to lower socio-economic group and 35.55% belonged to upper-lower socio-economic group and lacked all the basic household amenities.

The age-wise mean weight of the respondents was calculated and was found to be 39.33 kg, 38.95 kg and 39.06 kg for 16, 17 and 18 years of tribal adolescent girls, respectively. There was a mild decline in average weight from 16 to 17 years and again an increasing trend was observed from 17 to 18 years of respondents. The mean weight was

S.No.	years	N	%	Mean	SD	perce-ntile) weight in kg	Mean	SD	(50th perce. ntile) height in cm
1	2	3	4	5	6	7	8	9	10
1	16	116	38.54	39.336	±2.067	54	149.612	±2.332	162.5
2	17	112	37.21	38.955	±2.483	55.3	149.973	±2.295	163
3	18	73	24.25	39.068	±2.562	56.2	149.931	±2.518	163.2
4	Total	301	100	39.126	±0.022		149.82	±2.265	

found to be less than that of 50th percentile of NCHS standards in every age group. Sridhar and Gauthami (2017), Singh and Mondal (2014)reported similar findings among the tribal adolescent girls of various parts of India. Das and Gautam (2022) in their research found the mean body weight of 16, 17 and 18 years of Dongria Kondh adolescent girls of Niyamgiri Hills of Odisha, 42.6±4.6, 43.0±4.2 and 45.1±4.6 respectively which was significantly lower than 50th percentile of NCHS standards.

The age-wise mean height of the tribal adolescent girls was calculated and was found to be 149.61±2.332 cm, 149.97±2.295 cm and 149.93±2.518 cm for 16, 17 and 18 years of respondents respectively. There was a mild increasing trend age-wise but was negligible. The mean height was found to be less than that of 50th percentile of NCHS standards in every age group. Stunting (low height for age) resulted from prolonged nutritional deficiency since early life of the child. Much lower height for age as compared to NCHs 50th percentile was also observed by Singh *et al.* (2014), Santhanam and Maheswari (2022), Singh and Mondal (2014) in their studies. George *et al.* (2022) found the mean and standard deviation of height as 150.8±6.2 cm which suggested stunting among the adolescent tribal girls of Namkum block of Jharkhand. Banik *et al.* (2016) in their study among the children and adolescents of Limbu and Mech tribal communities of West Bengal reported that the mean height of 16 – 18 years old adolescent girls were 149.27±4.50cm and 153.04±5.66cm.UNICEF (2016) has reported that significant number of children in India were suffering from stunting. Nutritional stress in early period of life is the major cause of retarded growth leading to stunting and thinning. The respondents of all the three-age groups had significantly lower height and weight as per the age. The burden of physical work pressure prolonged scarcity of nutritionally adequate food

Table 3. **BMI of the tribal adolescent girls (n = 301)**

S. No.	Age in years	N	%	BMI	
				Mean	SD
	1	2	3	4	5
1	16	116	38.54	17.574	±1.013
2	17	112	37.21	17.323	±1.100
3	18	73	24.25	17.379	±1.057
4	Total	301	100	17.43351	±1.059

lack of awareness, poverty led to the problem of stunting and thinning among the adolescent girls.

BMI calculation is the best set of measurement found to be simple and useful indicator for nutritional status of adolescents. Body Mass Index was calculated by using the height and weight of the respondents. The mean BMI for 16, 17 and 18 years of tribal adolescent girls were found to be 17.57±1.013, 17.32±1.100 and 17.37±1.057 respectively and total average was 17.43±1.059. Prevalence of undernutrition in all age group was found to be high resulting in growth retardation, stunting, thinning among the tribal adolescent girls. From the research of Varoda *et al.* (2020), it was found that the mean BMI of Baiga tribal adolescent girls in Chhattisgarh District was 18.2, 17.9 and 18.0 respectively for 16, 17 and 18 years of respondents. Sinha (2014) in her study nutritional profile of tribal adolescent girls of Ranchi district

Table 4. **Distribution of respondents based on BMI (n = 301)**

S. No.	NIH and WHO Grade of Malnutrition BMI (kg m^{-2})	f	%	Asian- Indian Specific Guidelines BMI (kg m^{-2})	f	%
	1	2	3	4	5	6
1	<16.5 - Severely underweight	70	23.25	< 18.5 - Underweight	239	79.4
2	<18.5 - Underweight	169	56.15	18.5 – 22.9 Normal	62	20.6
3	18.5 - 24.9 - Normal weight	62	20.6	>23 – 24.9 Overweight	0	0
4	25 - 29.9 – Overweight	0	0	>25 Obesity	0	0
5	>30 - Obesity	0	0	-		

of Jharkhand found the mean BMI of the tribal adolescent girls was 17.09±2.54. However,Singh and Mondal (2014) in their study among the adolescents (belonged to Mongoloid tribal population) of Assam reported the mean BMI for girls of age 16, 17 and 18 years as 19.84±1.43, 20.27±1.64 and 20.69±1.04, respectively. Like a silent emergency, malnutrition, particularly undernutrition continues to be a major public health issue in India among the children and adolescents. Adolescence period is possibly less vulnerable to infection than a younger age and is commonly regarded as a relatively healthy period of the life cycle leading to, they being somewhat neglected. The vicious cycle of poverty, intergenerational malnutrition and chronic disease among the tribal adolescent girls can be interrupted by nutritional intervention.

Out of the 301 tribal adolescent girls studied, as per WHO grade of malnutrition cut off, 23.25% were severely underweight, 56.15 % of respondents were underweight and 20.6% were within normal range of BMI. As per Asian Indian specific guidelines for defining and managing overweight and obesity (2004), 79.4% of the respondents were underweight and 20.6% were having normal BMI. Ravula *et al.* (2017) in their research of adolescent girls of tribal regions of Telangana reported that 54% of the respondents of late adolescence and 82% of the respondents from early adolescence were suffering from undernutrition. Pandurangi *et al.* (2022) in their study reported that most of the adolescent were suffering from double burden of malnutrition in terms of stunting and thinning.

Table 5 depicts the association between different socio-economic variables with BMI of the tribal adolescent girls of Keonjhar district. Chi square test for correlation was carried out to know the association. No association was found in between the Kuppuswamy's Socio-Economic Status of the family, age and educational qualification of the respondents with BMI value. But a statistically significant association was found between number of family members of the respondents and total monthly income of the family with the BMI value of the respondents ($p < 0.05$). The incidence of under-nutrition was found to be more with the increase in the number of family members. With scare resources, the quantity and quality of food consumed were low with increase in number of members in family. Similarly, the respondents belonging to the family with more monthly income were found to have better BMI status than those who belonged to the family with less monthly income. Monthly income was one or have only the most significant determinants in terms of access, afford and availability of adequate food. Education serves as a key factor in development of any person/ community. As majority of the respondents were either illiterate or have only primary education, they hardly had any knowledge about the importance of balance diet, or requirements of proper nutrition for a healthy leaving. Parents educational qualification, occupational status and amount of monthly income serves as the most important determinant in the nutritional status of the children. Type of occupation of the parents' head of the family leads to purchasing power of the family, leading to consumption of amount and type of food and ultimately nutritional status. A total of 69.8% of the respondents' fathers were engaged in the elementary jobs *i.e.* daily wage labours, agricultural/ mining labours, collection of forest products which leads very low income and purchasing power. Access to food, availability

Table 5 Association of different socio-economic variables with BMI (n= 301)

Sl.No	Variables	BMI						
		Under Weight (%)	Normal (%)	Over Weight (%)	Obese (%)	Total	Chi-Square value	p-value
		<18.5	18.5-22.9	23-24.9	>25			
1	2	3	4	5	6	7	8	9
1	Age (Years)						2.805	0.83
	[illegible]	87	29	0	0	116		
	[illegible]	90	22	0	0	112		
	[illegible]	62	11	0	0	73		
2	Education						2.153	0.939
	[illegible]	41	11	0	0	52		
	Primary (Completed Class 5)	117	32	0	0	149		
	Upper primary (Completed Class 7)	31	09	0	0	40		
	Secondary (Class 8 to Class 10)	49	15	0	0	64		
	Higher Secondary	21	11	0	0	32		
3	Total Number of Family Members						21.655*	0.0014
	[illegible]	22	18	0	0	40		
	[illegible]	155	39	0	0	194		
	More than [illegible]	64	03	0	0	67		
4	Total Monthly Family Income						39.592*	0.000
	[illegible] Rs 5000	0	0	0	0	0		
	[illegible] Rs 5001 - Rs 8000	184	18	0	0	202		
	[illegible] Rs 8001 - Rs 10,000	49	31	0	0	80		
	Rs 10,000	38	11	0	0	19		

Table 5 [illegible]

Table 5 Contd

	BMI						
Variables	Under Weight (%)	Normal (%)	Over Weight (%)	Obese (%)	Total	X2 Chi-Square value	p-value
	<18.5	18.5-22.9	23-24.9	>25			
2	3	4	5	6	7	8	9
Kuppuswamy's Socio-Economic Status						6.477	0.371
Upper (I)	0	0	0	0	0		
Upper Middle (II)	0	0	0	0	0		
Lower Middle (III)	0	0	0	0	0		
Upper Lower (IV)	118	44	0	0	162		
Lower (V)	121	18	0	0	139		

Chi **square value p<0.05, significant**

of medical facility, availability of food throughout the year, care given to the children, etc were important determinants in shaping the health and nutritional status of the children and adolescents (Khan and Raza, 2014). Baliga *et al.* (2014), Kshatriya and Acharya (2016), Banik*et al.* (2016), Kuiti *et al* (2022) in their respective studies suggested that various socio-economic determinants such as literacy, type of occupation, total family income, family size were directly associated with the overall nutritional status of tribal adolescent girls and significant association between type of family, size of land holdings and occupation type of parents with the nutritional status of the adolescent girls.

CONCLUSIONS

The nutritional status of tribal adolescent girls (16 – 18 years) of Keonjhar district of Odisha was low.The mean BMI was 17.43351 ±1.059. Stunting, thinning was prevalent and age-wise height and weight was found to be less than that of 50th percentile of NCHS standards. Adolescence is a period of rapid growth and girls reach their peak stage of growth during this period. However the problems such as illiteracy, poverty, ignorance, geographical isolation, large family size, unavailability of basic healthcare facilities, etc. have made the tribal adolescent girls vulnerable to malnutrition, anaemia and other nutrition related problems.

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URBANIZATION IN INDIA : THE WAY AHEAD

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Urbanisation is a universal phenomenon. The demographic transition from rural to urban centres has brought in its fold more risks than opportunities. Alarmingly spreading slums, palpably poor sewerage disposal system, traffic logjam, inundated cities during monsoons, inadequate transportation facilities are some issues that have exposed the Achille's heel of urban administration in India. Recent steps in mission mode at the union and state levels in the country are expected to solve some of the daunting problems. As urbanisation here is still a starter (only 31 per cent as against 80 or 90 per cent in the USA or UK), urban administration has to prepare itself for an uphill task.
Key Words: Urbanisation, agglomeration, census, slum, Gurujam, infrastructure.

Urbanization has remained one of the ill-addressed challenges in India. The arrival of the colonial countries in different parts of the subcontinent during the 17th/18th centuries can be considered as the harbinger of urbanization in this part of the world. The accessible coastal places and commercially vibrant conglomerations like Calcutta, Bombay Madras, Delhi because of the frequenting and convergence of vested interests understandably went on adding to their existence demographically as well as spatially. The first municipal corporation came up at Bombay in 1888 after the passing of the Municipal Corporation Act 1888 and thereafter at Madras and Calcutta.[1] By the time India attained independence, there were hardly 14 percent of its population who used to be associated with urban locations. There was no concerted effort at the administrative level either during the pre or (immediately after) the post-independence period to address urban issues in India seriously. Urbanization in India can arguably be described as the byproduct of failed regional planning. Despite the fact that local self-government as a concept of administrative improvement was introduced in the later part of the 19th century (1982), cities of any type were left to themselves to grow up bereft of any planned administrative intervention.

The status quoist and apathetic attitude of the colonial outsiders and the Indians' inexperience in urban affairs were gradually replaced by the introduction of planning in India since the 1950s. Although the different Five Years Plans (the first being 1952-57), attempted in some way or the other to deal with urbanization in India, it was not until 1992 when the 74th Constitution Amendment Act was passed in the Indian Parliament which attempted to give a new direction to urban management in the country.

A synoptic view on urbanization in India suggests that it has been a slow process – the percentage of the urbanized moving from 13.86% in 1941 to 31% at the time of Census 2011. In gross terms, there are nearly 377 million Indians who are now inhabiting the different urban centres in the country. Compared with some other developing countries in terms of extent of urbanizaiton – China (45%), Indonesia (54%), Mexico (78%), Brazil (87%)[2], India is convincingly quite far behind. The decadal growth rate of urbanization in India shows a declining trend barring only during the period 1971-81 (with growth rate 3.79%) which was slightly higher than 2.32% (during 1951-61), 3.09% (1981-91), or 2.75% (1991-2001).

Comparison between the last two censuses (2001 and 2011) throws light on the nature of growth of urban centres in India. The number of towns stood at 7935 as per census 2011, which was an increase of about 2774 over the last census (2001). The classification of urban centres in India is important as they have been differentiated from each other on the basis of certain attributes. Before that a general gradual increase in the number of urban centers over a period of time is discernible. The number of urban centres in India in 1971 was 3126 which went upto nearly 8000 in 2011. Besides the growth in the number of urban centers, the growth of population in such places has also gone on the rise. Data analysis over the period of the last seven decades hints at a general

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declining trend in the growth rate of urban population or a slowing down of urbanization when compared with more urbanized countries. But the remarkable thing is that the absolute increase in urban population in India has been higher than that in connection with the rural population. This has huge implications for comitant development of infrastructure and other urban amenities.

The share of urban population in India has gone up from 13.86 per cent in 1941 to 31.16 per cent according to assessment made in Census 2011. It is projected that the Indians living in urban areas would be about 600 million by 2030, marking an increase of over 200 million within the coming one-and-half or two decades. The alarming rise in the total number of population in India which is expected to put the country at the top by replacing China, would obviously impact the concentration in urban pockets. The expanding economy of the country would also induce changes in the mind of the people which have of late been noticed in more and more of them being averse to rural but inclined to urban living as the latter are comparatively ahead of their rural counterparts in terms of infrastructural and other facilities.

Despite the fact that urbanization does have mixed effects, positive as well as negative, on society the transformation from rural to urban has been a universal fact. While countries like Singapore, Bermuda, Monaco and Nauru are the most urbanized, Trinidad and Tobago, Burundi, Papua New Guinea, Uganda, Malawi etc. are known to be the least urbanized countries in the world. The UK with almost 90 per cent of its population being urbanized and still going at 0.5% rate of urbanization is believed to be the first urbanized country. Another well known member, the US, is estimated to be urbanized upto 82 per cent of its population with a rate of urbanization of 1:3 per cent [4]. Across all these varieties of states it has been observed that the people's bias in favour of the urban has been dominant.

The Population Reference Bureau 2010 puts that almost half of the world's population lived in cities in 2010. By 2030, the share of such people could be upto 60 per cent. The growth in urbanization would bring in its fold the already complicated issue of spread of slums. CARE (Cooperative for American Relief Everywhere) (2006) estimates that the number of slum dwellers is expected to double from 1 billion to 2 billion over the next 25 years. The number of mega cities (with population over 10 million) is also assumed to rise from 19 in 2007 to 27 in 2025[5].

As the developing countries of the world are relatively late in witnessing urbanization, they are not adequately prepared to address the complicated challenges that urbanization usually brings in its fold. Cities throughout the world have tended to be congested, polluted, energy intensive, ridden by crime, corruption, poverty and are difficult to manage. The cost of investment in infrastructure has been enormous. Mega cities of the world are now hugging headlines due to unprecedented traffic jams. The Indian counterparts are not far behind in terms of the urban woes that come in intermittent doses. In late July 2016, there was 15km long traffic jam very aptly described by the press as 'Gurujam', referring to the notorious traffic jam that took place in Gurugram, the upcoming urban agglomeration previously known as Gurgaon which is adjacent to the Indian national capital[6]. The notoriety of the national capital of India is well known all over the world for its dangerous levels of air pollution. Just recently the educational institutions in the city were ordered to be closed for days together as the pollution level was quite alarming.

Lancet, the acclaimed international journal, reported that in 2015, 2:5 million deaths in India were due to air, water and other types of pollution, air pollution being responsible for nearly 1.81 million deaths and water pollution for 0.64 million deaths. The state of Global Air (SAG) Report, 2017, another international report records death due to air pollution in India at a figure less than Lancet's by 700000. Such variance in the reports of the two internationally acclaimed sources has come to the rescue of India's Ministry of Environment and Forests (MoEF) bosses who have promptly described them as misleading. The SGA 2017 report puts the deaths due to air Pollution in India at 1090400 while the same for china is 1108100. Comparatively, Lancet reported that India accounted for 28 percent of the 9 million deaths world wide in 2015 that were due to pollution[7].

In a measure of Air Quality Index (AQI) in New Delhi, it was severe at 426 in 2016 whereas in 2015 it was very poor at 327 and 326 in 2017, which is slightly better. This little improvement is credited to the Supreme Court restriction on the sale and use

of crackers on the day of Diwali (19 October 2017). How unfortunate is it that it is always some out- side intervention either from the Supreme Court of from the administration that the people of this country would come to some reluctant agreement (to abide by some restriction) event if it happens to be a social harn-kiri Idisguised as some foolish amusement !

Come monsoon every year, the vitals of our urban planning are laid bare to all. In July 2005, Mumbai came to a standstill, received nearly 944 mm rainfall in 24 hours and left at least 273 dead. In the following year in 2006, flooding in Mumbai claimed 182 lives. Heavy rains in Chennai during October-December 2015 left at least 100 dead and the damages were estimated worth Rs.20,000 cr. Bangalore and Hyderabad experienced severe water logging during July 2016[8]. In Bangalore, 5 lakes burst leaving vast areas inaundated. During the last monsoon in Mumbai the tragic incident of a doctor getting sucked in my a open manhole on a heavily flooded street in Mumbai could be the most tragic testimony to our civic management.

The exorbitant cost of sustainable urbanization can be gauged from just one aspect of the multi-pronged challenges that are thrown in particularly in connection with urban management in the Developing countries. As per the UN High Level Panel on Financing for development 2001, the cost then for the modest slum improvement target under the MDGs (Millennium Development Goals) was about $ 4 billion per year. For overall infrastructure needs in the developing countries, the investment requirements may amount at persent to as much as $120 billion a year.

Urbanization is often viewed as a negative trend with many poor people moving to cities in search of work. In some cases the unsuccessful end up in the underworld, living hand-to-mouth in dangerous slums, far from family support with problems such as cramped and unhygienic living spaces, higher costs, long commutes and often more crime and pollution being prevalent. That is why the UN warned that people who live in slums suffer as much as the rural poor.

Effects of urbanization on the environment have also been found to be disturbing. The loss of wild life, climate change, increased air pollution have affected communities adversely as have already been witnessed in cities like Shanghai, Jakarta, Mexico City during the 1990s.

Negative effects of urbanization should not mean that they are natural and irreversible. Rather they are more reflective of the human apathy and callousness in dealing with the challenge effectively. Rudy Giuliani and his team could exemplarily deal with a catastrophic human emergency during 9/11[9]. River Thames could be brought back from the dead due to human intervention which sixty years ago (in 1957) was one of the most polluted rivers in the world[10]. The ills of urbanization wherever they appear can be averted decisively by collective human effort. No single powerful authority or government can succeed unless the mass of people realize the gravity of the problem and come up to play their part in solving that problem.

The positive aspects of urbanization can be known from the fact that now-a-days urban centers have been found to be engines of economic growth. The Central Statistical Office (CSO) in India has found out from its estimates over a period of some years that urban share of GDP in the country has increased from 37.7 per cent in 1970-71 to 52 per cent in 2004-05. The mid-term appraisal of the Eleventh Plan in India projected the urban share of GDP at 62-63 percent in 2009-10.

It has also been realized that, urbanization will be central to India's strategy for achieving faster and more inclusive growth because agglomeration and densification of economic activities (and habitations) in urban conglomerations stimulates economic efficiencies and provides more opportunities for earning livelyhoods. The avenues for entrepreneurship and employment are also accompanied with urbanization. Recently it has been understood that urbanization has direct impact on growth potential of the country's economy. Rural-urban linkages have to be increased so that the growth in the urban economy will also help in accelerating growth in the rural sector.

The High Powered Expert Committee (HPEC) under the chairmanship of Dr. Isher Judge Ahluwalia, constituted by the Ministry of Urban Development for estimating the investment requirements for urban infrastructure services has observed that the fortunes

of the agricultural sector are crucially linked to the manner in which growth in the industry and services sector unfolds. People living in rural areas have started tapping the opportunities that cities provide for employment, entrepreneurial, opportunities and education. Growth in urbanization also induces growth in demand for food items other than vegetables, milk, eggs etc. This leads to investments in infrastructure, logistics, processing and packaging in rural-and peri-urban areas. Thus the rural sector also benefits from good management of neighboring urban conglomerations.

Vision of Cities in India.

In the matter of urbanization, the objective of the Twelfth Plan aptly captures the essentials – faster, more inclusive and more sustainable growth. Urbanization should be guided towards inclusive, equitable and sustainable growth of towns and cities with proper civic amenities. Ideal urbanization would ensure that towns and cities are free from slums and provide adequate opportunities for productive employment and a decent quality of life to all inhabitants including the poor. The smart cities would increasingly complete for investment nationally and internationally. For this, cities must provide world class infrastructure and services at affordable costs to give a competitive edge to the economic activities they undertake.

Cities should be able to provide basic services to migrant workers, other vulnerable sections of society including women and children. The future renewal of our cities should facilitate transition from 'informality' of large number of workers towards more formal livelihoods in line with their aspirations. They should address various vulnerabilities including residential, occupational and social vulnerabilities, associated with urban poverty. People should be brought to the heart of the urban agenda for-deciding the vision of their city, and for choosing the process of reaching that goal. All citizens must have access to basic services of clean water, sanitation, sewage, solid waste management urban roads, safe and affordable public transport system, affordable housing, and a clean and healthy environment. Besides creating opportunities for gainful employment cities should also be able to meet the rising aspirations of people for a better quality of life. Citizens should be proud of their cities and take responsibility for their cleanliness, safety and hospitality. Cities should be environmentally sustainable. Future growth of cities should be consistent with cities' natural endowments and the economic potential of the of the region in which they are situated. All cities should be efficient in using available resources particularly energy, water and land. Indian cities should also preserve their cultural and historical heritage and should benefit from the tourism potential of their heritage and natural endowments[11].

What is 'Urban' ?

On the basis of different, parameters adopted in defining 'Urban', persons and institutions of importance have attempted to define the concept in different ways. The World Development Report (2009), as elaborated by Uchida and Nelson, defines 'Urban' as all settlements above a certain minimum population size and minimum certain travel time by road.

The Organsation of Economic Cooperation and Development (OECD) approach seems more elaborate than the WDR approach. The OECD methodology consists of three main steps:

i) identifying contiguous or highly interconnected densely inhabited urban cores,

ii) grouping these into functional areas;

iii) defining the 'hinterland' of the functional urban area. The population size cut offs (50,000 or 100000) depending on the country and also the population density cut offs (1000 or 1500 people/ sq. km) to define the urban cores and then selects those areas from which more than 15 percent of workers commute to the core as hinterlands[12].

The UN Population Division on the basis of censuses in different countries has taken factors like population size, population density type of economic activity, physical characteristics, level of infrastructure etc. while attempting to define 'urban'. On the basis of population size, a majority of countries (about 100) use the minimum population threshold as criterion of defining 'Urban'.

Minimum Population Threshold	No. of Countries
200	4
400	1
500	1
600	1
1000	8
1500	6
2000	23
2500	13
3000	3
4000	1
5000	21
9000	1
10000	12
20000	4
30000	1
50000	1

Source : worldbank.org>sustainablecities

There are a few countries which use population density as the threshold for defining 'Urban'. While 150 persons/sq. km has been found to be the lowest in the category (followed in countries like Germany), 1500 persons/ sq. km. has been found to be the highest which are applicable in countries like China.

Another approach defines an 'Urban' area as the region surrounding a city. Most inhabitants of urban areas have non-agricultural jobs. Urban areas are generally developed meaning there is a density of human structures such as houses, commercial buildings, roads, bridges, railways etc. Urban area in this sense can refer to towns, cities, and suburbs. An urban area includes the city itself as well as the surrounding areas[13]. This can be better understood when- contrasted with rural areas. Rural areas, often called 'the country' have low population density and large amount of undeveloped land. Usually, the difference between the urban and rural areas is clear. But in developed countries like Japan such differentiation is less clear. In the countries like the U.S., for example, settlements with 2500 inhabitants or more are defined as urban. But in Japan, which is far more densely populated than the US, settlements with 30,000 people or more are considered as Urban.

Indian Approach

The Indian approach to define 'Urban' is well explained in the Census 2011. An urban area can be defined as.

(i) all places with a municipality, corporation, cantonment board or notified town area committee etc;

(ii) all other places which satisfy the following criteria:

(a) a minimum population of 5000

(b) at least 75 percent of the male main working population engaged in non-agricultural pursuits.

(c) a density of population of at least 400 persons per sq. km.

The towns under category (ii) are known as census towns. These were identified on the basis of Census 2001 data. Some other concepts in connection with urbansation in India and elaborated in the Census 2001 are: Urban Agglomeration: An Urban agglomeration is a continuous urban spread constituting a town and its adjoining outgrowths (OG), or two or more physically contiguous towns together with or without outgrowths of such towns. An Urban Agglomeration must consist of at least a statutory town and its total population (i.e. all the constituents put together) should not be less than 20,000 as per Census 2001.

Outgrowth (OG): An outgrowth is a viable unit such as a village or a hamlet or an enumeration block made up of such village or hamlet and clearly identifiable in terms of its boundaries and location. Some of the examples are railway colony, university campus, port area, military camp etc. which have come up near a statutory town outside its statutory limits but within the revenue limits of a village contiguous to the town.

According to Census 2011, there are 7935 towns in the country. The number of towns has increased by 2774 since the last Census. Many of these towns are part of UAs and the rest are independent towns. The total number of UAs/ towns which constitutes the urban frame is 6166 in the country[14]. The following is a concise sketch of facts about the extent of urbanization in India.

Total Urban Population
- 3 77 million (Census 2011)

Class I UAs/Towns with population (>1,00,000)
- 468 (2011)/394 (2001)

70% of urban population / 264.9 million

Million Plus cities with population(>10,00,000)
- 53/468 (42.6% of urban population)

Mega cities
- Delhi (16.3 million)

Kolkata (14.1 Million)

Urbanization in Odisha:

Urbanization is the movement of people from rural to urban areas, according to the UN. A process of concentration of population in a particular territory can also be understood as urbanization. In a slightly different terminology, urbanization can refer to the diffusion of the influence of urban centers to rural hinterland. Michael W. Mitchell defines urbanization as a process of becoming urban, moving to cities, changing from agriculture to other pursuits common to cities. According to Alan Gilbert, urbanization ""conveys something about economic, social, and cultural change. It is part and parcel of the process of modernization – a phenomenon that involves a shift from agricultural to urban forms of work, a change in social relationships, and important modifications in family life" .[15]

On the basis of the average growth rate of urbanization in India, as shown earlier, the noticeable trend is a slowing down of urbanization. But the absolute increase in urban population has been higher than that in case of the rural population. The declining trend has also reversed during 2001-2011. Urban centers in the country have gone up to 8000 in 2011 that were 5161 in 2001 and 3126 in 1971. Rural-Urban migration being a world-wide phenomenon, it is estimated that about 70 percent of the population would be living in cities by 2050. India world need about 500 new cities to accommodate the influx by then.

Odisha has got 16.68 percent of its population urbanized as against 31.16 percent urbanized in India. It must not be a cause of complacency or relaxation for both the national as well as the state governments. The importance of renewed and reinvigorated attention to urbanization in Odisha has increased ever since the capital city of the sate was ranked. No.1 in a list of 20 cities that were selected on different parameters to be taken up as smart cities by the national government[16]. This is clearly a case of jubilation for the government as well as the people of the state. But opportunities and risks come in tandem, risk of only managing the city in focus and forgetting the peri-urban or other emerging towns. Urbanization to be sustainable the administration has to take a centrifugal not a centripetal approach.

The Housing and Urban Development Department (HUDD) of the state of Odisha has taken up as objectives:

(i) improving urban planning and governance for effective enforcement of plans, rules, efficient urban management and service delivery;

(ii) facilitating reforms and interventions to improve financial base of ULBs and better citizen interface in service delivery;

(iii) enhancing service standards, transparency, accountability and simplifying process for grievance redressal.

(iv) encouraging PPP projects for infrastructure development, urban transport and solid waste management;

(v) slum development and rehabilitation and effectively implementing housing schemes for EWS, MIG, LIG;

(vi) implementing programs for skill development and urban poverty reduction;

(vii) encouraging innovation in urban management;

(viii) creation and maintenance of urban infrastructure, sewerage, solid waste management, storm water drainage, urban transport and other amenities[17].

The Citizen Charter of the department (HUDD) states that "proper and planned growth of cities and towns across the state with adequate infrastructure, amenities and services provided to the citizens" through the ULBs and para-statal agencies. Efficient management and delivery of civic services, affordable housing, safe drinking water, sanitation including solid waste management, storm water drainage, sewerage, roads, public transport, creation of livelihood opportunities by accepting economic growth of cities and towns and building capacity of urban poor are some other policy statement highlights.

The trends of urbanization in Odisha can be understood from the following table.

Census Year	Total No. of Towns	Total Population	Urban Population Percent	Decennial Population Growth (in Percent)
1941	29	13769880	412528 3.00	30.03
1951	39	14645946	594070 4.06	44.01
1961	62	17548846	1109650 6.32	86.79
1971	81	21944615	1845395 8.41	66.30
1981	108	26370271	3110287 11.79	68.54
1991	124	31655736	4234983 13.38	36.16
2001	138	36706920	5496318 14.97	29.78
2011	223	41947358	6996124 16.68	

Source: Rural -Urban Distribution of Orissa, Census of India 2001.

The challenges of Urbanization cannot be effectively addressed without sound financial allocation and expenditure. A glance at the expenditure of the Housing and Urban Development Department of the state reveals that there has been a steady increase over the past which is obvious. The budgeted amount for 2017-18 has been Rs.4478cr. as against that in 2016-17 which was Rs3357cr, thus the change in allocation being a 34.3 per cent increase over the past[11]. Based on the recommendations of the 14th Finance Commission and the 4th State Finance Commission, Rs.351cr. and Rs1117cr. respectively have been earmarked to be transferred to the ULBs of the state. The department-wise expenditure for 2017-18 of the Housing and Urban Development Department shows that the administrative expenses (Rs.570.45cr), programmes expenditure (Rs.2439.24cr) and the transfer from the state (Rs.1467.91cr.) together amounted to a total expenditure of Rs4477.60cr. To what extent such response by the government(s) can be effective in fulfilling the requirements of the smart city challenges is only a matter or time. The SCEWC (Smart City Expo World Congress) states that the cities or the urban centers in general should be able "to recognize, promote and support innovative solutions or strategies that can potentially change citizens' lives by increasing efficiency, generating business and improving quality of life"[12].

Issues of Service Delivery:

There is hardly any doubt regarding the woefully inadequate service delivery in India's urban centers. One of the glaring inadequacies in the nature of water supply. As per Census 2011, 70.6 per cent of urban population in India is covered by individual connections (91 percent in China, 86 in S.Africa, 80 in Brazil). Duration of water supply in Indian cities ranges from 1 to 6 hours (24 hours in Brazil and China, 22 in Vietnam). Per capita supply of water in Indian cities ranges from 37 lpcpd (liter per capita per day) to 298 lpcpd for a limited duration (while Paris supplies 150 lpcpd continuously and Mexico 171 lpcpd for 21 hrs per day). Most Indian cities do not have metering for residential water connections. Seventy per cent of water leakages occur from consumer connections and due to malfunctioning of water meters. Non-revenue water (NRW) accounts for 50 per cent of water production (compared with 5 per unit in Singapore).

Sanitation is in an appallingly neglected state. According to estimates, 4861 towns and cities do not have even a partial sewerage network. As per Census 2011, about 13 per cent of urban households do not have access to any form of latrine facility and defecate in the open; 37 per cent of urban households are connected with open drainage and 18 percent are not connected at all. As per CPCB (Central Population Control Board) 2009 report, only about 20 percent of sewage generated was treated before disposal in Class I cities and Class II towns. About 115000MT of municipal solid waste is generated daily in the country according to the CPCB 2005 report. Scientific disposal of the waste generated is almost non-existent in the country.

Public transport system is a poor performer in India. It accounts for only 27 per cent of urban transport in the country. Share of public transport fleet has gone down from 11 percent in 1951 to 1.1 percent in 2001. In 2009, only 20 out of 85 Indian cities with a population of 0.5 million had bus services. Expansion of the economy, in creasing purchasing power of the people have contributed to astromical growth in private vehicles thereby congesting the streets and abetting pollution in the cities.

Affordable housing in urban centers has remained an unrealized dream not only for the urban poor but also for the middle class. Real estate prices have gone beyond the reach of most Indians. The Technical Group on the Estimation of Housing Shortage projects the total shortage of dwelling units in urban areas in 2012 to be nearly 18.78 million units. The projected slum population in India is 94.98 million in 2012. As against this, the number of dwelling units sanctioned under JNNURM (Jawaharlal Nehru National Urban Renewal Mission) in 7 year mission period was 1.6 million units. If these challenges are not tackled expeditiously, the Indian cities would get increasingly chaotic and choked thereby converting more and more rural poor to urban poor. Improving the livelihoods of India's burgeoning population would remain a distant dream.[21]

Strategy for Urbanization:

The Isher Judge Ahluwalia-led HPEC have made some recommendations in this regard. Convergence at the central government level has been one of them. In India, the Ministry of Urban Development and that of Housing and Urban Poverty Alleviation have been found to be operating separately. Merger of such departments can decisively improve effectiveness and efficiency of urban management in India. Coordination between the allied ministries or departments at the central a well as state levels would also ensure better results in urban development.

The committee recommended the setting up of an independent utility regulator at the state level to monitor service levels and adjudicate disputes related to delivery and pricing of services. The regulator would facilitate transparency by regular publication of service level benchmarks, and help set the vision for the ULBs.

Empowering and extending the term of the Mayor was another recommendation of the committee. Eminence of elected bodies in decision-making is a pre-requisite for participatory development process. The heads of the elected bodies should be adequately empowered. For the objective of single point accountability the Mayor should be executive head of the city. In a metropolitan area the Mayor of the largest ULB should be the chair of the metropolitan planning committee. Whether a Mayor-in-Council or an Executive Mayor system should be in place, has to be determined by local conditions. In either case the tenure should be of 5 years. The executive head of the city should be able to run an efficient system of delivering urban services in a manner which harnesses agglomeration economies, minimizes congestion diseconomies and creates a socio-economic environment that attracts investment and generates livelihoods while adhering to the constitutional requirements of a duly elected legislative body, the third tier of government.

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DEVELOPMENT-DISPLACEMENT PARADOX: THE ODISHA EXPERIENCE

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The discourse on development is often beset by the paradox of displacement. Though development is construed as something positive and desirable (Bellu, 2011), the movement upward of the entire social system (Myrdal, 1974), displacement conflicts have come up as its inevitable and inescapable outcome. Development projects which avow the upliftment of poor or marginalized people have ironically consumed huge acres of land used by common people, thereby displacing people from their habitat. Michael M. Cernea (1996) states "The forced displacement of populations caused by many infrastructural development programmes epitomizes one category of disruptive changes that may occur as by-products of economic growth".

The development paradigm considers mega projects and large dams inevitable for development. The acquisition of land and Common Property Resources (CPR) for large projects in the remote corners of the country adversely affects the life and challenges the livelihoods of the people (Behera, 2012). Apart from the cost of displacement and relocation of the people, there is also the problem of deforestation, loss of agricultural land, environmental degradation and marginalization of the weaker sections during the process of land acquisition (Mohanty, 2011)."Primary" or "direct" displacement occurs when people are moved from their traditional lands to make way for a development project or when people move towards a project to meet a new labour demand. Primary displacement is usually predictable and can therefore be mitigated through planning. "Secondary" or "indirect" displacement is a result of environmental, geographical and sociopolitical consequences of the development project that takes place over time and distance from the initial project. This type of displacement is less predictable and difficult to control. One example of secondary displacement is when a community is forced to move because of pollution of their water supply by a mining project (Gellert & Lynch, 2003).

Odisha, one of the resource rich states of India has become the hotspot for investment in Steel and Alumina industries aftermath globalization. Foreign Direct Investment in steel/alumina sectors gained momentum after the structural reforms of 1990s. The growing demand for steel in the International markets has resulted in steel manufacturing giants coveting Odisha for their industries. The Government of Odisha capitalized on the growing international interest in the state, launched a systematic effort to bring investment into the state through the nodal agency for investment promotion, Industrial Promotion Investment Corporation Limited, Odisha (IPICOL) and signed nearly 79 MoUs in the steel sector (Datta, Mahajan, & Singh, 2009). Prior to this, in 1940s and 1950s development activities especially power plants and dams led to large scale displacement. Most of the development projects in Odisha have brought adverse effect in the form of displacement of people "from their traditional homeland and way of life and denying them their basic rights of livelihood" (Velath, 2009).

Tribals form a large percentage of those displaced from major projects like the NALCO, HAL and the Indravati Hydel Project (The Hindu, 2000). Rourkela Steel Plant caused direct displacement of 4,094 families in 64 tribal villages including 31 villages of Mandira Dam oustees. Among the oustees, more than 60% were tribals (Meher, 2003). In a study of Mahanadi Coal Field project out of 100 projects affected families or PAFs, 70 were from tribal community (Mohanty, 2011). The project area of Kalingana-

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gar had a significant tribal and dalit population. The two blocks of Sukinda and Danagadi under which the area falls, had a ST population of 36.06% and 28.19% and SC population of 11.89% and 29.31% respectively. The schedule tribe population was acquiring more area than others (Dash, Samal, 2008). In the Vedanta project area the tribal people living on the plant site were mainly Kondhs. Land was also acquired by the district administration from the large number of tribals and the Harijans of Bandhagunda and Rengopali villages for Vedanta alumina Project. The above data shows that displacement due to various development projects affected mainly tribals and Harijans than others.

Till 2000, about 20lakh people have been directly affected by development projects in variable degrees out of which about 5lakh have been physically displaced losing their home and hearth. While dams/ irrigation projects alone have displaced nearly 3.5lakh people which is roughly 70 percent of the total displaced persons, industrial projects have displaced about 60,000 people which is 12 percent of the total displaced, where as mining projects, urban development projects, thermal projects and wild life sanctuaries have displaced 3.37 percent, 2.60 percent and 0.5 percent respectively of the total displaced in the state of Odisha (Ota, 2001). Numerous studies have been made by scholars to point out the loopholes in the rehabilitation that proved beyond doubt that not more than 25 percent of those displaced during 1950-1980 measures have been rehabilitated properly (Hansda, 1983:23). The above referred figures account for the already completed projects but there are hosts of other ongoing or pipeline projects in which about 2lakh more people are expected to be displaced. An account of displacement and rehabilitation of people due to development projects is given below in tables 1, 2, 3 and 4.

Table.1
Magnitude of Displacement due to various Development Projects in Odisha (1950-1993)

SL. No	Types of Projects	No. of villages displaced/ affected	No. of families displaced/affected	Total land acquitted (in ha)
1	Mines	79	3143	2427.03
2	Industries	113	10704	21963.00
3	Thermal Power	73	2426	3155.31
4	Irrigation and hydel power (dams)	1181	64903	595918.60
	Total	1446	81176	622463.94

Source: Depriving the underprivileged for development – Balaji Pande Institute for Social and Economic Development

Table.2
Displacement and Rehabilitation by Development projects in Odisha

Project	Total Displacement	Total Rehabilitation	% of Rehabilitation	Back log of Rehabilitation	% of Backlog
Hydro electric multi purpose	325000	90000	27.69	235000	72.31
Industrial	71794	27300	38.03	44494	91.97
Mining	100000	60000	60.00	40000	40.00

Other parks and Sanctuaries	50000	15540	31.08	34460	68.92
Total	546794	192840	35.37	353954	64.73

Source- W. Fernandes and Asif (1995)

Table.3

Displacement due to Hydroelectric project in Odisha

Project	Year of Establishment	Submerged/Displaced (No.)				Rehabilitated families (No.)
	Village		Area	Families	Persons	
Macchakund	1949	225	20794	2938	14690	600
Hirakud	1948	285	182593	22144	160000	1879
Ballimela	1963	89	48000	2000	9600	NA
Rengali	1973	265	105905	10847	54235	6639
Upper Kolab	1976	159	24794	13095	50771	525
Upper Indravati	1978	99	32530	5301	26505	9585
	Total	1112	414615	56325	315801	13228

Source: N.Panigrahi (2003)

Table.4

Displacement by Industry and Mining Projects in Odisha

Project	Year	Land Acquired (Acre)	No. of Villages	No. of families	Total Population
Hindustan Aeronautic Ltd. Koraput	1962	7200	10	1200	6000
Bauxite Mining, Koraput	1981	5636	41	788	3104
Bauxite Mining, Sambalpur	1982	N.A.	N.A.	N.A.	N.A.
Steel plant Rourkela	1962	19557	30	2467	12335
Steel plant Gopalpur, Ganjam	1996	7898	11	2912	13892
Aluminium Smelter plant, Angul	1985	3828	40	3997	N.A.
Ordnance factory Saintala	1986	N.A.	14	1200	N.A.
National Test Range, Baliapala	1991	10000	92	9827	70000
MESCO	1994	530	5	53	320
Neelachal Steel	1996	2500	30	639	3749
Jindal Stainless Company	1997	678	N.A.	59	282
Rohit Ferro Alloys	1999	50	2	12	78

Vishal steel	2000	390	N.A.	23	123
Orion	2001	150	N.A.	N.A.	N.A.
Maitham Ispat	2001	100	N.A.	N.A.	N.A.
Uttamgala	2002	370	N.A.	N.A.	N.A.
Maharashtra Stainless	2002	500	N.A.	N.A.	N.A.
TISCO	2003	2400	16	122	497
Dinabandhu	2003	100	N.A.	N.A.	N.A.
K.J.Ispat	2004	50	N.A.	N.A.	N.A.

Source: A.D.M. Office, Kalinga Nagar

Impact Of Displacement

The forced displacement of population leads not only to break up living patterns and social continuity, but it also dismantles the existing modes of production, disrupts social networks, causes the impoverishment of many of those uprooted, threatens their cultural identity and increases the risk of epidemics and health problems (Cernea, 1995; Parasuraman, 1999; Chatterjee, 2004. Michael Cernea's (2000) Impoverishment Risks and Reconstruction Model highlights the risks associated with involuntary resettlement as (a) landlessness; (b) joblessness; (c) homelessness; (d) marginalization; (e) food insecurity; (f) loss of access to common property resources; (g) increased morbidity; and (h) community disarticulation.

Mohanty (2011) in her research study on the Ib Valley Project delineated the impact of displacement on similar lines as Michael Cernea. The specific problems of displaced people which she pointed out were -widening of socio-economic inequalities, drastic change in the cropping pattern, reducing dependence on trees and livestock, increase in the proportion of agricultural labourers, increasing trend towards nuclear family, improper use of compensation money, rise in the incidence of indebtedness, deterioration in the socio-economic condition of women in the PAFs, mis-utilisation of compensation by the male members on consumer durable items or liquor, rise in crimes due to increased alcoholism. Women oustees faced great difficulty in getting married because of the demand for more dowries. Use of cash compensation on the marriages left the family pauperised

Displacement is often accompanied by a mixed bag of outcomes, some positive and some negative. Unlike the Ib Project, in case of the Upper Indravati Hydroelectric Project (UIHE) there was a marked improvement in the literacy status of the displaced people. With the proper guidance of the UIHE Project officers and local NGO Agragamme, about 44 per cent resettled people purchased agriculture land to continue cultivation as a livelihood asset. Each project affected family whose house had been acquired was allotted a site free of cost. Only the families below the poverty line (BPL) had been given a onetime fixed grant of Rs 25, 000 for house reconstruction. However, in the new economic system, due to acquisition of agriculture land and the destruction of the village set up, women had no work to do. Women became idle and dependent. This led to sharp decline in the status conferred on the women,

The Tata Project at Kalinganagar affected about 1,200 families. Most of these people cultivated on government land over which they did not have patta rights. Therefore compensation was given only to those who had patta for their land. This kept a large section of people bereft of compensation. The share croppers also did not receive any compensation and were totally alienated from their agricultural work.

The displaced persons of Vedanta Alumina Limited (VAL) had their own unique problems. Vedanta was to mine bauxite from Niyamgiri Hills to feed the alyminium plant set up at Lanjigarh. There was a spiritual and rational basis for the rejection of min-

ing (Kothari, 2015) by the tribals residing there. The rules laid down by Niyam Raja, the spiritual source of the territory, included the protection of forests and rivers, common custodianship of resources, sharing of labour and its fruits rather than enjoying individual property. Meanwhile Prafulla Samantara, an avid activist fighting for the land rights of Dongria Kondhs filed a litigation in the apex court to stop the mining. The litigation ran a course of ten years and in a landmark judgment, the apex court ruled that Palli Sabhas (Village Councils) of the tribes had the right to vote for or against the mining. All the 12 village tribal councils voted against the mine. People's movement triggered the exit of Vedanta (https://M.Your Story.com/2017).

The POSCO Project at Jagatsinghpur was apprehended to destroy the betel based economy that sustained approximately 20,000 people (Sahu, 2017) in eight villages of Dhinkia, Nuagaon, Gadakunja gram panchayats. As mentioned in the MoU, signed between the State and POSCO, preference would be given to the people of Odisha, in terms of employment subject to need and their possessing the necessary qualifications. There was no mention of absorbing atleast one person from the displaced family in the company. Later due to heavy protests from people POSCO had to leave.

Issues involved in the protest movements in case of Utkal Alumina Project were a) displacement causing dispossession of assets, b) environment pollution that would lead to future health hazards and climate disturbances c) use of water from Barha, San and Gada rivers by the plant would affect 200 villages in the downstream of the rivers. The people in the area would face scarcity for irrigation and other purpose if the plant drew excess water from the river d) The UAIL policy document laid down compensation for only eleven categories of land viz. Atta land, Mala land and Bahal land etc while Dongar land (cultivation in denuded forest lands) was left out (PUDR,2005). The people who cultivated on Dongar land were mainly landless and the dongar land was their main source of livelihood.

There was no clear-cut policy of rehabilitation for the displaced people of Machhkund Hydel project. The adhoc policy measures adopted in the case of Hirakud Dam, Rourkela Steel Plant, Balimela and Salandi projects brought tremendous miseries to the oustees. The cash compensation principle which was adopted in case of Hirakud Dam failed to restore the previous living condition of the displaced because they spent the compensation money on wasteful expenditure (Baboo, 1992). The R and R Policy purely depended on the bargaining ability, organisational strength and political power of the group to be displaced. There was no clear cut definition of displaced persons and displaced families. Also there were no standardized compensation norms for different types of properties such as land, trees, ponds, well and common property resources lost by the oustees. Besides there was corruption on the part of R and R officials whotook percentages from DPS/PAPs for giving compensation as also while developing public amenities such as schools, ponds, dispensaries and resettlement colonies. Poor infrastructure was provided due to swindling of money. In some cases the DPS/PAPs cheated by submitting fraud records, got it authenticated by bribing officials to get undue benefits at the cost of the genuinely deprived.

Resettlement And Rehabilitation Policy: A Protective Cover For The Displaced People

The R&R policy of India was regulated by the 1894 Land Acquisition Act of the British era, which made the state's role pre-eminent in the acquisition of land for public purpose with payment of adequate compensation. There was no mention of livelihood security. It didn't contain any thing constructive for the displaced persons (DPs). It laid greater emphasis on private sector participation along with a major role played by the state. The consequent amendments in the R&R policy in 1993 & 1998 only strengthened the private interests, making land acquisition easier. Further policies were also made in 2003 which was quite weak in terms of physical relocation of the DPs and livelihood opportunity in newly settled areas as there was no concrete R&R law. Different projects adopted different compensation measures.

There was no concrete R&R Policy of the

Government before 2006 and it was only a series of guidelines from the government which regulated the rehabilitation and resettlement programme according to which displaced persons were provided a) financial compensation for loss of land b) provision of homestead land and assistance for house building and c) compensation for loss of livelihood. It is to be noted that provision of jobs to the displaced families was not obligatory for companies in the guidelines. Land for land as rehabilitation measure was also not considered by the government. The National Rehabilitation policy, 2006 for the first time intended to include the DPs in the preparation of Rehabilitation package. It widened the definition of the displaced, made higher compensation and job opportunities for locals according to the skills mandatory for the private project authorities. However, after a long wait for a century "The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act 2013" (LARR Act 2013)passed by the Government of India marked a watershed in the R & R policy structure.

The Act ensures a humane, participative, informed and transparent process in land acquisition for industrialization, development of essential infrastructural facilities and urbanization in due consultation with institutions of local self-government and Gram Sabhas. Therefore it aimed at making the affected persons partners in the development process land acquisition with least disturbance to the owner of the land.

However structural problems are implicit in the 2013 Act like "Land for Land" principle not universally applicable, absence of sufficient protection for small land holders and marginal farmers. Besides real estate developers' concerns like possible step increase in prices of land for housing projects as two thirds of cost usually goes for the land, especially in urban areas have not been addressed. Industrialists and their associations fear that the cost for setting up industrial establishments will go up by 300 to 400 percent. The investor's lobby feel it to be anti-growth. The rehabilitation process may also have to wait till the projects come up and generate surpluses or if it has to come first, then the project would turn burdensome. To remedy the shortcomings in the LARR 2013 Act and to boost the industry, the NDA government came up with a revamped version of the act in the shape of Land Acquisition Bill 2015 and introduced it in the Lok Sabha. The bill is yet to become an Act because of opposition in the Rajya Sabha.It has a pro capitalist inclination as it exempts five types of projects for which no consent is required from land owners and the state can through a notification disallow the social impact assessment study. These are: (i) defence, (ii) rural infrastructure, (iii) affordable housing, (iv) industrial corridors, and (v) infrastructure and social infrastructure including PPP projects where the government owns the land.

Recommendations

After the displacement, if the people are getting benefits as shareholders of the project, then that would provide them with more financial stability. Benefit sharing should be made the guiding thrust of industrial development. Any public investment or private investment, where revenue or profit is earned by the industry, the people who are affected by the projects or undertakings should be given a share from the said profit and revenue. When public investments in infrastructure produce public goods and public benefits which are measured by monetary or physical accounts, the public authorities should disburse a part of the benefit or revenue to the persons affected by the projects. This would strengthen the living standards of the affected people in the form of remission of land revenue, exemption of all types of education fees, free health, irrigation, fertilizer, concession in public transport, use of shopping complexes free of rent and easy micro credit for self help projects of the people.

To solve the vexed problem of displaced people, it is highly imperative to make the project attractive and its implementation smooth. The authorities must offer to the DPs or APs a self contained Peri-Urban Colony with surrounding agricultural and horticultural facilities as an integral part of implementation of the projects. It will reduce the agony and anguish of the local people and resistance against the new displaced status. Thus rehabilitation is not a welfare scheme planned by the project authorities but a right of the DP/PAPs to have a proportionate pre-deter-

mined share in all the benefits accruing from the project. When they do not accrue, the state must accept complete responsibility of compensating and rehabilitating them on a long-term basis.

Examples may be drawn from Coal India and NTPC rehabilitation policies as they resettled DPs through self employment. Training the DPs to deal with production and marketing on a cooperative basis is a possible solution. They can form cooperatives or production units using the power, irrigation facilities and other products like aluminium and minerals the project produces or be trained to supply provisions to it. The principle that the DPs/PAPs should have a proportionate pre-determined share in all the benefits accruing from the project should be upheld. The NALCO rehabilitation policy adopted direct employment, allotment of shops in company's township and introduced special training schemes by the company for upgrading the local displaced persons. In the NTPC project, authority provided direct employment under the project, training in I.T.I was provided by the state Government for which placements were provided in the power plant. The training cost was borne by the NTPC (shodhganga.inflibnet.ac.in).

Such examples should serve as a yardstick for future projects in Odisha. In fine development should shun its class perspective and its underlying principle should be people's welfare. People's voice in the process of their own development should be highly defended.

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Unheeding an Emergency: The Clarion Call of Climate Change

Srinibas Barik

roduction

re are rare occasions on which the whole of humanity ls itself embroiled in any major crisis. Climate change e days has emerged as just such a formidable llenge, which is about to cause havoc if immediate, nt mitigatory measures are not taken. Geographical, onal divisions among the members of the international mmunity act as the wedge in the path of any united, orted action. Segregated, sectarian approaches in ate action are no less than self-defeating. But the -Westphalian states, being overwhelmed with their ical, economic and strategic considerations, have y found any convergence in collective action against al emergencies. The two world wars may be some ption that induced the occasion for united action e nation-states. Since then the amorphous comity tions has been haunted by many national, regional global crises (like the economic depressions, the nt COVID-19 pandemic) which have bogged down ecision-makers, thereby exposing their parochialism lepriving mankind of some cherished gains.

mate change as a crisis is unique in the sense that ctor, in its micro capacity anywhere, if harms the le, is sure to impact it and the whole of humanity ace the consequences. 'On our planet, everything is cted to everything else. In a sense, we have a very planet. The winds are changing currently. This is natural, but there is also the signature of human nce on changing winds. Now, the winds affect the — and the oceans affect the glacier. If the winds are bed, they actually move ocean currents. So, they can warm ocean current to somewhere it hasn't been Some of that is moving towards Antarctica and g the change,' observes David Holland, Director of ork University's Environmental Fluid Dynamics Lab.[1] According to the World Development Report, 2010, 'The effects of climate change are already visible in higher average air and ocean temperatures, widespread melting of snow and ice, and rising sea levels. Cold days, cold nights, and forests have become less frequent while heatwaves are more common. Globally, precipitation has increased ....and many other regions have seen more frequent and more intense droughts. Heavy rainfall and floods have become more common, and the damage from and probably the intensity of storm and tropical cyclones have increased.'[2]

Recently, some of the exceptional climatic conditions (like the incessant rains in Kerala, India in August 2019 and the severe flooding in Venice, Italy in November 2019) compel us to see, that something is happening for the worse just because the adaptability to such disasters has been pushed to the limit, has rather proved to be precariously inadequate. Homo sapiens are highly resilient, which is evident from their rising numbers and the resultant disappearance of many other species, which have fallen prey to the greed of the former. Their activities are not limited to harming the animal kingdom, it goes against nature as a whole. Sometimes insightful observers agree on the fact that nature is always right. But mostly it is evident that nature is compelled to course correct when artifice (of man) arm-twists it.

A Microanalysis

Two consecutive devastating downpour in Kerala (India) in August 2019 and 2018 caused havoc by killing hundreds, rendering thousands homeless, maiming the state with large-scale destruction amounting to thousands of crores of rupees. The 2018 deluge was more severe, described by the state chief minister Pinarayi Vijayan as unprecedented since 1924. 'In August 2018, there was an abnormal amount of moisture build-up in air due to the south-west monsoon flow from the Arabian Sea and a low-pressure system over the Bay of Bengal. The lifting of moisture-laden air when it hits the [illegible]

sistant Professor (Political Science), S. B. Women's (Autonomous), Cuttack; R. D. Women's University, swar.

of the Western Ghats (orographic effect) acted together to make the rains deadly over Kerala,' stated Sandeep Pattnaik of the IIT, Bhubaneswar's School of Earth, Ocean and Climate Sciences.[3]

Venice in Italy experienced the worst floods in 50 years, attributable to climate change. With climate change and sea levels rising globally, Venice, originally founded on soft, boggy ground, finds itself in increasingly more trouble each year. Levels in the Mediterranean Sea basin could rise as much as five feet by the end of this century raising the risk that the subsiding city could be flooded more often than the current average of four times a year, as experts believe.[4] On the Venice floods, Nikky Berry (a BBC meteorologist) says, 'The recent flooding in Venice was caused by a combination of high spring tides and a meteorological storm surge driven by strong sirocco winds blowing north-eastwards across the Adriatic Sea. When these two events coincide, we get what is known as Acqua Alta (high water). The recent Acqua Alta occurrence in Venice is the second highest tide in recorded history. However, if we look at the top 10 tides, five have occurred in the past 20 years and the most recent was only last year.'[5]It is observed that climate change has exacerbated the frequency and severity of natural disasters like massive forest fires, droughts, hurricanes, floods. During 2018, more than 39 million people have been affected in such disasters.[6]

The Warning Signs

Climate change, the consequence of global warming, is going to adversely affect the whole of humanity in varying degrees. According to the World Development Report,2010, 'Climate change threatens all countries, with developing countries the most vulnerable. Estimates are that they would bear some 75 to80 percent of the costs of damages caused by the changing climate. Even a 2° warming above preindustrial temperatures — the minimum the world is likely to experience —could result in permanent reductions in GDP of 4 to 5 percent for Africa, and South Asia. Most developing countries lack sufficient financial and technical capacities to manage increasing climate risk. They also depend more directly on climate sensitive natural resources for income and wellbeing. And most are in tropical and subtropical regions already subject to highly variable climate.'[7]

Global warming is attributed to the concentration of greenhouse gases (GHGs) in the atmosphere. Carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) ozone (O_3) are the greenhouse gases present in the atmosphere, responsible for trapping the heat. 'They warm Earth's surface by impeding the escape of infrared(heat) energy into space. The warming effect created by the natural levels of these gases is the natural greenhouse effect. effect warms the world about 33° more than it would otherwise, keeps most of the world's water in the liquid phase, and allows life to exist from the equator to the poles.'[8]

The world is turning dangerously warmer because of irresponsible human activities that have added to concentration of such gases in the atmosphere. Activities like increasing industrialisation, burning of fossil fuels like coal, oil, and natural gas have significantly increased the concentration of gases like CO_2. Land-use changes and deforestation also have contributed to the increased emission of such gases. The Intergovernmental Panel on Climate Change (IPCC) describes such human activities as 'dangerous anthropogenic interference' that has caused the warming of the climate system unequivocal.

What If?

Given the present pattern of lifestyle and the growing population, to keep the rising atmospheric temperature under check seems a remote possibility. If the present trend continues unabated, catastrophic consequences are predicted. Experts speculate the rise of atmospheric temperature may vary between 2° to 5° or even in the worst case scenario it may touch 7° compared to the preindustrial level. According to some study, if temperatures exceed 5° above preindustrial levels, 'about 3 billion additional people would suffer water stress, corals would be mostly died off, some 50 percent of species worldwide would eventually go extinct, productivity of crops in both temperate and tropical zones would fall, about 30 percent of coastal wetlands would be inundated, the world would be committed to several meters of sea level rise, and there would be substantial burden on health systems from increasing malnutrition and diarrheal and cardiorespiratory diseases.'[9]

The danger due to climate change is not in the future tense only: the present is also replete with tell-tale signs of impending danger. As for example, the Antarctic and the polar regions have now been at the centre of climate studies. Michelle LaRue who teaches Antarctic Marine Science at the University of Canterbury, New Zealand states that 'Our polar regions are effectively Earth's refrigerators — they modulate our climate around the world and keep it relatively stable. By disrupting Earth's cooling system, we are likely to see more catastrophic weather events, like hurricanes, storms, droughts and flooding. Furthermore, the oceans absorb a substantial proportion of CO_2, but there is a limit to that ability and then the oceans start to become more acidic. When that happens, the calciferous or the calcium organisms that make up our primary pro

...e oceans become less likely to survive and provide ...urces for the rest of the food chain."[10]

...LaRue's forecast is potent to draw attention of ...one who has anominal understanding of the eternal ...dependence between the environment and the ...ces sustained by it. The remarkable change, according ...er, is visible at the Thwaites glacier. The glacier is ...ating and becoming lower and lower every passing ...r. During the course of research, drilling in the glacier ...d warm waters beneath and that is driving the ...ge, as LaRue reveals. 'If you live in, say, New York, ...da or Bangladesh, it is increasingly likely that these ...s could go underwater if steps are not taken. It could ...decades to centuries, but the timeline is unravelling ...w. This is an extreme event but unlike, say, hurricanes ...e we have experience of what happens, this is a once ...r event. It will be like having a typhoon, but one we ...ve never seen before. The Thwaites has lost about 600 ...n tons of ice over several decades. Scientists estimate ...te of ice loss has accelerated to about 50 billion tons ...num in the recent years.'

...e Antarctic Facts

...s Pugh (popularly known as UN patron of oceans ..., environmental diplomat) states some important ...about Antarctica. The coldest continent on earth ...r sheet of about 3 miles thick which contains about ...rcent of the world's freshwater. Between 2014-17, ...lost the amount of ice as the Arctic lost in last 30 ...As an unusual development, Antarctica recorded ...hest temperature (so far) on 6 February 2020, equal ...mperature recorded in Los Angeles at the same ... Pugh feels that the record high temperature could ...ed to 'foehn,' a warming of air coming down a ...r winds and warm ocean currents, as many ...s believe, are causing significant ice melt across ...rctic. According to their estimate, summer sea ... the region could disappear within 20-25 years. ...ica is now losing six times more ice than it did in ... The cold water in the region works as a massive ...k, taking CO_2 down into the depths and storing

... the positive effect of the Antarctic may be gone ...rtain later given the reckless human lifestyle that is ...massive damages to the environment. 'As carbon ... the world over rise, such heating intensifies, ... the melting of the Antarctic's ice. Between 1992 ... the rate of ice loss from the Antarctic peninsula ...ically quintupled. The possible dangers are ... as Antarctica melts, ocean levels will gradually ... studies positing, by even 10 feet. Such changes ... more extreme weather events, while rising oceans could flood multiple coastal areas. Losing valuable resources like land, crops, infrastructure, the disruptions to life will be at an unimaginable scale."[12]

Global Wealth Gap and Climate Change

Inequality among nations, which has to some extent declined after the introduction of LPG (liberalisation, privatisation, globalisation) would have declined faster had climate change not been an impacting factor. This finding is based on the research of Marshall Burke (Stanford economist) and Noah Diffenbaugh (a climate scientist at Stanford). According to them, when temperatures were hotter than average, economic growth slowed in poor countries but accelerated in the rich. That is because the world's richest countries are by and large in the cooler latitudes, while the poor countries are disproportionately concentrated around the equator. A slight temperature increase in such places can have a devastating impact on crop production, labour productivity, and human health.[13]

As has been found in many studies, global temperatures have risen by nearly 1° or 1.8° since the start of the industrial age and the two researchers were interested in calculating what effect that increase has had on national economies and the global wealth gap. Interestingly, the duo concluded that the poor countries lost out while the rich countries, especially those who have racked up a lot of emissions over the last 50 years, have 'benefited from global warming.' According to their estimate, the gap in per capita income in the richest and the poorest countries is 25 percentage points larger than it would have been without climate change.[14]

According to the study, between 1961 and 2000, climate change dampened per capita incomes in the world's poorest countries by between 17 per cent and 30 per cent. The hardest hit among the countries were some of the largest. Interestingly, India would have been 30 per cent richer without climate change, according to the study. By the same logic, Nigeria became 29 per cent poorer whereas Norway became 34 per cent richer. 'If you're a really cool country, you have been helped a lot. If you are a really warm country, you've been hurt a lot. And if you're in the middle the effects have been smaller or much more muted,' said Burke.[15]

Who Will Lend Voice to the Voiceless?

Climate change is not discriminatory in its impact, though the species (humans) largely responsible for inducing it, possess the ability to assess its impact and have been exclusively concerned for their survival, ignoring the others without whose complementary contribution/

presence the environment would be sustainableat all. There are millions of species, visible or invisible, which have exclusive role and contribution, due to which the unique nature of the earth's environment is an acknowledged fact. But climate change has turned out to be the nemesis of some varieties of them. 'Up to one million species face extinction due to human influence, according to a draft UN report that catalogues how humanity has undermined the natural resources upon which its very survival depends. The accelerating loss of clean air, drinkable water, CO_2-absorbing forests, pollinating insects, protein-rich fish, and storm-blocking mangroves — to name but a few of the dwindling services rendered by Nature — poses no less a threat than climate change."[16]

Researches on the Antarctic suggest that 'ice obligate species, which are animals that require ice to survive, are not going to do well with climate change. For example, emperor penguins need sea ice that is fastened to the Antarctic coastline as a platform to breed, raise their chicks and as safe zones from predators like leopard seals and killer whales. As ocean and air temperatures continue to rise, the extent and duration of ice around the continent is likely to decrease — which means that emperor penguins are likely to decrease in number as well.'[17]'Penguins, whales, and dolphins don't have a seat in the House of Commons, the US congress or the Indian parliament. Somebody needs to speak on their behalf,' pleads Lewis Pugh.[18]

Ignorance is Curse

The inverse relationship between forest cover and global warming is beyond doubt. If a (teenage adolescent) girl (Greta Thunberg) could feel the gravity of climate change, the 'green villains' and some grownups around the world — destroying and looting vast stretches of forests for short-term, selfish gains — is indicative of any sense of shame vanishing. The culprits and criminals — some forest department employees together with some men who matter in the government — have woven an obnoxious nexus to jeopardize all living organisms and destroy the environment:the metaphorical Kalidas busy in the suicidal axing of the branch on which he is seated. The Living Planet Report 2020 reveals that there is a 68 per cent average decline of birds, amphibians, mammals,fish and reptiles since 1970.[19]

No coercion, cajoling, nothing can persuade these debauches to desist from their destructive acts. These 'burdens on mother earth' have come with only one purpose in life —to gratify the self by hook or by crook. The global pandemic of COVID-19 has pulverized the whole world and mankind is still clueless as to how to get rid of it. Persistent efforts and campaigns are being made day in and day out to spread awarene people so that they refrain from activities tha aggravate the pandemic. Out on any Indian stre (a sensible human being) will be surprised to s 'spitting cobras,' shut-down and lock-down violat and mask-less morons roaming with careless aban and their numbers multiplying more potentially than virus they are abetting to spread. No system can br them to book except, perhaps, violent repression.

Sources claim that deforestation in India during t last decades has led to degradation of over 30 per ce of its land and loss of 1.6 million hectares of its fore cover.[20]This is in contrast to the ambitious claims mad in the biennial India State of Forest Report (ISFR). Th report claims an increase in the country's forest and tre cover to 80.73 million hectare or 24.56 per cent of its tota area. The International Union for Conservation of Natur (IUCN) and the Ministry of Environment, Forests an Climate Change (MoEFCC) in their 2019 progress repor on forest restoration state that 9.8 million hectares o deforested and degraded land have been brought under restoration since 2011.

But in the article it is claimed that a closer look at ISFR numbers reveals a disappointing growth of just 0.13 per cent in India's green cover. Claims and counter-claims are a disappointing recurrence in India. But what is unignorable (in India) is that deforestation and land degradation do impact agricultural productivity, water quality and biodiversity, thereby affecting over 600 million people in India. There is no denying the fact that more than a fifth of the country's population, according to the writer, depends on forests for subsistence. She cites a Tata Energy Research Institute (TERI) study, according to which forest degradation is depriving the country of 1.4 per cent of its GDP annually.

Senseless deforestation in India has directly and severely affected the forest-dwelling communities, being treated as encroachers of forest lands which they were cultivating for generations. The so-called developmental measures like mining, industrialisation, agriculture (irrigation) have significantly increased the carbon footprint of the country as a whole. However, some sources accused the forest dwellers to have been instrumental in increasing their and the country's carbon footprint. Luckily, some deviation from the traditional way of thinking are unravelling some positive changes.

Manisha Verma, Principal Secretary in the Tribal Development Department of the Maharashtra government claims that the carbon footprints of an average tribal household are negligible in comparison with the rich urban households.[21]She is optimistic that the Forest Right Act (FRA) if implemented sincerely, can be a fruitful step in the direction of forest conservation and tribal welfare. The Preamble to the FRA states that it aims to 'undo the

historical injustice' to forest-dwelling communities who were cultivating their land for generations but were treated as encroachers, as their rights were not recorded. The legislation recognises, vests, and provides for recording of rights of forest dwellers for self-cultivation up to four hectares, enabling security of tenure and livelihood to vulnerable communities. What is encouraging is that the act confers on the communities, the right to protect, regenerate and manage forest resources and provides for safeguards against arbitrary displacement. Forests have been preserved best where tribal communities reside, Verma concludes.

Misplaced Bias?

Attribution of responsibility for contributing to climate change has brought to the fore a novel idea: that the poor are more responsible for inducing the crisis than the rich. Such a finding has been made by a research institution in the U.S.A., as Sunita Narain mentions. The research institution inferred that the poor contributed substantially to global warming as two of their activities, rice cultivation and livestock rearing were both unsustainable activities.[22]But Narain is sceptical of such an accusation and insists on the fact that the world should differentiate between 'luxury emissions' from vehicles owned by the rich and 'survival emissions' from subsistence paddy cultivation and animal rearing by the poor.

Describing climate change as 'the biggest existential crisis that the planet has ever faced,' Narain differentiates that industrialised countries have to some extent succeeded in delinking the SO_2 emissions from economic growth but not so with CO_2 emissions. 'Per capita CO_2 emissions remain closely related to a country's level of economic development, and thus standard of living. It is evident that as long as the world economy is carbon-based-driven by energy from coal, oil, and natural gas, growth cannot be delinked substantially from CO_2 emissions,' according to Narain. She further states that, 'The only way to avert climate change is to reduce emissions dramatically. But things are never quite this simple. The use of fossil fuels (the major reason for CO_2 emission) is closely linked to economic growth and lifestyle. Every human being contributes to the CO_2 concentrations in the atmosphere. However, the person's lifestyle decides the amount that is emitted. The more prosperous a country's economy is, higher is its fossil fuel consumption, resulting in higher greenhouse gas emissions.'

A Silver Lining in the Cloud

Two former alumni of IIT, Kharagpur, Aniruddha Sharma and Prateek Bumb, have founded a company — Carbon Clean Solutions — which is based on a crucial technology the world needs, to reach the low carbon-emissions targets set out in the Paris climate agreement.[23] The technology in use since a long time, focuses on carbon capture and storage (CCS) where carbon emissions from plants are collected and injected deep underground at great cost. In recent years, the focus has shifted in part to carbon capture and utilisation (CCU), where the emissions are turned into useful products.

Carbon Clean Solutions by the duo captures CO_2 from its coal-fired boiler and converts it into soda ash (a chemical cousin of the baking soda)in its Tuticorin plant. Sharma claims it to be a world's first commercial-scale plant set to capture 60,000 tons of CO_2 annually, which does it so cheaply that it did not need any government subsidies. This may prove to be a major breakthrough as the UN and the IPCC (Inter-governmental Panel on Climate Change) emphasize on the need of a technology that can be helpful in burning of fossil fuels without releasing all of the CO_2 produced. The harnessing of renewable sources though is on the rise, it is not yet adequate to keep the global temperature from rising above 2°C in comparison with the pre-industrial average and if it so continues it may not be too late when climate change reaches a critical point of no return.

Conclusion

The signing of the Paris agreement on climate change by 171 countries, including India, on the Earth Day (22 April,2016) is a major development. This marks the culmination of two decades of efforts by the international community to bring together so many nations and get them to commit to a global agreement 'to save the one resource that we all share and the one planet that sustains us all.'[24]It is encouraging to note that the agreement is a record of sorts which brought together so many countries for the first time and many countries signed the agreement on the first day itself. It is also to the credit of international diplomacy that such a big event could be a possibility.

There are miles to go. The agreement is yet to be ratified by the U.S., China, E.U., India though, understandably, a handful of island nations have already done so. However, the Kyoto Protocol took four years to be ratified after finalisation. As a conditionality, it is only when at least 55 nations, representing 55per cent of the global emissions, ratify the Paris agreement, that it will come into force. The UNFCCC (United Nations Framework Convention on Climate Change) lists 135 different tasks that have to be completed by every signatory before the deal can be operationalised.[25] India, as a leading nation, has made the fight against climate change a priority item in its foreign policy and global governance agenda. Hopefully, other major states rise to the occasion earlier than expected as

there is still a long way to go before the full potential of the Paris agreement can be realised.

The climate conferences in the past have been in the nature of one step forward, two steps backward. The inherent extractive issues – selfish interest among nation-states – have been the nemesis of the series of conferences so far. Whether the Glasgow (Scotland, UK) UN Climate Change Conference (1-12 November 2021) will be a game-changer or will end up in a whimper, is only a matter of time to be assessed in terms of output. A serious revisit of the 'net-zero' emissions pledge by over 120 countries to be met by mid-century, is imperative before or during the Glasgow conference. 'Net zero or carbon neutrality means that the amount of CO_2 produced by a country is balanced by the amount removed from the atmosphere. According to IPCC, to limit the global temperature increase to 1.5°C, global net CO_2 emissions should decline by about 45 per cent by 2030, reaching net zero around 2050,' explains Chandra Bhushan, CEO, iFOREST (Chief Executive Officer, International Forum for Environment, Sustainability and Technology).[26]

It is quite heartening to note that India is right on track in its goal of achieving the 'net zero' emissions. '... India is doing all the things it needs to do to get us there (to net-zero). India has a plan right now for 450 GW. If 450 GW of renewable power is put into place, India would be one of the few nations helping to keep 1.5 degrees alive,' concurs John Kerry, US special envoy who was recently on a special climate diplomacy mission to India.[27] Micro-level response to an impending climate emergency is just like a drop in the ocean. If pledges by the 120 odd countries actually fructify, there may be some ray of hope in making the earth/environment sustainable. Else, doomsday is not too far if the extreme climatic conditions are any indication. Marco Lambertini, DG, WWF International makes a pertinent observation: 'It is time we answer Nature's SOS. Not just to secure the amazing biodiversity of life we love and have the moral duty to coexist with, but because ignoring it puts the future of nearly 9 billion people at stake.'[28]

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CONTOURS OF SOCIAL EXCLUSION: A STUDY ON RAGPICKERS IN CUTTACK CITY

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The urge for survival coerces a ragpicker to work under filthy and ignominious conditions. The work of a ragpicker is unskilled, irregular, dangerous and hazardous. They are stigmatized and socially excluded, often jeered as human scavengers. The present empirical study has made a critical analysis of the patterns of social exclusion faced by ragpickers. The research focuses on the deplorable living and working conditions of these people and the attitude of the government, which has not effectively catered to the problems of this community. Furthermore, the onslaught of privatization in Solid Waste Management has threatened their livelihood security. The paper therefore makes a serious attempt to assess the prevailing institutional mechanisms to address their problems and calls for inclusionary efforts on the part of the State to integrate this community in the formal waste management system.

Introduction

A Ragpicker is a person who ekes out a living by rummaging through refuse materials in the streets, in the garbage bins and dump yards. He collects the rags or recyclable materials and sells them for a pecuniary recompense to satiate his survival urge. Waste Pickers reclaim reusable and recyclable materials from what others have cast aside or thrown away as waste.[1] Chvatal describes waste pickers as individuals whose survival depends on collecting and sorting out waste as a way of generating income. This livelihood option is a part of informal sector and is considered stigmatized, downgraded and dehumanized.[2] The Waste Pickers, performing this work are compelled to live under poor and inhuman conditions and face social exclusion and stigmatization. "Vultures", "parasites" and "scavengers" are just some of the derogatory terms used for individuals who collect waste for a living.[3]

Social exclusion is seen as a process whereby individuals or groups and the environments in which they live are excluded from the resources and opportunities which are considered the norm in a society. Though there is limited theoretical underpinning [4] on the subject, it is usually connected to the well established notions on poverty and deprivation.[5] The constitutive components of social exclusion has been elaborated by Silver as exclusion from "livelihood; secure, permanent employment; earnings; property, credit, or land; housing; minimal or prevailing consumption levels; education, skills, and cultural capital; the welfare state; citizenship and legal equality; democratic participation; public goods; the nation or the dominant race; family and sociability; humanity, respect, fulfillment and understanding".[6] Social exclusion is not just about scarcity of material resources, but lack of opportunities, isolation, discrimination and marginalization from decision-making and from an adequate quality of life. As defined by India in an ILO country case study, it is "the denial of the basic welfare rights which provide citizens positive freedom to participate in the social and economic life.[7] The ragpickers are excluded in terms of access to livelihood assets and development opportunities. This paper calls for constructive and inclusionary efforts on the part of government to ameliorate their impoverished and hapless condition.

Review of Literature

Sibley, in his book mentioned that the structure and space of society is built in such a way that while it is appealing to some, it is oppressive to others. He has dealt with social and spatial exclusion of ragpick-

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ers.[8] Kamat in his article reflected upon the extreme poverty and illiteracy of ragpickers who mostly belong to rural immigrant families. They are affected by diseases while doing their work. They come in contact with chemical poisons and other types of infections.[9] Balkumar.et.al. in their study explored the socio-economic characteristics of child ragpickers and found out that these children easily become exposed to alcohol and drug abuse, and are coerced into criminal activities such as drug peddling and prostitution by adult criminals.[10] Chikarmane in her publication mentioned that the waste pickers are both economically deprived and socially excluded. She has highlighted about the role of KKPKP (Kagad Kach Patra Kashtakari Panchayat) and SWaCH (Solid Waste Collection and Handling or, officially SWaCH Seva Sahakari Sanstha Maryadit) Pune, a cooperative of self-employed waste pickers in empowering the ragpickers.[11] Hunt conducted a study on child ragpickers, where she focused on their inhuman living conditions. She concluded that the child ragpickers are mostly school drop-outs.[12] Shaheda, et.al. surveyed on the socio-economic and health status of ragpickers and concluded that ragpicking is one of the most dangerous works done under harsh conditions.[13] Srivastava in his article explains that the Sarva Shiksha Abhiyana, Free Mid-Day Meal Programme and many other affirmative actions have failed to motivate the ragpickers to attend school.[14] Mukherji in his book argues that scavenging plays a crucial role in the life of pavement dwellers.[15]

Methods of Study

An empirical study on ragpickers of Cuttack city in the state of Odisha (India) was conducted to explore into their socio economic problems and recommend appropriate framework for their uplift. The research focuses on the living conditions of these people and the attitude of government towards them. This field research was conducted on **50** ragpickers using random sampling technique in Cuttack city covering the slums of Imampada, Sati Gumpha, Rajabagicha Naik Colony, Nayabasti and Canal Road. Some ragpickers belonged to Railway Station and Bus Stand area. Three months were allocated to conduct the field research, and all possible resources were mobilized to gather as much information as possible in the limited amount of time. The research sites were selected on prior information available on the prevalence of ragpickers. Primary data was collected through questionnaire survey based on age, sex, educational status, socio-economic status and political participation. Structured and unstructured interviews were conducted to generate quantitative and qualitative information on their socio-economic conditions. Interviews were also conducted with Junkyard shop owners to get an idea on the scrap rates and the overall information on ragpickers. Secondary sources of data like government reports, relevant articles and media clippings were referred to make this study substantive.

Cuttack City generates 200 Tonnes of waste every day. The Municipal Corporation works in a private partnership with M/s. Ramkey Enviro Engineers Pvt. Ltd (Hyderabad based Company) for waste collection and disposal. The CMC (Cuttack Municipal Corporation) had signed an agreement with Ramky for solid waste management and mechanical sweeping of roads.[16] 40 wards were being handled by Ramky and 19 wards were under Municipal Corporation for waste collection. Residents and shopkeepers sell recyclable items, such as newspaper, glass containers, tin cans etc. to itinerant waste buyer. The waste pickers retrieve only those recyclable materials that are discarded or thrown away by households, commercial establishments and from municipal wastes bins. Both the itinerant waste buyer and waste picker sell the retrieved materials to kabadiwallas/waste-dealers. Then, there are agents/middlemen who facilitate transactions between kabadiwallas/waste-dealers and industries in Jagatpur (about 8 kms. from Cuttack) where they are compressed, so that they carry less space and less money would be charged for transportation. These materials are finally sent to recycling units in Kolkata and Delhi.

In this entire cycle of waste transaction comprising kabadiwallas/waste-dealers, waste-agents/middlemen, waste-industries and ragpickers, the ragpickers form the most vulnerable component, as they have no competitive bargaining power for the wastes they have collected. On the contrary, the kabadiwallas, itinerant buyers, agents (middle-man) and waste-industries jointly set profitable margins for their wastes, resulting in exploitation of the ragpickers.

Patterns of Social Exclusion

The study identifies the following areas of exclusion of the ragpicker.

1.1 Lack of access to basic amenities

1.2 Low income

1.3 Long work hours

1.4 Non-receipt of affirmative benefits

1.5 No minimum support price for the scraps

1.6 Absence of Decent conditions of Work

1.7 Absence of Inclusive Programmes and Indifference of Administration

1.8 Exclusion from effective democratic participation

Lack of Access to Basic Amenities

The ragpickers are deprived of accessing basic services such as toilets, drinking water and electricity. Lack of community toilets compel them for open defecation, which leads to a number of diseases like diarrohoea, dysentery etc. Out of the total 50 respondents, 19 nos. of ragpickers could afford electricity whereas 31 could not afford the same. Only 23 of them had hand pumps or municipality taps in the vicinity whereas the rest 27 walked long distances to fetch potable water. 9 of the ragpickers had either toilet facility in their home or accessed community toilets whereas 41 ragpickers defecated in the open (Table.1).

Basic Amenities Availed By Ragpickers

Table-1

Basic Amenities	Availed	Not Availed
Electricity	19	31
Water	23	27
Toilet	9	41

The above table reflects the deplorable conditions of ragpickers. They work under unhygienic conditions, and also live under the same. Defecation in the open area instead of toilet or community toilet is one of the main reasons for their poor health condition.

3.2 Low Income

25 Nos. of the respondents belong to BPL (Below Poverty Line) category (having their basic annual income 27,000 or less). 17 nos. of the respondents belong to APL(Above Poverty Line) category. The conditions of those people above poverty line is also not so well enough. The persons having trolleys collected more waste and generated more income. Only 7 male had trolleys while the rest 35 walked long distances to collect waste (Table.2).

Low Income of Ragpickers

Table-2

Category	No.	Percentage
BPL	25	60
APL	17	40
Total	42	100

N.B. Children (8 Nos.) are Excluded because they are not working as Independent ragpickers and assist their parents in Ragpicking. Their earning is included in their parents earning and children are not entitled for APL/BPL card.

60% of the ragpickers are Below Poverty Line. They work on daily basis, spend their income on the same day on household goods and liquor. They do not have any savings for the future. Though, 40 % of the ragpickers are Above Poverty Line, their conditions are also not so well enough as they are in the threshold region or just above the poverty line.

3.3 Long Work Hours

Waste pickers work for long hours, often more than 10 to11 hours of uninterrupted work. They mostly work all days of the week. The study reveals that out of the 50 samples, 10 numbers of ragpickers work for 4-5 hours daily, whereas 20 ragpickers work for 6-7 hours and 20 ragpickers work for more than 10-11

hours (Table.3).

Working Hours of Ragpickers

Table -3

Working Hours	Number of ragpickers	Percentage
4-5 hrs.	10	20
6-7 hrs.	20	40
10-11 hrs.	20	40

The work done by ragpickers is full of physical labour. Walking long distances, carrying a heavy weight on their back, bending for lifting the scraps exposes them to enormous physical strain. 40 % of the people work for 10-11 hours in a day to earn a slightly better living.

Non-Receipt of Affirmative Benefits

The study reveals that 48% of ragpickers do not avail any kind of government benefits. Only 43% have Ration cards and 9% have Antyodaya cards. It is also seen that out of 9 ragpickers who are qualified to get old age pension, only 5 are able to avail the benefit. Among the total sample of ragpickers only one (01) has got the beneficiary amount for construction of toilet (Table.4).

Affirmative Benefits Availed By Ragpickers

Table.4

Affirmative Benefits	Numbers	Percentage
Ration	18	43
Antyodaya	4	9
Not availed	20	48

For the poor, the affirmative benefits are an important source of their living, but the study reveals that 48% of the 50 ragpickers do not avail any kind of benefits, which means they are totally dependent upon their meagre income. Even those who have the BPL card get the ration irregularly. The study observes that out of 9 qualified beneficiaries for old age pension, only 5 are availing Rs. 300 as pension under Indira Gandhi National Old Age Pension Scheme (IGNOAPS). Apart from this, there is no specific social security scheme for these ragpickers. Though government support serves as a life-line mechanism for these people, they are not able to avail such.

No Minimum Support Price for the Scraps

The prices of scraps differ from shop to shop and from time to time as determined by the junkyard owner. There is no fixed price for their articles. Besides, the price of glass fluctuates with fluctuations in the share market. The ragpickers walk long distances on foot to collect rags and wastes. As soon as the sack becomes overloaded the ragpickers relieve themselves of the burden at the nearest junkshop where the prices may not be competitive. Many a times, the ragpickers, who are in trolley search better markets for their scraps which ragpickers on foot are devoid of (Table.5).

Prices of Some Scraps At Different Junkyard Shops in Cuttack City

Table- 5

Rates of Scraps (In Rs.) per K.G.

Shop No.	Plastic	Plastic water bottle	Cartoon
1	17	24	9
2	7	12	5
3	10	15	8
4	18	20	7
5	9	17	5

From the above table it can be ascertained that the scrap prices fluctuate substantially from one shop to another. As there is no Minimum Support Price for the scraps, the ragpickers face tremendous financial hardships.

Lack of Protective Gear:

Ragpickers work in filthy and poisonous environment. Inspite of their contribution to make the

city clean, the administration has not provided them with protective gear like gloves, shoes, rain-coats, aprons and face-masks etc. The ragpickers face a lot of hardships in the rainy season. They first collect waste and then dry those under sun before selling. The study reveals that in the rainy season 30 Nos.(71%) of ragpickers did ragpicking whenever the weather was dry. 5 Nos.(12%) of ragpickers who did not pursue their work, especially were older women. 7 Nos. (17%)of ragpickers opted for other work like that of a housemaid. Weather plays a very important role in their work as they work on the streets exposed to unpredictable weather conditions. Monsoon directly affects their earning. Many of the respondents told that a major part of wastes get washed away in water and the rest which are moist are difficult to collect as well as sell. Until, they are totally dried up, they cannot get full price of the product. As per the study many women develop some kind of allergies and fever by coming in contact with rain continuously for hours together.

Absence of Inclusive Programmes and Indifference of Administration

Though the ragpickers are entitled to general welfare benefits like having a ration card, access to old age pension etc. but they do not receive specific benefits as a ragpicker. The study reveals that (Table.4) 48% are yet to access Ration/ BPL card. Though, the Cuttack Municipal Corporation has taken an initiative to distribute the Identity cards to ragpickers but comprehensive endowments (health check-ups, protective gears, inclusion in management of solid waste etc.) attached to it are not yet evolved. Only 69 of them are identified. As per the study, 2 of them have already lost the card (Source, Survey). The CAG concluded that the waste crisis persisted because of the government's administrative weaknesses and other issues, including: imprecise and incomplete data about waste production, lax monitoring and enforcement of the Rules, a lack of comprehensive planning for waste management, ambiguity and disagreement about responsibility and accountability for regulatory oversight at the level of the central government, a lack of coordination and integration of the nation's waste management policies, and improper budgeting and inadequate staffing levels for waste management.[17]

Exclusion From Effective Democratic Participation

Poverty and hunger have made them politically apathetic. The ragpickers are quite apathetic towards politics. 40% did not have ration or antodaya cards. The respondents have voter ID cards and vote in the elections, but are quite indolent towards the politics. They are being used by politicians through freebies. They had no other options than to receive the petty monetary tips as they were extremely poor. 8% of the respondent ragpickers were not ready to give their interview, as they had no hope to get anything from the government.

Problems of Migrant Ragpickers

According to the study, 6% of the ragpickers are temporary migrants, who, come to Cuttack for ragpicking only during the lean period of agriculture. A respondent Nopu Sheikh, migrated from a village in West Bengal to Cuttack for ragpicking. He didn't have a bank account and kept his daily income with the Junkyard owner, which he finally collected when he left for his village. He had tried for an Identity card from the Cuttack Municipal Corporation (CMC) but failed to get it. Another problem related with migrants is the language barrier. A migrant ragpicker in Cuttack, Mohinuddin Mondal is unable to understand and speak any other language except Bengali.

Concluding Observations

The Government of Odisha in its "Report on Solid Waste Management in the Urban Local Bodies in Odisha" stated that large numbers of small sized ULBs are dispersed across the state and density of urban population is very low and, neither cluster approach nor setting-up processing plants is a viable option for management of wastes. It is precisely here, there is a need to go for decentralized composting of bio-degradable waste and recycling of the non-biodegradable waste through networking of ragpickers and Kabadiwalas into this municipal solid waste management system. As per the report, the Housing and Urban Development (H & UD) Department in the State Govt. will take steps to integrate the informal sector in to the mainstream (Solid Waste Management) SWM system of the ULBs through network building process.[18]

Political will is a necessary pre-requisite for their uplift, but the Government often favour corporate sectors. The Environment Ministry has revised Solid Waste Management Rules after 16 years, which shows an optimistic approach by the government towards these waste pickers. Clause 4 of the SWM Rules, 2016 reads "Integration of waste pickers/ ragpickers and waste dealers/ Kabadiwalas in the formal system should be done by State Governments, and Self Help Groups, or any other group to be formed".[19] This mandates urgent action on the part of administration.

The Bhubaneswar Municipal Corporation (BMC) in Odisha (India) has taken an initiative to identify ragpickers and include them in livelihood programmes. According to BMC sources, Bhubaneswar generates 500 metric tonne of municipal waste and there are 1500 ragpickers in the city who sell the waste to scrap dealers. In the first phase, the BMC has identified 500 ragpickers. After identification, the BMC plans to provide the list of identified ragpickers to 3 private agencies engaged by the BMC to collect and dump solid waste. The three private agencies will be asked to engage the ragpickers and pay them on a daily basis.[20]

Though Cuttack Municipal Corporation in the year 2016 adopted the novel measure of identification of ragpickers and distribution of identity cards to them, but no concrete endowments have been attached to it.[21] Only 69 ragpickers have been identified and given card so far. Further, privatization of waste has added a threat to their livelihood. The ULBs, at this stage should strictly and expeditiously take the initiative to include waste pickers in the formal system of solid waste management and their right to waste should be protected. Co-operatives of waste pickers as in Pune and Bengaluru, if emulated by other cities of India, could play a key role in formalising this informal economy. By setting up cooperatives, waste pickers can pool their resources and bid for bigger contracts. Cooperatives or associations can help them to be visible and make their voices more audible.

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Contents

Modern Theory of Evolution from a Vedanta Point of View

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Abstract

Philosophers, scholars and scientists, all over the world have been pondering over the issues of the evolution of the universe since time immemorial. As a result, different philosophical and scientific theories of evolution came into being. In this paper, an attempt is made to compare and contrast the different theories of evolution accepted by different system of Indian philosophy with that of modern scientific theories of evolution, with special reference to vedantic theory of evolution. A thorough analysis of different Indian theories and modern scientific theories do not exhibit different lines of thought. A beautiful convergence of science and spirituality is the hallmark of vedantic theories of evolution. It includes and, in a sense, transcends scientific theories of evolution in so far as it takes into account the explanation of consciousness and the material world.

Keywords: science, evolution, natural, vedanta, consciousness, teleology, spiritual

Introduction

How was our universe created? How did it come to be the seemingly infinite place as we know of today? These are the questions that have been puzzling philosophers, scientists and scholars since the beginning of time. As a result, different scientific and philosophical theories emerged to explain how the universe came into being. Origin and evolution of cosmos constituted an important subject in Indian philosophical system from the vedic times. Indian cosmology reached its perfection with most of its findings resulting from the direct experience of ultimate reality. Many modern scientists including Edwin believed that.

We can find different viewpoints about evolution in Indian philosophical systems. Different sources like Vedas, Upanishads, Brahmanas, puranas contain diverse views about evolution. Some of these are based on philosophical concepts while some others are narratives. It is mentioned in the Rg veda that the Hiraynyagarva is the source of the creation of the universe. In our puranas the creator God Brahma is described as performing the art of creation. Brahma is a part of trinity of gods that also includes Vishnu and shiva. Brahma, Vishnu and Shiva are described as creator, preserver and destructor of the universe respectively. In Satpatha Brahmana, it is mentioned that the current human generation descends from Manu. In Hindu scriptures, the concept of Dasavatar can be seen as having some similarities to Charles Darwin's theory of evolution. The first incarnation of Vishnu in the form of fish resembles the evolutionary origin of fish in the Silurian period. Hindus already had present notion of common ancestry between humans and animals. The Hindu dharma believes that Gods have animal features. Let us look at the views of the different Indian systems.

Sankhya Theory of Evolution

The idea of evolution is basic to all Indian thought. We should understand both the modern evolution theory and Indian theories on it. Sankhya is the Indian theory of evolution which is supposed to apply both to individual and cosmos. The basic entities of Sankhya theory of evolution are pure consciousness (purusa) and materiality (nature). Sankhya philosophy belongs to orthodox systems of Indian philosophy. We can find a rationalistic approach in Sankhya to solve philosophical problems. The distinguishing feature of Sankhya lies in its discussion on Issues about life and reality free from religious bias.

Evolution is the process of gradual development of plants, animals, etc from simple to more complicated ones. Two theories regarding the causation of the world is found in Indian philosophy- (1) Creation (2) Evolution. The idealists accept creation whereas the materialistic systems accept evolution. Sankhya philosophy being a materialistic philosophy accepts the theory of evolution with regard to the causation of the world. The etymological meaning of the word prakrti is that which evolves. In other words, whatever evolves is prakrti or nature. It is the ultimate material cause of the world. The Sankhya system with the help of the Satkaryavada establishes the existence of prakrti as the root cause of the world. The world is not the cause but has evolved from the unmanifest

source variously called as prakrti or pradhana or avyakta. Though unmanifest the existence of prakrti can be inferred from its products. Prakrti transforms itself into the world of our experience. It is uncaused and unconscious. In order to avoid the problem of infinite regress it is so regarded. Prakrti is the matrix of all modifications-physical and psychical, since it is the basis of all objective existence-matter, life and mind. Prakrti is not the primal matter but the potential cause of all and has in it the potentiality of all things and beings of the world. According to Sankhya pravachana sutra, prakrti is constituted of three gunas- sattva, rajas and tamas. Sattva is the nature of pleasure and tends to conscious manifestation and gives pleasure to the individual. Rajas causes hectic activity, restless efforts and causes pain. Tamas resists activity leading to apathy and indifference. The three gunas are never separate though different from one another; they cooperate to produce the objects of the world.

Nature has three constituent qualities or gunas called Sattva, Rajas and Tamas. The universe evolves out of the interplay of purusa and prakrti. The evolutionary sequence goes through many levels. The gunas are not to be taken as abstract principles alone. Indian thought believes that structure in Nature is recursive, and the gunas show up in various forms at different levels of expression. This implies that ingredients for the growth of life are available throughout the universe. Infinite numbers of universes are conceived. So each new one is created like a bubble in the ocean of bubbles. The tattvas are not discrete and their varying expression creates the diversity of life in and across leading different species. Each sensory and motor tattva is mapped into a corresponding organ. Indian thought conceives of 8.4 million species which is an impressive number.

Physicist Erwin Schrondinger states that the Sankhyas tattvas were the most plausible model for evolution of the sensory organs. Let us look at a quote on evolution of earth from the 1000 year old encyclopedic yoga Vaisistha. "I remember that once upon a time there was nothing on this earth, neither trees and plants, nor even mountains. For a period of 11000 years (4 million earth years), the earth was under lava....later apart from the polar region the rest of the earth was covered by water and then forests enveloped the earth, and great asuras or demons ruled. Then there arose great mountains but without any human inhabitants for a period of 10000 years (almost 4 million earth years) the earth was covered with the corpses of the asuras. Indicating the presence of other animals while the giant asuras were on earth.

View of Charvak

In its philosophical import of a scientific and naturalistic approach to metaphysics, Charvaka denies super naturalistic explanation of the origin of the universe. Because of its scientific temperament, Charvaka was not concerned with truths that could not be verified. It posited that the world itself and all material objects of the world are real. They held that all existence can be reduced to the four elements of earth, water, air and fire. All things come into existence through the combination of these elements and will perish with their separation. The most philosophically sophisticated position of Charvaka is the assertion that even human consciousness is a material construct, a particular combination of these four elements gives rise to consciousness. The body is the substratum of consciousness. This can be proved by Charvaka by taking the example from medical science that certain foods and drinks have the properties conducive to the intellectual power. It proves the relation of consciousness with the body and the material ingredients like food. Regarding the evolution of the universe, Charvaka holds the position that the origin and purpose of existence is not discoverable through scientific means. As there is no certainty about the origin of the universe, the most probable explanation is that it evolved as a result of a series of random events. While it denies the creator or teleology, it regards nature itself as a force that thrives according to its own law.

View of Jainism

Jainism states that the universe is without a beginning or an end and is everlasting and eternal. Six fundamental entities known as dravya constitute the universe. Although all six entities are eternal, they continuously undergo countless changes known as paryaya. Existence or reality is a combination of appearance, disappearance and persistence. It believes that the universe and its entities such as soul and matter are eternal. No one has created them and no one can destroy them. They don't accept any supernatural principle or God as the creator of the universe. The Jain evolutionary theory is based on grading of physical bodies containing souls according to the degree of sensory perception.

View of Buddhism

Evolution is not explicitly mentioned in the tripitakas. The major principles of

Buddhism don't contradict evolution. Many Buddhists tacitly accept the theory of evolution. Many Buddhists don't think about evolution since these kinds of questions are meaningless for Buddhistic goal: Nirvana. In his book "The Universe in a single atom...the convergence of science and spirituality", the Dalai Lama dismisses the element of randomness in the theory of evolution based on natural selection. Buddhists believe that the beginning of the world and life is inconceivable since they have neither beginning nor end.

Modern theory of evolution in nutshell

The Big Bang theory is a modern leading explanation about how the universe began. In simple language, it says that the universe started with a small singularity, then inflated over the next 13.8 billion years to the cosmos that we know today. The small singularity, after its initial expansion, the universe cooled sufficiently to allow the formation of subatomic particles and later atoms, galaxies, stars, planets and life. The universe as we know was created in a massive explosion that not only created matter, but the physical laws that govern our ever expanding cosmos. This is what the Big Bang theory accepts. The universe began as tiny point of infinite density that started to expand. The universe will reach a maximum size and then begin to collapse in on it. This resembles the periodic evolution and dissolution of Indian theories of evolution accepted by Sankhya and others.

Journal of cosmology, Havard (30.01.2010) vehemently verified the theory of Big Bang. The Big Bang's originators have not explained what the singularity of zero volume is and how it originated, why and where it existed and why it exploded. Existence cannot be born of non-existence. According to the Satkaryavada theory of causation, everything that exists has a cause and so this singularity too must have a cause, which is skipped over by the exponents of Big Bang.

Many European scientists starting from the time of Einstein favored the big bang model as a viable explanation for the origin and nature of the universe. Accordingly, a mere 13.7 billion years ago, all matter, space and time emerged into existence in a titanic explosion: the big bang. There was no universe before the big bang, the European Science believes. Instead, there existed a singularity of zero volume of infinite density and energy or the entirety condensed which exploded, multiplied and expanded to form the present universe. How this imperishable one evolves into the origin, expansion and existence of the cosmos? This point has not been addressed by them.

Interpretation of modern Big Bang theory of evolution in Vedanta terminology

Whatever may be the defects and deficiencies of Big Bang theory, Advaita Vedanta is never in conflict with modern science. I think what has been stated as singularity and infinite state in the Big Bang theory is nothing, but an elaboration of vedantic concept of Brahman. Even in a paper submitted by the physicist Stephen Hawking showed that singularity was an inevitable initial condition of general relativity and Big Bang model of cosmology. This view very much resembles the strict monistic tendency of vedantic philosophy. Again, the zero volume of infinite resembles the imperceptible nature of Brahman. To illustrate the point we have the famous illustration of Nyagrodha tree in Chandogya upanisad. In course of his instruction, sage Udalaka to his disciple svetaketu regarding the nature of Brahman, he was told that Brahman constitutes the essence of all that is the case. Svetaketu asked the question that how can we prove that Brahman is the cause out of which the entire universe arises. Udalaka asked Svetaketu to fetch a fruit from Nyagrodha tree. Thereafter he was instructed to break the fruit. When the fruit was broken, the seed came out of it. Then he was instructed to break the seed. When the seed is broken, not anything visible could be found. Then Udalaka said,"My son, that subtle essence that you do not find there, of that the very essence of Nyagrodha tree exists. Believe it my son, that Being, which you do not find, that subtle essence even that this entire world has for itself. It is the truth and that is the Brahman. In the first part of his instruction, sage Udalaka is postulating an all comprehensive spiritual reality which he calls 'Being' to explain the origin of all things, the cause of the entire universe.

All bodies of the universe are evolved, controlled and determined by an imperishable entity and the awareness about it is the supreme knowledge. This one which is Akhyara or imperishable, the Hindu scriptures call it Avyakta or indestructible too, both the synonyms of God. To quote Albert Einstein, "What is important is the force of this super personal content and the conviction concerning its overpowering meaningfulness." Both spiritualists as well as scientists equally admit that the reason that works out the cosmic existence is definitely imperishable and super personal. Then how this imperishable would make him immutable. Everything mutable is a compound and everything compound must undergo that change which is called destruction. So God would die, which is absurd. Therefore, there never was a time when there was no creation. This view of Swami Vivekananda which he presented in his paper on Hinduism at Parliament of religions, Chicago falls fully in line with the oriental as well as modern accidental world views.

Conclusion

In my opinion, these two thought lines are parallel and not tangent to each other. The spirituality of Vedanta philosophy is not at all a hindrance for the serial progress or regress in the bio-species of the universe. We can conclude that evolution is pondered over in Vedanta philosophy in two directions. (1) The ethico-religio-spiritual direction describes the journey of a soul with the help of theory of karma and rebirth. The empirical suggests that in the struggle for existence, certain bio-forms are created by adaption and certain bio-forms extinguish because of the low will power. It all happens due to the earnest instinct to live and law of karma. As a description about the evolution of the universe, the Big Bang theory has significant bearing on philosophy. Many fundamental issues which are unresolved by the theory of Big Bang remains mysterious. To unravel the mysteries of existence, vedantic theory of evolution, in a sense, includes as well as transcends scientific theories of evolution in so far as it takes into account the explanation of consciousness and material world. While scientific theories of evolution mostly deals with the physical aspect of evolution, Indian theories of evolution deals with physical as well as mental aspects too and transcends scientific theories of evolution.

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Jhankar

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ସଂପାଦକ,
'ଝଙ୍କାର'
ପ୍ରଜାତନ୍ତ୍ର ପରିସର
ଚାନ୍ଦିନୀଚୌକ
କଟକ-୭୫୩୦୦୨
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ମୂଲ୍ୟ : ୪୦ଟଙ୍କା

ଏ ସଂଖ୍ୟାରେ

ଜାମ୍ବାଳିକା ଜଗତାରୁ ମାଙ୍ଗଳିକା ମୌସୁମୀ

ସଂହିତା ମିଶ୍ର

ଅନେକ ଦିନ ତଳେ କଥା। କୋଶଳ ଦେଶରେ ଲୋମପାଦ [illegible] ଥିଲେ। ଦେଶରେ ଖରା-ବର୍ଷା-କୋଣ ନାନା ଦୁଃଖ ଦେ [illegible] କେଉଁଠି ବର୍ଷା ହେଉ ନାହିଁ [illegible] ଥିଲା। ବର୍ଷା ନାହିଁ ମାନେ ଚାଷ [illegible] ତ ଚିନ୍ତା ଥିବ। [illegible] ଜଳ ନାହିଁ [illegible] ପ୍ରଜାମାନଙ୍କୁ [illegible] ରାଜା ଋଷିମାନଙ୍କ ପରାମର୍ଶ [illegible] ରାଜ୍ୟରେ [illegible] ଋଷ୍ୟଶୃଙ୍ଗ [illegible] ପାଦ ଦେବେ ତ ବର୍ଷା ହେବ [illegible] ଚମ୍ପାପୁର ନଗରରେ [illegible] ଋଷିଙ୍କ [illegible] ଅନେକ [illegible] ପାଇଁ [illegible] "ଯେବେ ଋଷ୍ୟଶୃଙ୍ଗ ଋଷି [illegible] ପାଦ ଦେବେ" [illegible] ରାଜା [illegible] ଅନେକ ଅନୁଚିନ୍ତନ କଲା ପରେ ଋଷିମାନେ କହିଲେ - ବିଭାଣ୍ଡକ ପୁତ୍ର ଋଷ୍ୟଶୃଙ୍ଗ ଯେବେ ଚମ୍ପାପୁର ରାଜ୍ୟରେ ପାଦ ଦେବେ, ତା' ହେଲେ ବୃଷ୍ଟିପାତ ହେବ।

ଅନାବୃଷ୍ଟିରେ ଦେଶିଲା ଚମ୍ପାପୁର...

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ଏକାଠୁ ଦୂର୍‌ଦୂରାନ୍ତର୍ ଅଛି ସେ କେଉଁଠି ରୂପସୀ ନାରୀ। କେତେବେଳେ ଦେବତାଙ୍କ ତପସ୍ୟା ଭାଙ୍ଗିବା ପାଇଁ ତ କେବେ ଋଷିମାନଙ୍କ ତପସ୍ୟା ଭାଙ୍ଗିବା ପାଇଁ ଏହି ଅପରୂପା ରୂପଯୌବନା ଗଣିକାମାନଙ୍କୁ ହିଁ ପ୍ରେରଣ କରାଯିବ। ଚମ୍ପାପୁର ତ ସ୍ୱର୍ଗରେ ନୁହେଁ କି ଲୋମପାଦ ତ ଦେବତା ନୁହନ୍ତି। ଅପ୍ସରାମାନେ ତ ନାହାନ୍ତି। ଏପରି ସୁରେ ଗୀତ ଗାଇଥିଲା ବାରନାରୀ।

ଝୁମ.... ଝୁମ.... ରିମଝିମ ଝୁମ,
ଋଷ୍ୟଶୃଙ୍ଗ ତପୋବନ।
ଚାଲି କଳବୁଲି.... ସାଧନାପଥ
ଯେବେ ପାଦ ଦେବେ ଚମ୍ପାପୁର ଭୂଇଁ....
ତେବେ ହେ ହୋଇବ ବରଷା....
ମେଣ୍ଟିବ ମାଟିର ତୃଷା ପାଇବ ଜୀବନ....
ପାଇବ ଭୋଜନ....
ହେ ପୁରଜନ....

ଚମ୍ପାପୁର ନଗରରେ ନାଗରାଣୀଟିଏ ଥିଲା। କୋଶଳ ନାମ ବରତା। ନାମ ବରକର। ଧୋବ ପତପର। ବାରନାରୀ ବେ ଛଉରା। ଇଉରେ ହେଲ ଦାଣକୁ ବାହାରି ଋଷ୍ୟପାଶିଆକୁ ଧଇଲା। ତହୁଁ ରାଜଦରବାରକୁ ଅଇଲା। ମହାପାତ୍ର ବରତାକୁ ଦେଲ ପଦ୍ମନାଭ। ଉଲ ଧରି ବାନା ବୋଇଲା। ତହୁଁ ବାରନାରୀ ରାଜ ଆଜ୍ଞା ଧରି, ଯାତ୍ରା ପାଇଁ ସଜ ହୋଇଲା। ବନ-ପର୍ବତ-ଗିରି-ଶିଳ ବାଟ ପାରକୁ ଦେଖ ମୋ ଅକାରଣ କଷ୍ଟ ଦେଖୁ ହେ ରାଜନ। ନାବଧରି ମୁଁ କରତ ପରେ କରିବି ଗମନ, ନାବ ଭିତରେ ନିମନ୍ତେ କରନ୍ତୁ ଯତନ।

ପାଠକେ! କଥା ତ ଆପଣମାନେ ଜାଣନ୍ତି। କୋଟିଏରେ ନାବଧରି ଅଭିଯାତ୍ରିଣୀ ବରତା ଯାତ୍ରାର ଉଚିତ ଦିବସରେ ଋଷ୍ୟଶୃଙ୍ଗଙ୍କୁ କୋଳରେ ଧରି ଚମ୍ପାପୁରକୁ ଫେରିଆସିଲା। ତା' ପରେ ଝୁମୁଝୁମାଳ ବରଷା, ଧଡ଼ଧଡ଼ାଣୀ ଘଡ଼ଘଡ଼ି ଆଉ ଚମକିଆଣ ବିଜୁଳି। ବରଷ ତ ପାଇଲେ ଆକାଶ ପୃଥିବୀ ସଙ୍ଗେ ମିଶିଲା। ପୂର୍ଣ୍ଣ ଭୂମିକର୍ଷଣ-ବୀଜବପନ-ଏକସୁ ଅନେକ ଅନେକ ବେପାର ସୁବିଧା ଘଟିଲା ଯାହାରେ

ବାବନ.... ବାବନ.... ବାବନ

ଅଳପ.... ଅଳପ.... ଅଳପ

ମେଘୁଲ ଭଳକରେ ଏପରି ଅନାବୃଷ୍ଟି ଜାତରେ କରତା କୋଷା ଉପଭୋଗଙ୍କୁ ବାଚନ ଦେବା ଦେଖି ଆମ କବି ବଳରାମ ଦାସଙ୍କ ମନୋଜ ପଢ଼ିକଲେ। କାରଣ ବାଲ୍ମୀକି ରାମାୟଣରେ ଋଷ୍ୟଶୃଙ୍ଗ ଉପାଖ୍ୟାନ ଅଛି କେବଳ କରତା ନାହିଁ କି ନାହିଁ ମଧ ଶଚୀପୁଟରର କାହାଣୀ, ଜନ୍ମସ୍ମୃତି ପ୍ରସଙ୍ଗ, ଜାତିର୍ଦ୍ଧଶର ଅଭୋଗର ମନୋଜ ବର୍ଣ୍ଣନା। ଆମ ଭଲଦାୟ କବିମାନେ ପ୍ରାରମ୍ଭରୁ ହିଁ ପ୍ରୟାସରେ। ଉଦାହରିଥିବା ପଥରେ ପାଦ ଦେଇଦେଇ ସେମାନେ ବାଟରାଳି ଭରିଥିବେ ଆଉ ଭଲି ପାଇ ପାଇ ନୂଆ ପଥଟିଏ ଗଢ଼ିବେ। ସାରଳା-ବଳରାମ-ଜଗନ୍ନାଥ ତିନିଜଣଙ୍କ ପଥ ନିର୍ମାଣରେ ଚିରିଙ୍ଗ ଚିତ୍ରିତ କବି। ୧୯୮୦ ମସିହାରେ ଜଗମୋହନ ରାମାୟଣର ପ୍ରଥମ ଖଣ୍ଡ ସଂସ୍କରଣ ଶ୍ରୀ କୃଷ୍ଣଚରଣ ସାହୁଙ୍କ ସଂପାଦନାରେ ପ୍ରକାଶିତ ହୁଏ। ଖଣ୍ଡର ମୁଖବନ୍ଧରେ ପ୍ରଖ୍ୟ ସଂପାଦକ ବଳରାମ ଦାସଙ୍କ ଅବଦାନକୁ ପ୍ରତିପାଦିତ କରି ଆଦିକାଳରୁ ଯେଉଁ ଭଳିକୋଟି ଉପାଖ୍ୟାନର ସୂଚନା ଦେଇ କବି କିପରି ମୁଖକଥା ସହ ନୂତନ କଥା ସଂଯୋଜିତ କରିଛନ୍ତି ତାହାର ତୁଳନାତ୍ମକ ଆଲୋଚନା କାଳରେ ଋଷ୍ୟଶୃଙ୍ଗ ଉପାଖ୍ୟାନ ସଂପର୍କରେ ସବିଶେଷ ସୂଚନା କରିଛନ୍ତି। ପଣ୍ଡିତ ସୂର୍ଯ୍ୟନାରାୟଣ ଦାସ, ସୁରେନ୍ଦ୍ର ମହାନ୍ତି ପ୍ରମୁଖ ଓଡ଼ିଆ ସାହିତ୍ୟର ଇତିହାସ ଲେଖକମାନେ ଋଷ୍ୟଶୃଙ୍ଗ ଉପାଖ୍ୟାନ ବର୍ଣ୍ଣନାରେ ବଳରାମଙ୍କ ମୌଳିକତା ପ୍ରସଙ୍ଗ ଉପସ୍ଥାପିତ କରିଥିଲେ। ବାଲ୍ମୀକି ରାମାୟଣର ବାଳକାଣ୍ଡରେ ନବମ ଓ ଦଶମ ସର୍ଗରେ ଋଷ୍ୟଶୃଙ୍ଗ କାହାଣୀ ବର୍ଣ୍ଣିତ। ନବମ ସର୍ଗର ସଂକ୍ଷିପ୍ତ ଏବଂ ଦଶମ ସର୍ଗର ସଂପୂର୍ଣ୍ଣ ବର୍ଣ୍ଣନାକୁ ଏକତ୍ରିତ କଲେ ଏହାର ସାରକଥା ହେଉଛି - ଅଙ୍ଗ ଦେଶରେ ରାଜା ଲୋମପାଦଙ୍କର ଅଧର୍ମାଚରଣ ନିମନ୍ତେ ରାଜ୍ୟବାସୀ ଅନାବୃଷ୍ଟି କଷଣ ସହ୍ୟ କରୁଥିବାବେଳେ ବ୍ରାହ୍ମଣମାନଙ୍କ ପରାମର୍ଶକ୍ରମେ ବିଭାଣ୍ଡକ ମୁନିଙ୍କ ଆଶ୍ରମକୁ ବେଶ୍ୟାମାନଙ୍କୁ ପ୍ରେରଣ କଲେ। ବେଶ୍ୟାଗଣ ଋଷ୍ୟଶୃଙ୍ଗଙ୍କୁ ଭୁଲାଇ ନେଇ ଆସିଲେ ଏବଂ ରାଜକୁମାରୀ ଶାନ୍ତାଙ୍କ ସହ ତାଙ୍କର ବିବାହ ସଂପାଦିତ ହେଲା।

କବି ବଳରାମ ମୂଳ ରାମାୟଣର କଥାଭାଗ ସହ ଋଷ୍ୟଶୃଙ୍ଗଙ୍କ ଜନ୍ମ, ଅଙ୍ଗଦେଶ (ଚମ୍ପାପୁର)ରେ ଅନାବୃଷ୍ଟିର କାରଣ, କରତା, କାମମୋହିନୀ ପ୍ରଭୃତି ବେଶ୍ୟାଙ୍କ ନୌକାଯାତ୍ରା ଓ ଋଷ୍ୟଶୃଙ୍ଗଙ୍କ ପ୍ରଲୋଭନ ଆଦି ପ୍ରସଙ୍ଗ ସଂଯୁକ୍ତ କରନ୍ତି। ଋଷ୍ୟଶୃଙ୍ଗଙ୍କ ଜନ୍ମ ପ୍ରସଙ୍ଗ ବାଲ୍ମୀକିଙ୍କ ରାମାୟଣରେ ନାହିଁ। ସଂସ୍କୃତମହାଭାରତ ଦ୍ୱାରା ପ୍ରଭାବିତ ହୋଇ ସାରଳା ଦାସ ଏହି ବୃତ୍ତାନ୍ତ ବର୍ଣ୍ଣନା କରିଥିଲେ, ବଳରାମ ଦାସ ମଧ୍ୟ ବ୍ୟାସବର୍ଣ୍ଣିତ ମହାଭାରତୀୟ ଆଖ୍ୟାନକୁ ପ୍ରଳମ୍ବିତ କରିଛନ୍ତି। ଆଲୋଚ୍ୟ ପ୍ରବନ୍ଧ ସହ ଋଷ୍ୟଶୃଙ୍ଗଙ୍କ ଜନ୍ମ ବୃତ୍ତାନ୍ତର ପ୍ରତ୍ୟକ୍ଷ ସଂପର୍କ ନଥିବାରୁ କରତା ପ୍ରସଙ୍ଗ ହିଁ ବିଚାର କରିବା। ବାଲ୍ମୀକି ରାମାୟଣରେ 'କରତା' - ଏହି ନାମଟି ବ୍ୟବହୃତ ହୋଇନଥିଲା। ତେବେ କବି ବଳରାମ ଓଡ଼ିଆସାହିତ୍ୟାକାଶରେ କରତା ନାମଟି କେଉଁଠାରୁ ଆଣିଲେ? ସଂପାଦକ ଶ୍ରୀଯୁକ୍ତ ସାହୁଙ୍କ ମତାନୁସାରେ 'କରତାକୁସ' ଏହି ନାମଟି ସଂସ୍କୃତ ମହାଭାରତରେ ରହିଛି। ମୁନୀନ୍ଦ୍ର ସାରଳା ଏହାକୁ 'କରତାକୁସ' ନାମରେ ଗ୍ରହଣ କରିଛନ୍ତି। ବଳରାମ ଦାସ ତାହାକୁ 'କରତା ବେଶ୍ୟା' ନାମରେ ଗ୍ରହଣ କଲେ।

ସମାଲୋଚକ ସୁରେନ୍ଦ୍ର ମହାନ୍ତି 'ଓଡ଼ିଆ ସାହିତ୍ୟରେ ମଧ୍ୟପର୍ବ' ଓ 'ଉତ୍ତର ମଧ୍ୟପର୍ବ' ଗ୍ରନ୍ଥରେ ବାଲ୍ମୀକି ରାମାୟଣ ବର୍ଣ୍ଣିତ ଏହି ଉପାଖ୍ୟାନଟି ଏକତଳ ଚିତ୍ରିତ (one dimensional) ହୋଇଥିବାବେଳେ ବଳରାମ ଦାସ ନିଜର ବର୍ଣ୍ଣନା କରିଥିଲେ ଏହି କାହାଣୀକୁ ତ୍ରିସ୍ତର ଚିତ୍ରିତ (three dimensional) କରି ଏକ ଅଦ୍ଭୁତ ବୈଚିତ୍ର୍ୟ ପ୍ରଦାନ କରିପାରିଛନ୍ତି ବୋଲି ସ୍ୱୀକାର କରିଛନ୍ତି। ଅତଏବ ନିମ୍ନୋକ୍ତ ପ୍ରସଙ୍ଗରେ ରହିଛି କବି ବଳରାମଙ୍କ କବିତ୍ୱଶକ୍ତିର ମୌଳିକତା।

→ ଅନାବୃଷ୍ଟିର କାରଣୋଲ୍ଲେଖ
→ ରାଜ ଦେହୁରା ମାଧ୍ୟମରେ ଋଷ୍ୟଶୃଙ୍ଗଙ୍କ ପ୍ରଲୋଭନ
→ କରତାବେଶ୍ୟାର ନାବ ନିର୍ମାଣ ନିମନ୍ତେ ଅନୁରୋଧ
→ କୋଟିଏଟି ନାବର ଅବିଳମ୍ବେ ସଜ୍ଜୀକରଣ
→ କରତା, କାମମୋହିନୀ ସମେତ ବାରବନିତାଙ୍କର ନାବାରୋହଣ, ରାଜାଙ୍କ ନିକଟରୁ ମେଲାଣି, ବ୍ରାହ୍ମଣାଦିଙ୍କର ଅନୁକୂଳ ମନ୍ତ୍ରପାଠ ଏବଂ ଯାତ୍ରାରମ୍ଭ।
→ ପଥପ୍ରାନ୍ତର ଅପରୂପ ପାରିପାର୍ଶ୍ୱିକ ଦୃଶ୍ୟ
→ ଯାତ୍ରାର ତେରଣ ଦିନ ପରେ ଗନ୍ତବ୍ୟ ସ୍ଥଳରେ ପ୍ରବେଶ ଏବଂ ନାରୀରୂପ-ଦେହ ତଥା ପ୍ରକୃତି ସଂପର୍କରେ ସଂପୂର୍ଣ୍ଣ ଅନଭିଜ୍ଞ ଜଣେ ଯୁବ ସନ୍ନ୍ୟାସୀଙ୍କର ମାନସିକ କ୍ରିୟା ପ୍ରତିକ୍ରିୟାଦିର ନାଟକୀୟ ବର୍ଣ୍ଣନା।
→ ଯିବା ପାଇଁ ତେରଣ ଦିନ ସମୟ ଲାଗିଲା, ଲଳଣି ଥିଲା ପାଞ୍ଚ ଦିନର ଏବଂ ଫେରିବା ବେଳ ବାର ଦିବସ କଟିଗଲା। ଏହିପରି ସଂପୂର୍ଣ୍ଣ ଊଣିଶ ଦିନର ଅବଧି ପରେ କରତା କୋଳରେ ଶୋଇ ମୁନି ଚମ୍ପାପୁରକୁ ଆସିଲେ।

ବାସ୍ତବରେ କବି ବଳରାମ ଏହି ଊଣିଶ ଦିବସର ଯାତ୍ରା ତଥା ପୂର୍ବାପର ବର୍ଣ୍ଣନାରେ ଯେଉଁ ବୈଚିତ୍ର୍ୟମୟ କବିତ୍ୱ ପ୍ରଦର୍ଶନ କରିଛନ୍ତି, ତାହାର ପଟାନ୍ତର ନାହିଁ। ନୌକା ଯାତ୍ରାକାଳୀନ ତଟବର୍ତ୍ତୀ ଦୃଶ୍ୟକୁ ନିମ୍ନୋକ୍ତ ଉଦାହରଣ ରୂପେ ଗ୍ରହଣ କରାଯାଇପାରେ।

"କାହିଁ ଶେତ ନେଉଳ ଖେଦାଖେଦି ହୋଇ
ନେପାଳି ମୂଷାକୁ ସେ ଅଛନ୍ତି ଗୋଡ଼ାଇ ।୫୦୨
କିଚୁ ମୟୂର ସେ କରନ୍ତି ନୃତ୍ୟ ରସ।
କାହିଁ ବଣ ପାରୁଆ ଉଡ଼ନ୍ତି ଚଉପାଶ ।୫୦୩
ଗହନ ବନସ୍ତରେ ବୋବାଇ ଏକ ବାଘ
ହୁକୁହୁକି ପ୍ରାୟେକ ଶୁଭଇ ଶବଦ ।୫୦୪
ପର୍ବତ ଉପରେ ଥାଇ ଦେଖଇ ଭଲ୍ଲକ
ନାବ ଦେଖି ଧାଇଁ ଆସିଲା ନଦୀକୂଳ ।୫୦୫

(ଜଗମୋହନ ରାମାୟଣ-ପୃ.୩

ଏପରି ଚାବଚ୍ଚ ବର୍ଣ୍ଣନା ଷୋଡଶ ଶତାବ୍ଦୀର ରସମୁଗ୍ଧ ଉତ୍କଳୀୟ ପ୍ରକୃତିର ରସିକ ଚିତ୍ତ ବ୍ୟତୀତ ଆଉକିଛି ହୋଇ ନପାରେ। ତେବେ କବି ବଳରାମଙ୍କର ମୂଳ ଲକ୍ଷ୍ୟ ଥିଲା ବ୍ରହ୍ମଚାରୀ ଋଷ୍ୟଶୃଙ୍ଗଙ୍କୁ ତପୋଭ୍ରଷ୍ଟ କରିବା। କବି ବଳରାମ ତ ଯେମିତି ମତ୍ତ ବଳରାମ ହୋଇ ଜରତୀ କିପରି କାମମୋହିନୀ ଆଉ ବାରନାରୀଙ୍କୁ ନେଇ ଋଷିପୁତ୍ରଙ୍କ ସହ ଛଳନା କରି ତାଙ୍କୁ ନେଇ ଆସିଲେ ତାହା ବର୍ଣ୍ଣନା କରିଛନ୍ତି। ଜରତୀ ରାଜଧର୍ମ ପାଳନ କରିଛନ୍ତି, କିନ୍ତୁ ନାରୀଧର୍ମରୁ ବିଚ୍ୟୁତ ହୋଇଯାଇ ନାହାଁନ୍ତି କି? ଜଣେ ଋଷିପୁତ୍ରଙ୍କୁ ବାରବର୍ଷକାଳ ଅନାବୃଷ୍ଟି ଭୋଗୁଥିବା ରାଜ୍ୟରେ ଆପଣ ପାଦ ଦେଲେ ବୃଷ୍ଟିପାତ ହେବ ଏବଂ ନଗରବାସୀଙ୍କର ଜୀବନରକ୍ଷା ହୋଇପାରିବ ଏହି ଅନୁରୋଧ ରଖିଥିଲେ ସେ କ'ଣ ଏପରି ଅନୁରୋଧକୁ ଅସମ୍ମାନ କରିପାରିଥାଆନ୍ତେ ଋଷିର ତପସ୍ୟା ଯଦି ଜଗତର ମଙ୍ଗଳକାରକ ହେବ ନାହିଁ, ତେବେ ସେ ତପଶ୍ଚର୍ଯ୍ୟା ଅକାରଣ ନୁହେଁ କି? କିନ୍ତୁ ତତ୍‌କାଳୀନ ସମାଜର ଆବଶ୍ୟକତା ଦୃଷ୍ଟିରୁ, କାବ୍ୟ-ମହାକାବ୍ୟ ମଧ୍ୟରେ 'କାମ' ନାମକ ପୁରୁଷାର୍ଥର ଅପରିହାର୍ଯ୍ୟ ଉପସ୍ଥିତି ହେତୁରୁ କବି ବଳରାମ ଏପରି ଚଟୁଳ-ଚତୁର-ଛଳନାର ଛଇଳ ବର୍ଣ୍ଣନା ପ୍ରଦାନ କରିଛନ୍ତି। ଦେହ ନୈବେଦ୍ୟ ଦେବା ପୂର୍ବରୁ ନାରୀ କ'ଣ ମମତାର ମନ୍ତ୍ରୋଚ୍ଚାରଣ କରିପାରିବନି। ଋଷ୍ୟଶୃଙ୍ଗ ଜନ୍ମରୁ ମାତୃଦର୍ଶନ କରି ନଥିଲେ। ତାଙ୍କର ପ୍ରତ୍ୟକ୍ଷ ମାତା ହିଁ ନଥିଲେ। ଯୌବନର ପ୍ରଦୀପ୍ତ ଶରୀରରୁ କେବଳ କାମର କିରଣ ହିଁ ଝରିଆସିବ। ଛଳନାହୀନ, ସତ୍ୟଭାଷୀ, ମାତୃକଳ୍ପା ଯୁବତୀମାନେ ପଣତ ପକାଇ ଋଷିପୁତ୍ରଙ୍କୁ ଚମ୍ପାପୁର ଆଣି ପାରିଥାନ୍ତେ? ଋଷ୍ୟଶୃଙ୍ଗ ବେଶ୍ୟାରମଣୀମାନଙ୍କର ଛଳନା ବୁଝି ପାରି ନଥିଲେ। ସେ ତ ଭାବିଲେ ତପୀମାନଙ୍କୁ ଦର୍ଶନ କଲେ। ପିତା ବିଭାଣ୍ଡକଙ୍କ ପ୍ରଶ୍ନର ଉତ୍ତର ଦେବାକୁ ଯାଇ ସରଳ ଋଷ୍ୟଶୃଙ୍ଗ କଅଣ ଉତ୍ତର ଦେଇଛନ୍ତି ତାହା ଦୃଷ୍ଟାନ୍ତସ୍ୱରୂପ ଗ୍ରହଣୀୟ।

"ଋଷ୍ୟଶୃଙ୍ଗ ବୋଇଲେ ଶୁଣ ତୁ ପିତାମହ।
ଆଜ ସେ ସଫଳ ହୋଇଲା ମୋ ଦେହ ।୬୬୫।
ଅପୂର୍ବ ତପୀ ଦେଖିଲି ଆଜି ମୁହିଁ ତାତ
ରୂପେଣ ମୋହି ସେ ପାରନ୍ତି ଜଗତ ।୬୬୬।
ଯେ ଆମ୍ଭର ଜଟା ପିଙ୍ଗଳ ବର୍ଣ୍ଣକେଶ
ତାଙ୍କର ଶିରରୁହ ଭ୍ରମର ସଦୃଶ ।୬୬୭।
ରୁଦ୍ରାକ୍ଷ କାଠମାଳ ଆଭରଣ ନାହିଁ
ଅପୂର୍ବ ଅଳଙ୍କାର ଅଛନ୍ତି ସେ ଲାଇ ।୬୬୮।
x x x x x
ଭୋ ତାତ ଧନ୍ୟ ଧନ୍ୟ ତପ ତାହାଙ୍କର
ଉତ୍ତମ ତପ ତ ଦେଖିଲି ତୁମର ।୬୭୪।

(ତତ୍ରୈବ-ପୃ.୪୩)

ପୁତ୍ର ମୁଖରୁ ସମସ୍ତ ପ୍ରସଙ୍ଗ ଶ୍ରବଣ କରିବା ପରେ ପିତା ବିଭାଣ୍ଡକ ହିଛନ୍ତି ସେମାନେ ଯତି ନୁହଁନ୍ତି ରାକ୍ଷସୁଣୀ, ଦଇତୁଣୀ, ପିଶାଚୁଣି। ସମାନଙ୍କୁ କେବେ ହେଲେ ବିଶ୍ୱାସ କରିବୁ ନାହିଁ। ନାରୀ ବିଶ୍ୱାସଭାଜନ ନୁହେଁ, ମାୟାବତୀ, ମିଥ୍ୟାବତୀ ଏପରି ନାରୀ ନିନ୍ଦାର ପ୍ରଚ୍ଛନ୍ନ ସନ୍ନିବିଷ୍ଟ ଅଭିବ୍ୟକ୍ତିମାନ ସହ ଯୋଡି ହୋଇଚାଲେ କବି ବଳରାମଙ୍କ ବିରହ। ଅବଶ୍ୟ ନୌକାଯାତ୍ରା ସମାପ୍ତ ହେବା ପରେ ଜରତୀ କ୍ଷମା ପ୍ରାର୍ଥନା କରିଛନ୍ତି ଏବଂ ରାଜ୍ୟର ହିତାର୍ଥେ ଏହି କର୍ମ ସଂପାଦନ କଲେ ବୋଲି ସ୍ୱୀକାର କରିଛନ୍ତି। କବି ବଳରାମ ମୂଳକାହାଣୀ ସହ ଅନାବୃଷ୍ଟିର କାରଣ-ନିରାକରଣ, ମାନବିକ ମନସ୍ତତ୍ତ୍ୱ ଓ ସୁରମ୍ୟ ପ୍ରକୃତି ଆଦି ଉପାଦାନକୁ ସଂଯୋଜିତ କରି ରସାଳ ଉପାଖ୍ୟାନ ନିର୍ମାଣ କରି ଜରତାଦି ନାରୀମାନଙ୍କୁ ଅକାରଣରେ କାମ କାୟଲରେ କର୍ଦ୍ଦମାକ୍ତ କରି ଦେଇଛନ୍ତି।

କବିସମ୍ରାଟ ଉପେନ୍ଦ୍ର ଭଞ୍ଜ 'ବୈଦେହୀଶବିଳାସ' ମହାକାବ୍ୟର ଚତୁର୍ଥ ଛାନ୍ଦରେ ଅଳଙ୍କାରର ଆଭୂଷଣ ମଧ୍ୟରେ ଉତ୍କଳୀୟ ରାମାୟଣବର୍ଣ୍ଣିତ ଉପରୋକ୍ତ ଆଖ୍ୟାନଟିକୁ ବୟାନବେଗୋଟି ପଦ ମଧ୍ୟରେ ମାଳବଗଉଡା ରାଗରେ ବର୍ଣ୍ଣନା କରିଛନ୍ତି। ଅନୁପ୍ରାସ ଓ ଶ୍ଳେଷାଦି ଅଳଙ୍କାରମଣ୍ଡିତ କବିସମ୍ରାଟଙ୍କର ସେହି ଉତ୍କଳୀୟ ବର୍ଣ୍ଣନା ବର୍ଣ୍ଣନାର ଦ୍ୟୁତି ଦୃଷ୍ଟାନ୍ତ ମାଧ୍ୟମରେ ଗ୍ରହଣ କରାଯାଉ।

"ବୃଷ୍ଟିହୀନ ଦ୍ୱାଦଶ ବରଷ ଚମ୍ପାବତୀ
ବଡ ଚିନ୍ତା ଭରି ଲୋମପାଦ ନରପତି ଯେ ।୨।
ବରଷା କରିବ ଋଷ୍ୟଶୃଙ୍ଗ ଆଗମନେ
ବ୍ରହ୍ମଜ୍ଞାନ ପରି ଘେନି ଯୋଗୀନ୍ଦ୍ର ସମାନ ଯେ ।୩।
ବୁଲାଇ ନିଜ ନବରେ ପଞ୍ଚରତ୍ନ ପ୍ରାଚୀ
ବଜ୍ରଧରି ଶତମନ୍ୟୁ ପରାୟେ ସେ ଝଳି ଯେ ।୪।
ବିକାଶରେ ପଦ୍ମ-ରାଗ ସବିତା ପ୍ରତିଭା
ବିହିଛି ସେ ମାରକତୀ ହୋଇ ରତି ଶୋଭା ଯେ ।୫।
ବିଦ୍ରୁମେ ମହାଉଜ୍ଜ୍ୱଳ ଅଟବୀ ସଦୃଶ
ବହି ଗର୍ଭେ ମୋତି ଶୁକ୍ତି, ଏ ତ୍ରିବିଧ ଶ୍ଳେଷ ଯେ ।୬।

(ବୈ.ବି.ପୃ.୪୪)

ରତ୍ନଭକ୍ତି ସଂପର୍କରେ କବି ବଳରାମ ପଦଟିଏ ହିଁ କହିଥିଲେ। "ହୀରା ମଣିମାଣିକ୍ୟ ଯେ ମୁକୁତା ଚନ୍ଦ୍ରକାନ୍ତି ଶୁଦ୍ଧ ସୁବର୍ଣ୍ଣ ଜଡିଲା ଅଳଙ୍କାର ଶୋଭାପାନ୍ତି ॥" ଭଂଜ ସ୍ୱକୀୟ ଚାତୁର୍ଯ୍ୟରେ ପଞ୍ଚରତ୍ନରେ ପରିପୂର୍ଣ୍ଣ ପାହୁଟିର ବର୍ଣ୍ଣନା କଲେ। ହୀରା, ପଦ୍ମରାଗ ମଣି, ମର୍କତ, ପ୍ରବାଳ ଓ ମୁକ୍ତା ଏହିପରି ସେହି ବିଶେଷ ପାହୁରେ ପଞ୍ଚ ପ୍ରକାରର ଦୁର୍ଲଭ ରତ୍ନ ଥିଲା। 'ବଜ୍ର' ଶବ୍ଦର ଦୁଇଟି ଅର୍ଥ ଗୋଟିଏ ହୀରା ଏବଂ ଅନ୍ୟଟି ଇନ୍ଦ୍ରଦେବତାଙ୍କର ଅସ୍ତ୍ର। ଅର୍ଥାତ୍ ଆଳିଟି ବଜ୍ର ଧାରଣ କରି ଇନ୍ଦ୍ରଙ୍କ ପରି ପ୍ରତୀୟମାନ ହେଉଛି। ବୃଷ୍ଟିହୀନ ରାଜ୍ୟର ଅଧିବାସୀଗଣ ଦ୍ୱାରା ପଥରରେ ଉଦ୍‌ଭାସିତ ପରାତଟିକୁ ଅଭଙ୍ଗ ଶ୍ଳେଷ ଓ ସଭଙ୍ଗ ଶ୍ଳେଷ ସାହାଯ୍ୟରେ ରତ୍ନସ୍ଥଳୀର ସୌନ୍ଦର୍ଯ୍ୟ ବ୍ୟକ୍ତ କରିବା ପରେ କବି ଲେଖନ୍ତି,

"ବେଶ୍ୟାସାର ଜରତୀ ତା ରତୀ ହୋଇ ନେଲା
ବନ୍ଦୁଁ ଆଜନ୍ମ ତପସ୍ୱୀ ଆଣିବି ବୋଇଲା ଯେ ।୭।
ବୃଷଭ-ଗୋତାଇ ଧେନୁ ପଛରେ ଯେମନ୍ତ
ବେଦାଧ୍ୟୟନ ଛଡାଇ ଆଣିବି ତେମନ୍ତ ଯେ ।୮।

(ତତ୍ରୈବ, ପୃ.୪୫)

ଆକାର ଗୌରବ ଉଦ୍‌ଭାଗିତ, ଉନ୍ନତ ଉଜ୍ଜ୍ୱଳତା ବର୍ଣ୍ଣିତ ହେଲେ ନାରୀକୁ ଏତେ ଅଧୋଗାମିନୀ କରି ଦେଲେ କବି। ବାରବର୍ଷ ଧରି ଅନାବୃଷ୍ଟି ଭୋଗୁଥିବା ରାଜ୍ୟଟିକୁ ରକ୍ଷା କରିବାର ପ୍ରଭାବ ଅଭାପ୍ସାଠାରୁ ପଞ୍ଚଶରନ୍ ପରିପୂର୍ଣ୍ଣ ପ୍ରକୃତି ପ୍ରତି ଗତି ହେଉଥିଲା ଜଗତ। ବୋଧହୁଏ ଋଷିପୁତ୍ରଙ୍କୁ ଆଶ୍ରମରୁ ନଗରକୁ ଆଣିବା ପାଇଁ ବୃଷଭ ଆଉ ଧେନୁର ରୂପକାତ୍ମକ ଚିତ୍ର ପ୍ରଦାନ କରି ନାରୀର କାମଶକ୍ତିକୁ ସୁଦୃଢ଼ ପ୍ରଦାନ କରାଗଲା ହେଲେ ଧେନୁ ପଛରେ ବତ୍ସତରୀ ପରି ଯଦି ଋଷ୍ୟଶୃଙ୍ଗ ଆସି ଥାଆନ୍ତେ ମାତୃଶକ୍ତିର ମୈତ୍ରୀ ବାଣୀ ଉଦ୍‌ଘୋଷିତ ହେଇ ନଥାନ୍ତା କି?

ବର୍ଦ୍ଧକୀ ଡକାଇ ନାବ ଗଢ଼ାଗଲା ଏବଂ ଏହି ନାବଗୁଡ଼ିକ ବେଶ୍ ଅର୍ଥାତ ବୃହାକୃତିର କରାଯାଇଥିଲା। ସେହି ନାବ ମଧ୍ୟରେ ନାନାବିଧ ଉପକରଣ ଭର୍ତ୍ତି କରି ଗୋଟିଏ ଜଙ୍ଗଲ ସୃଷ୍ଟି କରିବା ପାଇଁ ନିର୍ଦ୍ଦେଶ ଦିଆଗଲା। ନାବ ନିର୍ମାଣ ତଥା ସଜ୍ଜୀକରଣାଦି ପ୍ରସଙ୍ଗକୁ ନେଇ କବି ବଳରାମ ଯେପରି ବିସ୍ତୃତ କରିଛନ୍ତି କବିସମ୍ରାଟ ତାହା ନ କରି ଦୁଇଟି ପଦ ମଧ୍ୟରେ ସମାପ୍ତ କରିଛନ୍ତି। ନଦୀ ମଧ୍ୟରେ ଜଳଯାତ୍ରା ତଥା ପାରିପାର୍ଶ୍ୱିକ ଦୃଶ୍ୟ ମଧ୍ୟ ଅତ୍ୟନ୍ତ ସୂଚନାଧର୍ମୀ। ତେବେ ଦ୍ୱାଦଶ ଓ ତ୍ରୟୋଦଶ ପଦରେ ଯମକାଳଙ୍କାରର ପ୍ରୟୋଗ ପ୍ରସଙ୍ଗ ସୂଚିତ କରିବା ଆବଶ୍ୟକ ମନେହୁଏ।

"ବସିଲେ ତରଣୀ ଅଙ୍କେ ଛାୟା ପରା ହୋଇ
ବିରାଜିବା ପୁଷ୍କର ଗମନେ ସେ ଯୋଗାଇଲେ ଯେ ।୧୨।
ବିଖ୍ୟାତ ଉଡୁପ ନାମ ଯୁକ୍ତ ତାରାଳିରେ।
ବ୍ୟସ୍ତବନ୍ତ ଗତି କରେ ନିଶି ଦିବସରେ ଯେ ।୧୩।

ନୌକାରୋହୀ ବାରଜଣ ବାରନାରୀ ସୂର୍ଯ୍ୟଙ୍କ ଅଙ୍କରେ ଛାୟାଦେବୀଙ୍କ ପରି ଶୋଭା ପାଉଥିଲେ। ଗତିଶୀଳ ପଦ୍ମପୁଷ୍ପସମ ଏହି ନାରୀମାନେ ଶୋଭା ପାଉଥିଲେ। 'ଉଡୁପ' ଶବ୍ଦର ମଧ୍ୟ ଦୁଇଗୋଟି ଅର୍ଥ ରହିଛି ନୌକା ଏବଂ ଚନ୍ଦ୍ର। ତାରାଳି-ମଧ୍ୟ ଏକାଧାରରେ ସୁନ୍ଦରୀ ସଖୀଗଣ ତଥା ତାରକାମାଳାକୁ ବୁଝାଉଛି। ଅତଏବ ରାତ୍ର କାଳରେ ଏହି ଚନ୍ଦ୍ରମା'ଙ୍କୁ ତାରକାରାଜି ବେଢ଼ିଥିବା ପରି ପ୍ରତେ ହୁଏ। ଏହିପରି ରଜନୀ ଦିବସ ଏକତ୍ରିତ କରି ସେମାନେ ଆଶ୍ରମ ସନ୍ନିକଟସ୍ଥ ତଟ ଦେଶରେ ନାବ ରଖି ତପୋବନ ମଧ୍ୟରେ ପ୍ରବେଶ କରିଛନ୍ତି। ମୁନିଶ୍ରେଷ୍ଠ ଋଷ୍ୟଶୃଙ୍ଗ ସେହି ତପୋବନ ମଧ୍ୟରେ କୌଣସି ବୃକ୍ଷ ତଳେ ବିଶ୍ରାମ ନେଉଥିଲେ। ବାରଜଣ ରମଣୀ ସେଠାରେ ପହଞ୍ଚି ବୀଣାବାଦନ ପୂର୍ବକ ସଂଗୀତ ଗାନ କଲେ। ଜୀବନରେ କେବେ ହେଲେ ନାରୀମୁଖ ଦର୍ଶନ କରି ନଥିବା ଏହି ତପସ୍ୱୀ ସେମାନଙ୍କୁ ଯତି ମନେକରି ପାଖକୁ ଡାକିଛନ୍ତି ଏବଂ କହିଛନ୍ତି, "ବସ ମଠ କରି, କହ ମଠ ନ କରିଣ ହେ।" ଅର୍ଥାତ୍ ବିଳମ୍ବ ନ କରି ଶୀଘ୍ର କୁହନ୍ତୁ ଆପଣମାନଙ୍କ ମଠ କେଉଁଠାରେ। ପରବର୍ତ୍ତୀ ପଦରେ ସେମାନଙ୍କର ମନ୍ତ୍ରଜପ ପ୍ରସଙ୍ଗ ଏବଂ ସେମାନେ ବିଷ୍ଣୁଭକ୍ତ ନା ଶିବଭକ୍ତ ଏସବୁ ପ୍ରସଙ୍ଗ ପଚାରିଛନ୍ତି। ଉତ୍ତରରେ ବନିତାଗଣ ନାସିକାଫୁଲାଇ ଗେଲେଇ ହୋଇ କହିଲେ,

"ବନେ ତୁମ୍ଭେ ଭ୍ରମ, ଆମ୍ଭେ ବନୀରେ ବିଳମ୍ବୁଁ
ବନୌକା ତୁମ୍ଭେ, ବନିତା ଆମ୍ଭେଟି ଏ ବସ୍ତୁ ଯେ ।୨୬।

ତୁମ୍ଭେ ବନରେ ବାସୀ ଏଣୁ ତୁମର ନାମ ବନୌକା, ଆମ୍ଭେ ସେହିପରି ବନୀ ବା ଉପବନନିବାସୀ। ତେଣୁ ଆମ ନାମ ବନିତା। ତମେ 'ରାମାୟ ନମଃ' - ମନ୍ତ୍ର ଜପ କରିବା ବେଳେ ଆମେମାନେ 'କାମାୟନମଃ' ବୀଜମନ୍ତ୍ର ଜପ କରିଥାଉ। ଉଣତ୍ରି... ପଦରେ ସନ୍ଧ୍ୟାଗମନ ପରେ ସେହି ବେଶ୍ୟାଗଣ ଫେରିଯାଇଛନ୍ତି। ଜରତୀ ପ୍ରଥମଦିନ ବନ ମଧ୍ୟକୁ ଆସି ନଥିଲେ। ବୈଦେହୀଶବିଳାସ... ସ୍ତବକର ଆଲୋଚ୍ୟ ଚତୁର୍ଥ ଛାନ୍ଦର ଛୟାଳିଶ ସଂଖ୍ୟାତମ ତଥା ଷଟ୍‌ଚତ୍ୱାରିଂଶତ୍ ଛାନ୍ଦରେ ମୁନିସୁତ ସଂପୂର୍ଣ୍ଣ ରୂପେ ରମାଗଣଙ୍କର ବଶୀଭୂତ ହୋଇଯାଇଛନ୍ତି ଏବଂ ପିତାଙ୍କର ପ୍ରସ୍ଥାନ ପରେ ସେହି ରମଣୀମାନଙ୍କର ସଙ୍ଗଲାଭ ନିମନ୍ତେ ବ୍ୟାକୁଳ ହୋଇପଡ଼ିଛନ୍ତି। ଷାଠିଏତମ ପଦରେ ତାଙ୍କୁ ନୌକା ମଧ୍ୟରେ ଉପବିଷ୍ଟ ପ୍ରତାୟମାନ... ଜରତୀଙ୍କ ନିକଟକୁ ସହଚରୀଗଣ ନେଇଯାଇଛନ୍ତି। ଷାଠିଏରୁ ଏକଷ... ପଦ ମଧ୍ୟରେ ରତିକ୍ରୀଡ଼ା ଏବଂ ବାସରୀ ପଦରୁ କେଉଟମାନେ ନାବ... ବାହିବା ଆରମ୍ଭ କରିଦେଇଛନ୍ତି। ଏହି କେଉଟାଣି ନୌକାଯାତ୍ରାକୁ କ... ରଥଯାତ୍ରା ସହ ତୁଳନା କରିଛନ୍ତି। ତମାଳବନପୁରରେ ନାବ ଲାଗି... ପରେ ବର୍ଷା ଆରମ୍ଭ ହୋଇଛି। ଏହା ପରେ ଦଶରଥଙ୍କର ତମ୍ପାପୁ... ଆଗମନ କରିଛନ୍ତି ତଥା ଜରତୀଙ୍କ ପରାମର୍ଶରେ ଶାନ୍ତାଙ୍କ ଋଷ୍ୟଶୃଙ୍ଗଙ୍କ... ବିବାହ ସ୍ଥିର କରାଯାଇଛି।

ଦ୍ୱାଦଶ ବର୍ଷଧରି ବୃଷ୍ଟିହୀନ ହୋଇ ରହିଥିବା ରାଜ୍ୟରେ ଋଷ୍ୟଶୃଙ୍ଗଙ୍କ ଆଗମନରେ ବର୍ଷା ହେବ। ଏହା ହିଁ ବଳରାମ ଦାସ... ଜଗମୋହନ ରାମାୟଣ ଏବଂ ବୈଦେହୀଶବିଳାସରେ କୁହାଯାଇଥିଲା। ବଳରାମଙ୍କ ବର୍ଣ୍ଣନାନୁଯାୟୀ ବେଲଗଛ ତଳେ ତୁହୁରାଗି ଋଷ୍ୟଶୃଙ୍ଗ ... କରୁଥିବାବେଳେ କାମମୋହିନୀ ଯାଇ ଓଳଗି ହେଇଛନ୍ତି, ତା'ପ... ଋଷି ଆଶୀର୍ବାଦ କରି, ଆସନରୁ ଉଠି ତାଙ୍କ ସହ ବାର୍ତ୍ତାଳାପ କରିଛ... ଉଭୟ କବିଙ୍କ ବର୍ଣ୍ଣନାରୁ ଏହା ସୂଚିତ ହେଲା ଯେ ଋଷ୍ୟଶୃଙ୍ଗ ଗଭ... ତପସ୍ୟାରେ ଉପବିଷ୍ଟ ନଥିଲେ। ତାଙ୍କର ଯୋଗନିଦ୍ରାଭଙ୍ଗ ଉଦ୍ଦେଶ୍ୟ... ରାଜକାର୍ଯ୍ୟରେ ନିୟୋଜିତା ନାରୀମାନଙ୍କର କାମବିକାର ପ୍ରଦର୍ଶ... କୌଣସି କାରଣ ନଥିଲା। କିନ୍ତୁ କାବ୍ୟକଳା ଦୃଷ୍ଟିରୁ, କାବ୍ୟପ୍ର... ଲାଭ-କ୍ଷତିର ହିସାବ ହେତୁରୁ ଏପରି ବର୍ଣ୍ଣନା ସ୍ଥାନିତ ହୋ... କବିସମ୍ରାଟ ଉପେନ୍ଦ୍ର ଜରତୀ ଏବଂ ତାଙ୍କର ସଖୀମାନଙ୍କୁ ଜାଲ... ଅର୍ଥାତ୍ ବିଷବୈଦ୍ୟ କରି ସେମାନେ କିପରି ପଦ୍ମତୋଳା ଗାନ ... ମନ୍ତ୍ରଧୂଳି ପକାଇ ମୁନି-ନାଗଙ୍କୁ ପର୍ଣ୍ଣ କୁଟୀରରୂପୀ ବିବର ମଧ୍ୟରୁ ବା... କରି ଆଣି ନାବ ରୂପକ ପେଡ଼ିରେ ବନ୍ଦୀ କରି ତାଙ୍କୁ ଖେଳା... ତାହାର ବର୍ଣ୍ଣନା କରିଛନ୍ତି।

ସାହିତ୍ୟ ଯଦି କାହାଣୀ ହୁଏ, ଶବ୍ଦ ଋତୁର୍ଯ୍ୟ ହୁଏ ... ଏପରି କସରତ ଗ୍ରହଣୀୟ। କିନ୍ତୁ କାବ୍ୟ ତଥା ଚରିତ୍ର... ଯେତେବେଳେ ମହାକାଳର ପ୍ରବାହରେ ସଭ୍ୟତାର ବାର୍ତ୍ତାବହ ... ସଂଚରଣ କରନ୍ତି, ଅତୀତ, ବର୍ତ୍ତମାନ ଓ ଭବିଷ୍ୟତ ଗୋଟିଏ ବି... ମିଳିତ ହୁଅନ୍ତି, କାବ୍ୟରୂପୀ ସମୁଦ୍ର ଗର୍ଭରୁ ସଂସ୍କୃତିରୂପୀ ମୁକ୍ତା... ଯେତେବେଳେ ଜାତିର ଅପରିହାର୍ଯ୍ୟ କର୍ତ୍ତବ୍ୟ ହୋଇ... ସେତେବେଳେ କୌଣସି ଆବଶ୍ୟକତା ନଥାଇ ନାରୀକୁ କୌ... ଏପରି କାମକଳଙ୍କର ବିଜ୍ଞାପନ ବର୍ଜନୀୟ।

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Bioprospecting of Tropical Silkworm Antheraea Mylilta (Drury) Ecoraces Found in Tribal Dominated Forests of Odisha

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ABSTRACT Biological resources play a key role in economic development of any country. Tasar silk cocoons produced from tropical tasar silkworm, *Antheraea mylitta* Drury (Lepidoptera: Saturniidae) are one of the important forest produce of the country and tasar culture is an old age tradition flourishing as a traditional and cultural heritage of tribes of India. It has 56 reported ecoraces distributed along Central, East, Northeast, and South India with varied phenotypic, physiological, and behavioral characters. These wild ecoraces harbor many beneficial genes and their alleles are developed through centuries by the process of natural selection. Out of them, in the tribal dominated state of Odisha, at least eight ecoraces have been reported till date. However, due to anthropogenic stresses such as habitat destruction, pollution, deforestation, mining, urbanization, and other activities, there is pressure on the survival of these ecoraces. This has resulted in drastic decline in wild tasar cocoon production in the state of Odisha in particular. Hence, there is a crucial need to involve and educate local tribals of the state on wild cocoon collection and insect conservation to save the ecoraces from extinction. The tasar wild insect needs conservation both under short- and long-term measures and on and off their habitat for the sustainable utility and socioeconomic upliftment of rural tribals of the state. These ecoraces are very much important for bioprospecting and biowealth management point of view, so maintenance and sustainable management are need of the hour to protect and conserve the ecoraces for posterity. The present paper reports about bioprospecting of tasar because of its unique diversity and traditional knowledge for tribal welfare of the state of Odisha, India.

KEY WORDS *Antheraea mylitta*, Anthropogenic stresses, Conservation, Ecoraces, Technology package

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Bioprospecting can be defined as a systematic and organized search for useful products derived from bioresources including plants, microorganisms, animals (here tasar silkworm ecoraces) that can be developed further for commercialization and overall benefits of the society. India, the second largest populous country in the world, has the biggest task of providing employment and livelihood to her population. The national prosperity is intimately linked with increasing employability and enhancing per capita productivity of the population. India is basically an agro-based country with more than 70% of its population deriving livelihood through gainful employment from agriculture or related activities. Second, most of them are from rural areas, and hence, there is the need to diversify the job opportunities and employability. This could achieve the dual role of national productivity and proving gainful employment. India is endowed with very huge wealth of tasar flora and has an illustrious tradition of tasar cultivation which is recognized as an emblem of the tribal culture.

The state of Odisha has a rich traditional heritage of tasar culture. The art of tasar culture has been patronized by Bhanja Dynasty of Mayurbhanj, Odisha, since long. The magic of tie and dye of the weavers designed fabrics of Odisha has a worldwide recognition. The state has demand of 500 MT of raw tasar silk annually for the handloom sector. The tasar sector of the state includes districts of Mayurbhanj, Balasore, Keonjhar, Sundergarh, Sambalpur, Deogarh, Angul, Dhenkanal, Jajpur, Sonepur, Boudh, Nawarangpur, Nuapada, and Kalahandi. About 46,828 ST/SC/OBC families are practicing tasar culture in these districts. Annually, more than 57,000 Kahans of tasar cocoons are produced and tribal farmers are getting income of about

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11.42 crore rupees out of it with very nominal investment on seed. Tasar culture has a long tradition and way of life to the tribal population of the state. Favorable agro-climatic and soil conditions are available in Odisha for the growth of tasar culture. There is also a big demand of Odisha's tasar fabrics in foreign countries and hence earning of good amount of foreign exchange is possible through the development of tasar culture sector. However, the extensive collection of nature grown cocoons, rapid deforestation, and human encroachment to insect habitats has declined the tasar ecorace population of the state. Besides, wild/natural populations are supposed to harbor many beneficial alleles developed through centuries by the process of natural adaptation. Thus, there should be proper characterization and documentation of the available tasar genetic resources through molecular tools where the genetic structure, genetic relatedness, identity, and gene flow among the ecoraces can be assessed. Moreover, it calls for a coordinated management between the tribal rearers and the Central and State Sericulture Departments for this insect conservation to save this valuable resource from extinction.

Tropical tasar silkworm *Antheraea mylitta* Drury is polyphagous and wild in nature. It belongs to family Bombycoidea and family Saturniidae. The sericigenous insect feeds primarily on *Shorea robusta* (Sal), *Terminalia tomentosa* (Asan), and *Terminalia arjuna* (Arjun) besides variety of secondary and tertiary food plants available in the tropical deciduous forests of the state. Wide range of distribution by species is highly diversified geographically, climatically, and edaphically which, in turn, permitted the accumulation of diverse genes complexes in the species due to the conspicuous adaptation in different ecological pockets. The species has been subdivided into a number of ecological races or "ecoraces" which show wide variation in the phenotypic, physiological, behavioral, and genetic characters. However, these variations among population were observed to be only because of geographical isolation and adaptation to the specific micro-niche in which they exist. As such, these are kept under the synonyms of *A. mylitta* and are referred to as ecoraces. Out of the 56 reported, tasar ecoraces in the country as specified in the Annual Reports of CTR and TI, Ranchi, there are eight reported ecoraces found in the state of Odisha, that is, Modal, Nalia, Jata, Adaba, Sukinda, Umarkote, Boudh, and Daba. There is another ecorace called Sukli from Khairapali area whose preliminary investigations on its confirmation to be a ecorace are still going on (Srivastav *et al*., 2002). The Modal ecorace was originally identified in Mayurbhanj district, Nalia in Sundergarh district, Jata at Thakurmunda area of Mayurbhanj district, Adaba in Mohana and Adba area of Gajapati district, Sukinda in Sukinda area of Jajpur district, Umarkote in Omarkote area of Nawarangpur district, Boudh in Boudh and Sonepur district, and Daba in Mayurbhanj district.

The wild ecorace Modal is exclusively confined to the hills of Similipal Biosphere Reserve. This reserve in Mayurbhanj district is a lenticular elongated plateau with steep slopes (500–600m). It covers an area of 2750 sq.km and was declared a bioreserve during 1994 by the Government of India. The Similipal bioreserve is rich in biodiversities, such as the vast expanse of stately Sal (*S. robusta*) forest which serves as the principal food plant of this ecorace, which produces

Fig. 1. Modal ecorace cocoons.

the heaviest cocoon among all the sericigenous lepidopteron of world (Fig. 1). It is a hill studded ecosystem with varied topography, soil, and climate: Innumerable crests and valleys and cascading waterfalls. The Similipal Biosphere Reserve is the conglomeration of a National Park, a Project Tiger and a Sanctuary and is divided into three zones: (i) Central core zone (with 845.70 sq. km area where no human activity is permitted and gazetted as a National Park under the provisions of wild life protection act). However, the tribal of this area collect wild cocoons from this area. (ii) middle buffer zone (with 1904.30 sq. km of area is gazette as a sanctuary and is restricted for conservation, research, environmental education and training, tourism, and recreation) and (iii) peripheral zone with 77.07 sq. km of area is restricted to research and can be utilized as sustainable resource. Similipal forests have taken million of years to evolve and have a stabilized ecosystem and it should be protected from destruction. Although efforts are made by the Modal Ecorace Conservation Project being implemented in the state by the State Sericulture Department and CSB, still they have to be more intensified and rigorous for conservation of this valuable genetic resource.

There is another ecorace prevalent in Mayurbhanj district called Nalia. This ecorace is also found in the forests of Sundergarh districts. The advantages of Nalia crop over Modal are easy multiplication before the onset of winter, short larval period, and better quality of commercial cocoons having high market value. In spite of these advantages, very less attention has been paid towards the sustainable utilization and conservation of Nalia ecorace. The population of Nalia needs to be conserved by systematic, planned use of natural resources. Further care should be taken to maintain the racial purity of this species (Rout *et al*., 2009). Commercial exploitation of semi-domesticated ecoraces such as Daba and Sukinda should be strictly avoided in the Nalia dominated area. Another ecorace called Jata-Daba has been identified in the Thakurmunda area of Mayurbhanj district (Rout *et al*., 2008). Only preliminary information of its possible exclusivity, characteristics, behavior, and performance is known till date. About 600 rearers in 35 villages of Thakurmunda area of Mayurbhanj district are engaged in the rearing of Jata-Daba. Recently, the Regional Tasar Research Station, Baripada, has taken up a thorough investigation with regard to its origin,

behavior, biological characters, and sustainable utilization. On the similar lines, excepting a few published literatures available on their phenotypic characterization and biological characters, thorough information with regard to origin, behavior, and sustainable utilization is not available for the Boudh, Sukinda, Umarkote, and Adaba ecoraces reared extensively by the tribal rearers of the area at Boudh and Sonepur district, Jajpur district, Nawarangpur district, and Gajapati district, respectively. There is no proper documentation for all these ecoraces which are an essential component for conservation of these valuable genetic resources. Only the name and some quantitative and qualitative data are mentioned in the recent literatures. Further, characterization of the available tasar silkworm genetic resources through molecular tools will not only support the conservation approach but also help in the sustainable utilization through breeding program. The genetic structure, genetic relatedness, identity, and gene flow are the important features of genetic resources which need to be assessed without any delay.

The commercial attributes of the ecoraces, viability in the offered eco-climatic condition suggests their biotic and economic potential. Insects have highly organized sensory and neuromotor systems more comparable to those of vertebrates and interactions between insects and plants in case of herbivorous insects, or hosts for parasitic insects are often called coevolutionary (Carlsson and Berkes, 2005). They respond to altered conditions by genetic change and this heterogeneity or elasticity within insect species allows persistence to efficiently face the environmental change (Edward *et al*., 2002; Kakati and Chutia, 2009). Thus, exploration of host plant tasar insect interactions is critical to attain optimal wild silk conservation, their sustainable utilization, and commercial exploitation. The single-species conservation is argued to preserve many other species by default which is known as umbrella effect and the conservation of silk insect wildlife indirectly conserves forest biodiversity of the state. Thus, although the launching of the Modal Ecorace Conservation Project in the tribal dominated district of Mayurbhanj by the Directorate of Textiles, Govt. of Odisha and Central Silk Board during 2001–2002, has made an positive impact on the tasar culture, production, and conservation, similar programs should also be taken up for the other ecoraces available in the state of Odisha to save this valuable genetic resources from silent extinction.

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Geospatial mapping of ecoraces of tasar silkworm (*Antheraea mylitta* Drury) using remote sensing and geographic information system techniques

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ABSTRACT

Tropical Tasar silkworm *Antheraea mylitta* Drury (Family: Saturniidae) produces Tasar silk which has very high demand globally and because of their wide range of distribution in tropical regions, they have adapted to different niches forming different ecoraces. In Odisha alone seven types of ecoraces of *A. mylitta* have been reported namely Modal, Sukinda, Nalia, Jata-Daba, Adaba, Umerkote, and Boudh. These ecoraces show differences in their phenotypes, genetic constitution, fecundity, voltinism, etc. In the past few decades, there is the substantial deterioration of habitats due to many anthropogenic activities. This has resulted in a large decline in wild Tasar cocoon production. Lepidopterans are accepted as ecological indicators of ecosystem health and it is apprehended that through anthropogenic and climatic factors this precious genetic resource which took millions of years to evolve, may face the threat of extinction shortly if adequate conservation measures are not taken. This paper attempts the geospatial mapping of these ecoraces in the state of Odisha through RS and GIS tools which will provide a greater scenario for their conservation.

Introduction

The Tasar (tussah/tussor/tussore) silkworm is a semi-domesticated wild silkworm that belongs to the family Saturniidae. Almost 35 species of *Antheraea* are responsible for the production of wild silk. Out of those 35 species, 3 species are exploited in India for wild silk culture, i.e. Tropical Tasar silkworm (*A. mylitta*), Temperate Tasar silkworm (*A. proylei*), and Muga silkworm (*A. assama*) (Jolly, 1985). The *A.mylitta* wild distribution is spread over West Bengal, Odisha, Andhra Pradesh, Jharkhand, Bihar, Chhattisgarh, Madhya Pradesh, and Maharashtra states of India (Sinha, 2003). Observations indicated that the distribution of *A. mylitta* Drury is almost between 12-31°N latitude and 72-96°E longitude. To date almost 64 ecoraces have been reported (Rao *et al.* 2003). In the state of Odisha total number of 7 ecoraces have been reported, namely Modal, Sukinda, Nalia, Jata-Daba, Adaba, Omarkote, and Boadh/Boudh (Table-1). These ecoraces are mainly restricted to tropical moist deciduous forest areas (Sinha and Prasad, 2011). Geospatial technology includes GIS (Geographical Information System), GPS (Global Positioning System), and satellite-based technologies such as RS (Remote sensing). GIS mostly captures image data, its input, update, transformation, manipulation, query, modeling, analysis, and visualisation of geographically referenced information through a set of computer programs (Bonham Carter, 2014). GPS provides positioning, navigation, and timing (PNT) services by capturing data from satellites (Eldredge *et al.* 2010). RS is an earth observation instrument that delivers regional information on climatic factors and landscape features (Saran *et al.,* 2020). For regional and spatial information, GPS and RS are useful. But for geospatial data integration as well as accurate geospatial analysis in a real-time manner,

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Table 1: Ecoraces found in Odisha and their preferred host plant (Vijayan *et al.*, 2010)

SN	ECORACE	PREDOMINANT FOOD TYPE	SOIL TYPE	FOREST TYPE
01	Modal	*Shorea robusta*	Red Loamy	Tropical moist deciduous
02	Sukinda	*Terminalia arjuna, Terminalia tomentosa*	Red Loamy	Tropical moist deciduous
03	Jata-Daba	*Terminalia arjuna, Terminalia tomentosa*	Red Loamy	Tropical moist deciduous
04	Umerkote	*Shorea robusta*	Red Loamy	Tropical moist deciduous
05	Boudh	*Terminalia arjuna, Terminalia tomentosa*	Red Loamy	Tropical moist deciduous
06	Adaba	*Terminalia arjuna, Terminalia tomentosa*	Red Loamy	Tropical moist deciduous
07	Nalia	*Shorea robusta*	Red Loamy	Tropical moist deciduous

GIS has been proven very useful (Zhen *et al.,* 2010). In order to preserve the natural biodiversity present in the *Antheraea mylitta* species population, attempts are made to understand and conserve their ecoraces. These ecoraces conservation (in-situ and ex-situ) links genetic diversity to utilisation, protecting diverse gene pools, habitats, and ecosystems for human socio-economic needs (Metzler and Zebold, 1995). Through their ecorace conservation, we can utilise their valuable genes in enhancing productivity (Mirhosein *et al.,* 2004) and building their new population through the genetic hybridisation technique (Kumaresan *et al.,* 2004). The increasing international demand for Tasar silk, their abundance of host plants, and the limited option of productivity of ecoraces for commercial rearing demand the exploration of these ecoraces (Ojha *et al.,* 2009). Previously, Sinha and Prasad (2011) mapped the distribution of all 44 ecoraces of *A. mylitta*. Sahay *et al.* (2011), have identified the Tasar culture growing regions of Odisha. Renuka and Shamitha (2015) have also mapped the location of Daba, Bhandara, Andhra local, Modal, Sukinda, and Railey ecoraces in India. But there is no particular map available for all the ecorace found in Odisha yet. Hence the need for a map showing the location of different ecoraces in Odisha is a must for further development of sericulture in the state. In this current paper, an attempt has been made to map all the available ecoraces of Tasar silkworm (i.e. Modal, Sukinda, Jata-daba, Omarkote, Boudh, Adaba, and Nalia) and their geographical locations in different regions of Odisha (Table 2).

Material and Methods

Study area:

Odisha is a state of Eastern coastal India, situated between latitude 17°78'N and 22°73'N and longitude 81°37'E and 87°53'E, covering an area of 1,55,707km^2, which is 4.87% of the total area of India, with a coastline of 450 km. According to the 2021 forest cover estimation published by Odisha State Forest Department (https://www.odishaforest.in), the total forest cover of Odisha is almost 61,204km^2, which makes up 39.31% of the total land of the state. Out of 30 districts of Odisha, most of the ecoraces of Tasar silkworm *A. mylitta* are confined to Mayurbhanj, Boudh, Gajapati, Jajpur, Kalahandi, Nawarangpur, and Sundergarh districts.

Non spatial data collection:

For individual location identification of different ecoraces and their cultivation grounds, both primary and secondary data have been used. Secondary data have been derived from different research papers available about ecoraces and their endemic locations from different authors. For Modal, Nalia, Sukinda, and Jata-Daba both primary and secondary data have been utilised. For Boudh, Umerkote, and Adaba, only primary data have been collected from forest personnel of those regions and regional TRCS (Tasar Rearers Cooperative Societies) centers.

Map plotting:

The mapping has been done with intensive use of Geo-information technology like RS (Remote Sensing), and GIS (Geo Information Systems) (Fig-1).The source political map of Odisha with its 30 districts has been obtained from https://gisodisha.nic.in. The Forest boundary map of Odisha was collected from official website of the Odisha state forest Department (https://www.odisha forest.in). The forest map data belongs to the 2021 official data record issued by the government of Odisha, mapped with IRS-Resourcesat 2- LIS III, with a spatial resolution of23.5m and a scale of 1:50,000. For the protected areas and their spatial data collection the official boundary map of different sanctuaries and national parks has been obtained from the Forest and Environment Department of Odisha http://odishawildlife.org/map.html. Shapefiles of

Table 2: Ecoraces and their geographical distribution in Odisha

Ecorace Name	Location Name	Location On Map	Average Elevation Asl (In Meters)	District
MODAL	Gudgudia	21°52'59"N 86°15'19"E	379	Mayurbhanj (Similpal National Forest)
	Sarat	21°26'39"N 86°20'38"E	203	Mayurbhanj (Similpal National Forest)
	Lulung	21°56'42"N 86°33'20"E	300	Mayurbhanj (Similpal National Forest)
	Arjunvilla Village	22°06'14"N 86°15'24"E	335	Mayurbhanj (Similpal National Forest)
	Khadambeda	22°10'55"N 86°25'34"E	358	Mayurbhanj (Similpal National Forest)
	Kitabeda	22°10'07"N 86°25'16"E	350	Mayurbhanj (Similpal National Forest)
SUKINDA	2.1 Ankurpali	22°19'21"N 84°53'36"E	242	Jajpur
	2.2 Sukaran	20°57'30"N 85°57'57"E	223	Jajpur
	2.3 Kundal	20°39'52"N 86°10'28"E	72	Jajpur
	2.4 Kansa	21°91'54"N 85°56'53"E	6[illegible]	Jajpur
NALIA	3. Raghubeda Forest Range	21°28'52"N 85°46'33"E	434	Keonjhar
JATA-DABA	4.1 Thakurmunda	21°31'24"N 86°09'39"E	329	Mayurbhanj
	4.2 Kendujuiani	21°39'03"N 86°07'0[illegible]"E	346	Mayurbhanj
	4.3 Mahuldiha	21°26'5[illegible]"N 86°10'39"E	268	Mayurbhanj
	4.4 Kuldiha	21°27'24"N 86°42'56"E	91	Mayurbhanj
ADABA	5. Adaba	19°40'21"N 84°10'25"E	386	Gajapati
UMERKOTE	6. Umerkote/Umarkote	19°40'21"N 82°12'09"E	612	Nabarangpur
BOUDH	7. Satkosia Range	20°35'12"N 84°27'06"E	320	Boudh

district boundary and forest boundary were converted to KML to find the locations on Google Earth in order to see the present status of the forest in the state. The shape files have been converted to UTM (Universal Transverse Mercator) to calculate areas of cultivation ground and for correct placements of scale bolts. The next step was to pin mark different villages of Tasar silkworm Ecoraces. For this purpose individual village or area location was pinned using Google Earth-9 software. The GIS of google earth is supported by Google Landsat 8 with Copernicus sentinel (Data SIO, NOAA, U.S. Navy, NGA, GEBCO). For individual precise pinning of different villages that are located within 60 km^2 of area of each other, Maxar technologies, CNES/Airbus and Terrametrics source help of same Google Earth-9 software has been taken. The project file of pinned locations with georeferences of ecorace clusters in different districts of Odisha that has been done with Google Earth 9 software. The forest cover map and pinned location map have been overlaid together to create a new more informative map of our interest cultivation grounds, nearby forest covers, along with to which district or range the villages belong to can be shown together in a single map image. Area calculation of different cultivation ground or forest ranges in different districts has been done through ISRO- CHAMAN

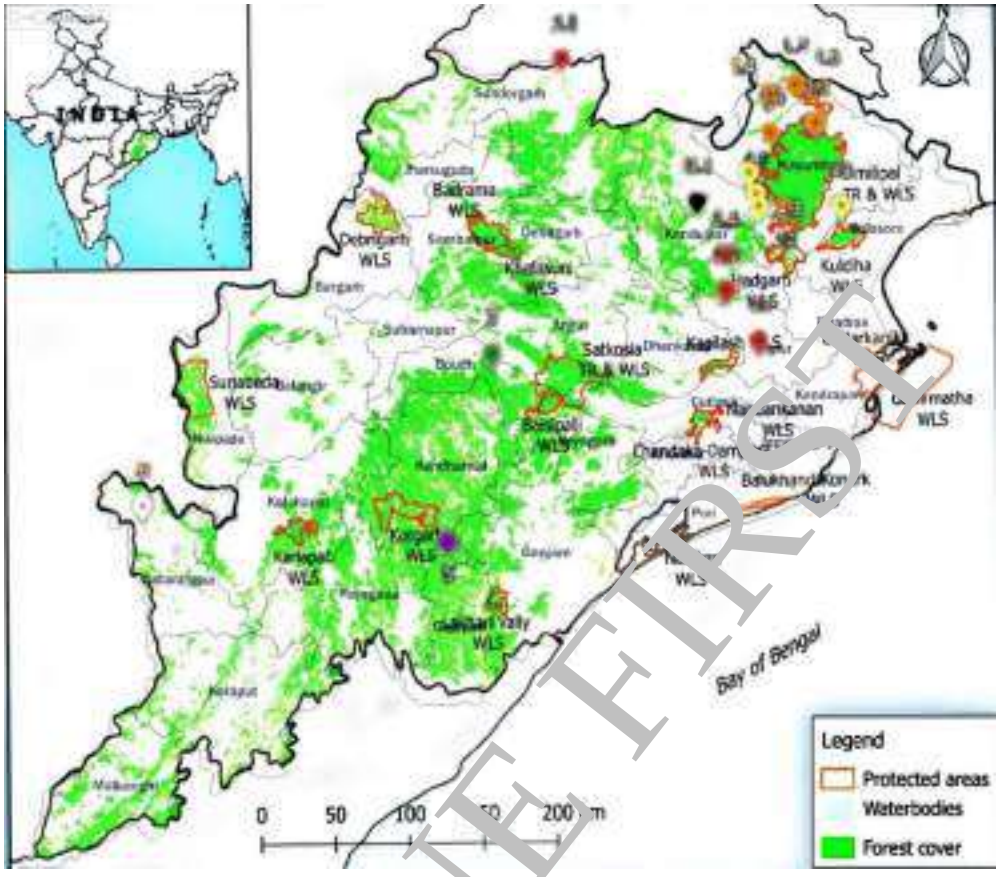

Figure 1: Location mapping of different ecoraces of Tasar silkworm *A.mylitta*

(Coordinated Programme on Horticulture Assessment and Management using Geoinformatics) and Bhuvan-2D and Bhuvan-3D websites. After this appropriate band combination, necessary contrast enhancement has applied to make the image more interpretable.

Results and Discussion

The 7 ecoraces of Tasar silkworm *Antheraea mylitta* found in Odisha are Modal, Sukinda, Nalia, Jata-Daba, Boudh, Omeri and Adaba.

Modal: The modal ecorace is endemic to the Similpal National Park and Biosphere Reserve and to nearby regions of Mayurbhanj. It is one of the largest and highest-yielding Tasar ecorace. This ecorace is exclusively wild, univoltine, almost disease free, and produces the heaviest cocoons. This ecorace alone contributes to 19% of raw silk production in India and this area of almost 823sq.km is covered by semi-deciduous forest. The Similpal National Park is spread over an area of 2750sq.km area out of which the core region is 303sq.km area (Sahu and Debta, 2020). The abundance of Arjun, Asan, and Sal plants in the forest region is responsible for the good habitat of the Modal Tasar silkworms.

Sukinda: The trivoltine Sukinda ecorace is economically profiting for the sericulture. State Department of Sericulture collected this ecorace from the Kundal, Ankurapa, Sukaran, and Kans areas of Sukindagarh of Jajpur district, in the 1970s and then introduced them to other regions for cultivation (Sahay *et al.,* 2011). For our mapping purpose, these regions have been selected. The cocoons are yellow or grey in colour, having a silk ratio varying between 10.5-13.1%. This race

particularly is semi-domesticated and they perform better in semi-domesticated environments than in wild. Sukindagarh used to be the main hub for Sukinda ecorace cultivation but since this region is full of ore mines and industries, which are constantly being over exploited, the negative impact of this over-exploitation, mining, and industrialisation are affecting the natural habitat of Sukinda tasar ecorace.

Nalia: A bivoltine ecorace of *A. mylitta* found in near forest area of the Keonjhar district of Odisha. Early multiplication, short larval period, and better quality commercial character make this ecorace more desirable by Sericulturist (Rout *et al.,* 2009). The availability of this ecorace is in the range of Raghubeda Forest range of Keonjhar and the forest patch between the borders of Sundergarh and Keonjhar district of Odisha.

Jata-Daba: Another bivoltine ecorace of *A. mylitta* is found in almost 35 villages of the Thakurmuda region of Mayurbhanj (Rout *et al.,* 2008). For our mapping purpose, we have taken Thakurmuda, Kendujiani, Mahuldiha, and Kuldiha of the Mayurbhanj district. This ecorace is preferable because of its higher percentage silk content.

Adaba: Adaba ecorace is one of the most unexplored ecoraces of Odisha found in the Adaba forest Gajapati district. Since Adaba is also one of the wild ecoraces, almost all of its life stages are spent in the wild on its host plant. The Naxal issues in the Adaba forest have always been a greater hindrance to the biological exploration of local fauna and flora including its endemic Tasar silkworm ecorace and its host plant. This is the same reason why the Adaba ecorace is unknown to many sericulturists and researchers of this field.

Umerkote: Umerkote/Omarkote is one of the endemic ecoraces found in Kalahandi and Nawarangpur forest cover regions of Odisha. The forest area is mostly covered with moist deciduous forest of 298km^2.

Boudh: Although not many reports have been published about this ecorace, but some papers do claim that this Boudh/Boadh Ecorace is also found in the Phulbani region i.e. new Boudh and Kalahandi district (Sinha and Prasad, 2011). This ecorace is suspected to be endemic to the moist deciduous forest range of these two districts and some parts of nearby regions. Sinha and Prasad (2011), have proven that the morphological difference between different ecoraces is relevant to their biochemical constitutions like protein content, lipid content, and carbohydrate content, including genetic constitutions, which makes each ecorace genetically unique from their sister ecorace. It also has been noticed by them that the *Shorea*-based ecoraces (Modal, Nalia, Umerkote) have greater shell weight as compared to *Terminalia*-based ecoraces like (Sukinda, Boudh, Jata-Daba, Adaba). In some research papers, Bogei is also considered as a separate ecorace of *A. mylitta* but in reality, it's the rearing (commercial) variety of Modal and Nalia that are called Bogei by local people.

The evolution of GIS, GPS, and RS technologies has enabled the collection and analysis of spatial, non-spatial, and field data in such a sophisticated manner that was not possible before the arrival of these software technologies. The use of these technologies in India increased after the 1990s IT revolution. Since the 2000s these technologies have been actively in use by both Government and Non-governmental authorities worldwide for Resource management such as agriculture, soil, water, land cover, forest cover estimation, mining area detection, Wildlife management, and agricultural land detection, etc. Currently, the advancement of mobile technology also has enabled to use the GPS via satellite imaging for regular use without any expensive handset use. In 2011, Sinha and Prasad mapped all the 44 ecoraces of *A. mylitta* Drury documented officially, using imagery techniques of GIS data. The horizontal accuracy within a map depend mostly on the Ground Sampling Distance or GSD i.e., number of pixels per centimetre. Inaccurate maps will lead the investigator astray because the critical data point of the problem might not be there at the moment on the Map. Hence accuracy of the map is very critical for right investigation of the project. In India ISRO Bhuvan (2014) and ISRO-CHAMAN (2014) are in use for the estimation of area of land forest cover, coast line, and Plantation cover, etc. CHAMAN GIS is exclusively used for agricultural, horticultural and forest assessment. Banana, Citrus fruit, and Mango plantation cover of different states is already in the data base of CHAMAN. Similarly, we can implement the GIS and GPS along with data from Imagery RS to create locational plantation planning

for A. mylitta Drury host plants such as Arjun, Asan, and Sal in corresponding regions where the availability of different ecorace prevails. By doing so, more host plants will be available for Tasar silkworm culture to the local tribe people which in turn will improve the economy of the region.

Conclusion

The potential use of RS and GIS has been very satisfactory for the study of forest cover and locations in required places. RS, GIS, and GPS techniques have been very crucial in our field for geospatial mapping of Tasar silkworm (*A. mylitta*) ecoraces throughout Odisha. As for spatial data collection, there is still a lot of knowledge gap among professionals regarding the availability of ecoraces and their geographical distribution. The LANDSAT 9 images have been very useful for the identification of individual villages and nearby forest range. In Odisha, mostly Modal, Sukinda, and Nalia are commercially exploited for Tasar production. Other Jata-Daba, Umerkote, Boudh, and Adaba don't have that much commercial importance yet because they yet have to be explored properly in their endemic places. Geospatial mapping technique has long been in our country mapping system. This technique has been used for forest area and forest cover mapping, census mapping, cluster mapping of plantations, coastal erosion checking, etc. Many states including Odisha have been collaborating with ISRO (Indian Space Research Organisation) for all GIS, GPS, and RS data for different censuses like tiger reserves, elephant reserves, etc. But for Tasar silkworm (*Antheraea mylitta* Drury) ecoraces and their mapping, no organised map have ever been in the picture. Hence to fulfil such a demand for the growth of the economic status of Tasar silk production and available ecorace genetic pool diversity maintenance, the Geospatial technique of mapping might be proven a greater success.

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Conflict of interest

The authors declare that they have no conflict of interest.

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Present status and prospects of sericulture in the state of Odisha

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Abstract
There are more over 40 countries in the world that practice sericulture and among them, India occupies the second position after China in the production of raw silk. India is unique in the production of silk being the only country in the world that produces 5 different types of silks namely Mulberry, Tropical Tasar, Oak Tasar, Eri, and Muga. India has an 18 percent share in global raw silk production and it is also a great consumer of raw silk and silk fabrics. The high-cost labor, heavy industrialization, and the climatic restrictions imposed on the mulberry leaves' availability are responsible for the decline in the sericulture in temperate countries like Japan, South Korea, the USSR, etc., which in turn, allows the yield of only two crops per annum. However, in India, the prevailing tropical climate helps in practicing sericulture throughout the year and also yields a stream of about 4– 6 crops per annum. In Odisha, there are about 15,000 traditional families who are involved in silk rearing, and about one lakh people actively practice sericulture which provides indirect employment to an equal number of reelers, spinners, and weavers.

Keywords: sericulture, agro-industry, global raw silk production, silk rearing, status of sericulture

Introduction
Sericulture may be defined as the phenomenon or the process of raising the food plants for the silkworm for the production of silk. It can also be stated as an overall process that includes breeding and rearing of silk moths for the production of cocoons, reeling of yarn from the cocoon, and weaving of the yarn into fabric (Dash *et al*, 2018). Sericulture is a traditional, natural resource or agro-based cottage industry which requires little knowledge and expertise, requires a large expenditure of labor that help in providing profitable income source to the tribal poor in a large scale that helps in the improvement of the socio-economic status of large farming country like India (Dash et al, 2018). Almost 60 lakh people are engaged in different sectors of sericulture and it was estimated that about 11 men are engaged per day per kg of cocoon production i.e., in both on-farm and off-farm activities showing that it provides a large employment value to the rural peoples which in turn improves their livelihood (Pateriya, 2021). The different natures of silk-like unparalleled grandeur, natural sheen, and inherent affinity for dyes, high absorbance, lightweight, soft touch, and high durability make it knows as the "Queen of textiles" all over the world (Bukhari and Kaur, 2019).

There are more over 40 countries in the world that practicing sericulture but among them, India occupies the second position after China in the production of raw silk but India is unique in the production of silk being the only country in the world that produces 4 different types of silks namely Mulberry, Tasar, Eri, and Muga. A total of 86.5% of silk is produced as mulberry silk and the rest 13.5% is the production of non-mulberry silk (Dash *et al*, 2018). The list of some major mulberry silk-producing states of India are Karnataka, Andhra Pradesh, Tamil Nadu, Jammu & Kashmir, and West Bengal, and the non-mulberry silks are produced in the states of Jharkhand, Chhattisgarh, Orissa, and north-eastern states. The major Eri and Muga silk-producing states are Assam, Meghalaya, and Manipur. The present paper throws light on the development and the growth rate of the raw silk productivity in recent years in Odisha. It also highlights the plantation rate that's suitable for the sericulture and also the improvement of livelihood of the farmers.

History of Sericulture in India
According to history and tradition, sericulture was first originated in China as early as 2640 BC and is introduced by the queen of China, Hoshomin. For a long time, the Government of China considered sericulture as a national secret and it was unknown for the other countries as an industry (Ravikumar A, 2011). The knowledge of silkworms and its product reached Japan through Korea in the 3rd century AD and later into Europe (Bukhari and Kaur, 2019). According to the reports, about 400 years back the sericulture was introduced into India and till 1857 this industry was first flourished as an agro-industry with an annual production of two million pounds of silk fiber. During the period of 1857- 1895, this industry has survived the onslaught of Pebrine disease. After 1928, due to the fierce competition from advanced sericulture countries like Japan, China, and other European countries, there is a decline seen in the sericulture industry. But again, after the independence, this industry started flourishing as an agro-industry and it also helps in giving employment to over 7 million people in the country (Ravi kumar A, 2011).

History of sericulture in Odisha
According to the historical research, the Tamralipta port of Odisha is famous for the export of China and India silk goods to Egypt and Rome through the sea route by both direct as well as transit trade and this trade relationship between Odisha and Rome is justified by the remnants of Sisupalgarh and through the description of Chinese visitor Huen Tsang to Odisha. Later Romans learned the art of

sericulture from China which results in the end of the trade relationship between Odisha and Rome from around the 6th century. Several archaeological pieces of evidence that include lithographic recordings, palm leaf inscriptions, remnants of ancient structures, etc., and also the culture, tradition, and festivals observed by the present inhabitants recalling the glorious past are the proofs that Odisha had a fabulous wild silk thread long ago (Dash *et al*, 2018). The princely state of Mayurbhanj is considered to be the origin of Tasar sericulture in Odisha which received Royal patronage from the Bhanja dynasty (640- 1952 AD) (Dash *et al*, 2018; Sahu, 2015). Then it started spreading all over India and also the tribal peoples of many districts of Odisha like Mayurbhanj, Keonjhar, Sundargarh, Dhenkanal, Angul, Deogarh, Sambalpur, Jajpur, Boudh, Sonepur, and Nuapada have practiced this technique. According to the folklores and palm manuscripts of Odisha, the Tasar cocoons were collected by the Adivasis (tribal people), then it was processed by the Patras (weavers) and are then traded by the sadhabas (traders) who're traveled overseas for their trade (Dash *et al*, 2018).

According to Thomas Wardle's "wild silk of India (1880)" about 3.3 MT of Tasar was produced in the Sambalpur area and it was reported that the Modal race contributes the best cocoons. In 1910, according to the Bengal District Gazetteers, the tasar rearing was the traditional occupation of many forests dwellers and in Bonei, Bamra, Dhenkanal, Gangapur, Mayurbhanj, Narsinghpur, Nilgiri, Pal lahara, Rairakhol, and Sonepur area it is considered as one of the main Minor Forest Produce (MFPs). The mulberry sericulture in Odisha was introduced with the establishment of Mulberry Demonstration Firms (MDF) during the sixth five-year plan. During the 1940s, the former Bihar- Odisha Government introduced Eri silk culture in Odisha and was practiced by the tribal peoples of Odisha as a part of their occupation for a source of their income generation (Dash *et al*, 2018).

Status of Sericulture in India

Sericulture continues to play a major role in the economic development of various countries. In 2018, the International Sericulture Commission mentioned a list of major silk-producing countries that includes China, India, Uzbekistan, Brazil, Japan, the Republic of Korea, Thailand, Vietnam, DPR Korea, and Iran. Few other countries like Kenya, Botswana, Nigeria, Zambia, Zimbabwe, Bangladesh, Colombia, Egypt, Japan, Nepal, Bulgaria, Turkey, Uganda, Malaysia, Romania, Bolivia, etc. are also practicing cocoon production and raw silk but in very small quantities. India holds the second position in the world after China and has an 18 percent share in the global raw silk production (CSB, 2013), and is also a great consumer of raw silk and silk fabrics. The high-cost labor, heavy industrialization, and the climatic restrictions imposed on the mulberry leaves' availability are responsible for the decline in the sericulture in temperate countries like Japan, South Korea, USSR, etc., and in turn, allows the yield of only two crops per annum. However, in India, the tropical climate helps in practicing sericulture throughout the year and also yields a stream of about 4- 6 crops per annum (Bhattarcharjya *et al*, 2021). The performance of sericulture in India is given in the Table no.- 1.

The tropical environmental regions include Karnataka, Tamil Nadu, Andhra Pradesh, West Bengal, and the temperate regions includes Jammu and Kashmir who traditionally practice sericulture. More than 80% of the total area of these five-silk-producing states are under Mulberry cultivation and account for about 97% of total raw silk production in the country. India is the only country having a unique distinction of being producing all the five kinds of silk namely, Mulberry (*Bombyx mori*), Eri (*Philosamia ricini*), Muga (*Antheraea assamensis*), Tropical tasar (*Antheraea mylitta*), and Temperate Tasar (*Antheraea proylei*). Among them, the most popular variety is mulberry silk, that contributes around 79% of the country's silk production (Bhattarcharjya *et al*, 2021). The state wise production of raw silk during 2017-18 to 2019-20 and current financial year 2020-21 (Till December- 2020) are given in the Table no.-2. Among the five varieties of silk produced in 2019-20, Mulberry accounts for 70.47% (25239 MT), Tasar 8.75% (3136 MT), Eri 20.11% (7204 MT), and Muga 0.67% (241 MT) of the total raw silk production of 35820 MT. (CSB note, 2020- 21) The establishment of the central silk board Bangalore helps in increasing the trend of sericulture. Therefore, sericulture is not restricted to the traditional states only but now sericulture is showing an increasing trend in non-traditional states as well. Except for mulberry, all other varieties of silks are generally known as Vanya silks (Bhattarcharjya *et al*, 2021). The quantity and the value of raw silk imported during 2017-18 to 2019-20 and the current financial year 2020-21 (till December 2020) is given in the Table no.- 3 and the export values are given in the Table no.- 4.

Status of sericulture in Odisha

Three types of silks are cultivated in Odisha that is Mulberry, Tasar, and Eri and all these types of silk differ in their food plant, duration of the life cycle, quality of cocoon, and yarn i.e size, weight, texture, color, strength, etc. (Dash *et al*, 2018; Sahu, 2015). In rural sections of Odisha, silk cultivation has a huge potential to generate employment opportunities on a massive scale. Here, sericulture is a livelihood activity that goes around the year and provides remunerative income to the farmers. In Odisha, there are about 15,000 traditional families who are involved in silk rearing and about one lakh people actively practice sericulture providing indirect employment to an equal number of reelers, spinners, and weavers. At present, tribal and some non-tribal people under the BPL category are practicing sericulture and producing silk cocoons with the support of the Government of Odisha. There are four major identified eco-races found in Odisha as Modal, Laria, Daba, and Sukinda out of which Modal and Laria are wild eco race *Antheraea paphia*, whereas Daba and Sukindadaba are semi-domesticated eco-races of *Antheraea mylitta* D (Dash *et al*, 2018). The activities taken under Tasar sector is given in the Table no- 5 and the activities taken under Eri and Mulberry sector is given in the Table no. 6.

Tasar

Odisha has a rich heritage of Tasar culture. In 1952, Tasar culture was first started in Odisha by the princely state of Mayurbhanj under the Royal patronage of the Bhanja dynasty (Sahu, 2015). Odisha holds the third position in Tasar production in India, contributing 107 MT of Tasar in 2015-16 (Dash *et al*, 2018). In different parts of northwest Odisha, namely Keonjhar, Mayurbhanj and Sundargarh districts, Tasar rearing is one of the important traditional

occupations of indigenous communities which produce 90 percent of the total Tasar production in the state. There is more no. of the scheduled cast and scheduled tribe families practicing Tasar culture in fourteen hilly districts of Odisha such as Mayurbhanj, Balasore, Keonjhar, Sundergarh, Deogarh, Anugul, Jajpur, Boudh, Sonepur, Kalahandi, Nuapada, Nawarangpur, etc. The number of Tasar reeling cocoons produced in Odisha during 2019-20 is 1303.34 Lakhs (Odisha Economic Survey, 2020).

Eri

Eri silk moth rearing was introduced in Odisha by the erstwhile Bihar-Odisha Government during the 1940s, with the establishment of an institute at Bhagalpur (Bihar). In 1957, there were four eri rearer co-operative societies viz. Sidhal, Dampara, Bhandal, and Indupur in Cuttack district. Three eri seed stations were established by the Government of Odisha at Patangi, Khurdha, and Chandaka. In Odisha, now there are three seed stations, thirteen eri centers, and one eri co-operative society is devoted to ericulture (Sahu, 2015). Eri culture is also traditional in Odisha, but enough importance had not been given earlier for its growth (Dash *et al*, 2018). This type of silk is well known as "Ahinsa silk" as in other sericulture the pupae is not killed, as the yarn is spun after the emergence of the moth (Sahu, 2015). According to the suitability of the climate and the possibilities of adaptation of eri- culture to commercial basis, it is practicing in fourteen districts of Odisha i.e, Cuttack, Kendrapada, Jagatsinghpur, Nayagarh, Khurdha, Dhenkanal, Anugul, Sambalpur, Keonjhar, Kalahandi, Koraput, Rayagada, Gajapati, Phulbani, and Sundargarh (Dash *et al*, 2018; Sahu, 2015). During 2019- 20, about 1173 acres of the area was planted with Castor plants, and about 5.1 MT of raw silk was produced (Odisha Economic Survey, 2020).

Mulberry

Mulberry sericulture was introduced during the 8th plan. During the year 1986-87, a special Bivoltine Sericulture Development Project (BSDP) was implemented in the undivided Ganjam district, in R. Udayagiri and Mohana block covering Chandragiri, Chandiput, and Ramgiri areas, and subsequently, National Sericulture Project (NSP) was launched in Koraput district (Sahu, 2015) Mulberry sericulture is a non-traditional activity for Odisha. It is practiced in twelve districts of Odisha such as Gajapati, Rayagada, Koraput, Phulbani, Kalahandi, Sonepur, Deogarh, Sambalpur, Nayagarh, Khurdha, Keonjhar, and Mayurbhanj (Dash *et al*, 2018; Sahu, 2015). During 2019-20 about 68 acres of the area was planted with Mulberry plant and the total raw silk production is 2.12 MT (Odisha Economic Survey, 2020).

The total raw silk production in Odisha is 137.55 MT in which Tasar position is highest i.e., 130.33 MT, Mulberry silk produced in very low amount. It is seen from the table that Tasar accounts for 94.76%, Eri and Mulberry account for 3.70% and 1.54% respectively (Odisha Economic Survey, 2020)

Discussion

Along with India, Odisha is also unique in the production of three varieties of silk that include Tasar, Eri, and Mulberry. In Odisha, the suitable climate and also the participation of the cooperative sector helps in increasing the trend of sericulture. Sericulture is considered the most appropriate labor-intensive agro avocation which is best suited for the economic development of the rural and tribal people belonging to BPL category. Various measures can be taken for the development of the sericulture that may include the establishment of the proper storage system, the establishment of the proper marketing system, more awareness program should be organized that provide the rural people that should include seminar or training or demonstration programme for the prophylactic measures to prevent disease and also disease management, district-wise skill development programme for pre and post cocoon sector and provision for advance technologies, organizing plantation programme of the host plants, training and motivate the farmers for the increasing the development of the sericulture and also their economic status, etc. All these measures will also act as a major factor for the protection of our culture, heritage, and socio-cultural values. Sericulture has been identified as a promising tool for poverty alleviation with increasing employment opportunities and a great contributor to the state GDP.

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Table 1: Performance of Sericulture Sector (India)

Particulars	2015-16 Achmnt.	2016-17 Achmnt.	2017-18 Achmnt.	2018=19 Achmnt.	2019-20 Achmnt.	2020-21	
						Target	Achmnt. (Apr- Dec. 2020)
Mulberry Plantation (Lakh ha.)	2.09	2.17	2.24	2.35	2.39	2.54	2.47
Raw silk Production: (in MT)							
Mulberry (Bivoltine)	4613	5266	5874	6987	7009	8375	4556
Mulberry (Cross breed)	15865	16007	16192	18358	18230	19125	11842
Sub Total (Mulberry)	20478	21273	22066	25345	25239	27500	16398
Vanya (in MT)							
Tasar	2819	3268	2988	2981	3136	3740	1156
Eri	5060	5637	6661	6910	7204	7500	6273
Muga	166	170	192	233	241	260	202
Sub Total (Vanya)	8045	9075	9840	10124	10581	11500	7631
Grand Total	28523	30348	31906	35468	35820	39000	24029

(**Source:** CSB, 1st Jan 2021)

Table 2: State-wise raw silk production during the Last 3 Years (2017-18 to 2019-20) and Current Financial Year 2020-21 (till December-20) in MT. (In India)

Sl. No.	State	2017- 2018		2018- 2019		2019- 2020		2020- 2021	
		Target	Achmnt.	Target	Achmnt.	Target	Achmnt.	Target	Achmnt. (P) (Apr- Dec- 20)
1	Karnataka	11120	9322	10750	11592	12000	11143	12600	8483
2	Andhra Pradesh	6090	6778	7805	7481	7946	7962	8208	5520
3	Telangana	160	163	200	224	295	297	310	166
4	Tamil Nadu	2000	1984	2190	2072	2300	2154	2300	1206
5	Kerala	12	15	14	16	20	13	17	5
6	Maharashtra	328	373	415	519	630	428	475	285
7	Uttar Pradesh	300	292	340	289	365	309	354	179
8	Madhya Pradesh	230	103	160	100	165	61	80	28
9	Chhattisgarh	405	532	670	349	562	480	535	248
10	West Bengal	2590	2577	2775	2394	2900	2295	2520	298
11	Bihar	85	63	95	55	86	56	58	0
12	Jharkhand	2774	2220	2658	2375	2604	2402	2904	800
13	Odisha	140	116	148	131	150	137	160	68
14	Jammu & Kashmir	180	132	190	118	170	117	142	0
15	Himachal Pradesh	40	32	43	34	50	31	45	20
16	Uttarakhand	44	35	45	36	42	40	25	8
17	Haryana	2	0.7	2	0.7	2	1	1	0.3
18	Punjab	6	3	5	3	5	3	4.5	1
19	Assam	4705	4861	4980	5026	5395	5316	5519	5038
20	Ar. Pradesh	58	54	65	59	75	64	67	39
21	Manipur	560	388	435	464	600	504	542	313
22	Meghalaya	1070	1076	1110	1187	1220	1192	1245	999
23	Mizoram	100	83.6	105	92	130	104	113	42
24	Nagaland	770	615	633	620	682	600	649	230
25	Sikkim	17	0.001	3	0.4	1	1	2	0.08
26	Tripura	85	87	125	230	130	111	125	51
Total		33840	31906	35960	35468	38530	35820	39000	24029

(**Source:** Central Silk board, 1st January 2021)

Table 3: Raw Silk Imports

Year	Quantity (MT)	Value (Rs. In Crores)
2017- 18	3712	1218.14
2018- 19	2785	1041.35
2019- 20	3315	1149.32
2020- 21 (Till Dec- 2020)	1150	351.03

(**Source:** CSB, 1st Jan 2021)

Table 4: Exports (Rs. In Crores)

Items	2017- 18	2018- 19	2019- 20	2020- 21 (P) (Till Dec- 2020)
Natural Silk Yarn	15.66	24.72	16.77	5.75
Silk fabrics and made- ups	864.81	1022.43	982.91	326.64
Readymade garments	650.48	742.27	504.23	454.22
Silk Carpet	17.34	113.08	143.43	131.96
Silk Waste	101.19	129.38	98.31	112.30
Total	1649.48	2031.88	1745.65	1030.87

(**Source:** CSB, 1st Jan 2021)

Table 5: Activities taken under Tasar Sector

Activities	2017-18	2018-19	2019-20
Tasar Plantation (Ha)	765	845	1812
Production of Dfls (lakh nos.)	20.20	20.43	23.13
Procurement of Dfls (Lakh nos.)	5.05	5.00	5.00
Consumption of Dfls (Lakh nos.)	25.25	25.43	28.13
Production of reeling cocoons (Lakh nos.)	1,220.03	1,232.8	1303.34
Production of raw silk (est. in MT)	106	123.28	130.33
Production of silk waste (est. in MT)	19	25	-
Farmers covered (nos.)	16,041	16,514	16,531

(**Source:** Directorate of Textile, Odisha)

Table 6: Activities taken under Eri and Mulberry sector

Eri Sector	2017-18	2018-19	2019-20
Castor Plantation (Acres)	1,600	1,720	1,173
Consumption of Dfls (Lakh nos.)	1.39	1.00	0.82
Production of cut cocoons (est. in MT)	8	6.59	6.37
Production of Raw silk (est. in MT)	7	5.27	5.1
No. of farmers covered (Nos.)	3,200	3,440	2,780
Mulberry sector			
Mulberry Plantation (Acre)	102	78	68
Procurement of Dfls. (Lakh nos.)	1.23	1.03	0.65
Consumption of Dfls. (Lakh nos.)	1.23	1.03	0.65
Production of reeling cocoons (Lakh nos.)	22.48	24.94	14.79
Production of raw silk (est. in MT)	3	2.77	2.12
Production of Silk waste (est. in MT)	0.3	0.28	-
No. of farmers covered (Nos.)	1,717	1,216	-

(**Source:** Dept. HT & H, Odisha)

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Traditional medicinal plants used against diabetes by the tribes of Gajapati district in Odisha - An ethnobotanical exploration

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Abstract

The use of herbal medicine is traditionally rooted in India and still an essential part of public healthcare. In recent times, a radically increasing incidence brought *Diabetes mellitus* and its therapy to the focus of public health interests in India. The current study focuses on the exploration of ethnomedicinal knowledge of plants used against diabetes by the tribes of Gajapati district of Odisha. Preparations of information of the anti-diabetic plants were recorded by the help of the tribes of the district namely Savara, Shaber, Lodha and Kandha. Documentation of aboriginal knowledge related to anti-diabetic properties of native plants was made by interaction with local traditional medicine men. A total of 66 species belonging to 29 families were recorded as being used for the treatment of diabetes in the area under study. The most frequently mentioned plants were *Aegle marmelos, Andrographis paniculata, Asparagus racemosus, Azadirachta indica, Clerodendrum philippinum, Cucurma longa, Gymnema sylvestre, Helicteres isora, Hemidesmus indicus, Hybanthus enneaspermus, Pterocarpus marsupium* and *Woodfordia fructicosa*. Most of the herbal preparations of plants used against diabetes were prepared from leaves followed by roots and fruits. However, the available data regarding the anti-diabetic activity of some plants identified in this survey is not sufficient to recommend their use. Pharmacological investigation and clinical intervention studies are required to provide evidence for a safe and effective use of the identified plants in the treatment of diabetes.

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Introduction

Diabetes mellitus is considered as one of the most common and serious metabolic disorders affecting a large number of populations throughout the world. It is considered as one of the five leading causes of death in the world (Joseph and Jini, 2011). It is expected that the silent killer will result in increase of death by 2-3 folds by 2030 (Shaw *et al.*, 2018). The major parameters responsible for diabetes are modern life style, sedentary habits, unbalanced diet, workloads affect the elite class genre of population. At the same time the high cost of allopathic drugs is the major concern among the rural poor. Currently it is estimated 25% of the world's population is affected by diabetes (Maryam, 2015).

Diabetes is a state in which the homeostasis of lipid and carbohydrate metabolism is improperly regulated by insulin in the pancreas. It damages the blood vessels and nerves and if uncontrolled it leads to complications like retinopathy, nephropathy and cardiopathy (Nagappa *et al.*, 2003). There are two major forms of diabetes - Type I (insulin-dependent Diabetes mellitus) and Type II (non-insulin-dependent Diabetes mellitus). Type I Diabetes mellitus occurs when the pancreatic β- cells are destroyed which are responsible for secreting insulin. Type II Diabetes mellitus results when pancreas gradually losses its ability to produce insulin (Ahmed *et al.*, 2017). Among all the constraints in treating diabetes, the major constrain is available therapy i.e. the use of allopathic drug which are reported to produce serious adverse side effects. Therefore, there is a need to acquire knowledge about the different indigenous plants and several herbal formulations to cure diabetes (Satyanarayana *et al.*, 2006). Presently a good number of herbal medicines have been recommended by WHO for the treatment of Diabetes mellitus apart from currently available therapeutic options (WHO, 2000). The ethnomedicinal literature indicates more than 800 plant species to possess hypoglycaemic activity (Alarcon-Aguilara *et al.*, 1998). Lately, the WHO advocated the use of medicinal plants for the management of *Diabetes mellitus* and further suggested to encourage the expansion of scientific analysis of hypoglycaemic properties of different plant species (Akah *et al.*, 2011). Several successful reports have confirmed the efficacy of various herbal formulations which were found to be effective in the treatment of diabetes (Chikejie *et al.*, 2015). Since time immemorial, individual with diabetes have been treated orally with folk medicine of a variety of plant extracts.

The main objective of this study was to carry out a thorough survey of all the anti-diabetic plants used by the major tribes of Gajapati district of Odisha.

Materials and methods

The area under study i.e. Gajapati district (Fig.1) is located in the southern part of the state of Odisha. It lies between 18.6^0 to 19.39^0 North latitude and 83.48^0 to 84.08^0 East longitudes. The district is surrounded on the south by Srikakulum district of the state of Andhra Pradesh and three districts of Odisha in the other directions namely Ganjam in the east, Rayagada in the west and Kandhamal in the north.

The geographical situation of the district is characterised by undulated topography with hilly terrain where temperature varies from 10-37 ^{0}C in tribal blocks and 16-39 ^{0}C in the plain blocks with humid climate. The district has light textured brown forest soil which is highly acidic in nature. The main soil types are clay and sandy loam.

An exhaustive survey was carried out in the area under study for collection, documentation and identification of the plants used against diabetes by the tribes of the local population. Plants with anti-diabetic properties were documented basing on the interviews with herbal medicinal practitioners, medicine men and knowledgeable aged population of the tribal pockets of the 7 blocks of the district. The plant list was prepared based on the interviews and questionnaires.

The investigation was aimed to reveal (elucidate) the traditional medicinal practices among the tribal folks. Details of list of plants, its parts used, mode of

treatment, methods of preparation and administration were recorded. Certain proofs were also recorded from patients who were administered with the medicinal dosages against diabetes. The voucher specimens were collected, identified and deposited as herbarium samples in the Department of Botany, School of Applied Sciences, Centurion University, Bhubaneswar, Odisha.

Fig. 1. Map of Gajapati district of Odisha.

Results and discussion

An aggregate of 66 plant species belonging to 29 families were recorded and identified to be anti-diabetic (Table 1). Most of the species belonged to family Fabaceae followed by Cucurbitaceae, Rutaceae, Menispermaceae, Myrtaceae and Acanthaceae.

The herbal formulations prepared were either in crude form or are mixtures of various ingredients. From the survey, it was observed that maximum percentage of formulations were prepared from leaves followed by roots for the treatment of diabetes.

People of Gajapati district are famous for administering plant formulations to treat various diseases (Fig. 2). Tribal medicine men have a thorough knowledge about the ethnomedicinal uses of plants and its formulations used to treat diabetes. They validate the disease through common clinical symptoms like excessive thirst or urination, fatigue, weight loss or blurred vision, slow healing of cuts and wounds, always feeling hungry etc.

Among the plants listed the widely used medicinal plants by the tribes are *Aegle marmelos, Andrographis paniculata, Asparagus racemosus, Azadirachta indica, Carica papaya, Cucurma longa, Helicteres isora, Hemidesmus indicus, Madhuca indica, Phyllanthus emblica, Pterocarpus marsupium* and *Woodfordia fructicosa*. Through exhaustive review of literature it is found that among the 66 plant species used by the tribes, 18 species have been proven as anti-diabetic through various experiments (Table 1).

Table 1. List of Ethnomedicinal plants used by the tribes of Gajapati district of Odisha for the treatment of Diabetes.

Botanical name with voucher no. and family name	Local name	Habit	Mode of administration and localty (Loc.)	References (Biological activity)
Abroma agusta Linn.f. [SJ-2014] Sterculiaceae	Pishacha-ganjei (O)	Shrub	The juice (10 ml) of the root bark or fresh stem-bark and flower juice (10 ml) is given once in a day for 7 days. [Loc.-Gosani]	---
Abrus precatorius Linn. [SJ-1006] Rutaceae	Kaincha(O), Karjani (Kon)	Climber	Fresh leaf-juice (about 15 ml) taken once early in the morning. [Loc.-Gumma]	---
Aegle marmelos (Linn.) Corr. [SJ-2 001] Rutaceae	Bela(O), Sinjo(S)	Tree	Tender leaf juice (10 ml) mixed with 2-3 drops of honey given twice daily (evening and morning) on empty stomach to reduce blood sugar within 3-4 weeks. [Loc.-Mohana]	Mudi *et al.* (2017) Ansari *et al.* (2017) Panaskar *et al.* (2013)
Aerva lanata (Linn.) Juss. ex Sch. [SJ-1070] Amaranthaceae	Paunsia (O), Lopongarak (Kon)	Herb	Root paste (5 g) or decoction of the whole plant (10-15 ml) is given two times a day for 10 days to correct cardiac problem caused due to diabetes. [Loc.- R.Udayagiri]	---
Ajuga macrosperma Wall. ex Benth. [SJ-1056] Lamiaceae	Rit mel (S)	Herb	Leaf powder (2g) mixed with powder of 3-5 black pepper (*Piper nigrum*) taken once daily for 15 days in both diabetes and body swelling. [Loc.-Mohana]	---
Aloe vera (Linn.) Burm.f. [SJ-1034] Liliaceae	Ghee-kuanri (O), Ghee-kumar (S).	Shrub	About 5 ml of leaf juice mixed with 8-10 drops of Tulsa juice (*Ocimum sanctum*) given twice a day for fifteen days in acute cases. [Loc.-Nuagada]	---
Andrographis paniculata (Burm.f.) Wall. ex Nees. [SJ-1004] Acanthaceae	Bhuinimba (O), Bhuingkara (Sao).	Herb	About 10ml of leaf/root-decoction given once a day for six months against both hyperglycaemia and gastric disorder. [Loc.-Mohana]	---
Asparagus racemosus Willd. [SJ-1026] Liliaceae	Chhatuary (O), Kedarnari (S), Penhepari (Kon)	Herb	Tuberous root powder (5g) mixed with 5 drops of honey given to the patient once in a day for one month to restore potency. [Loc.-Rayagada]	Somania *et al.* (2012) Hannan *et al.* (2007)
Azadirachta indica A.Juss [SJ-1064] Meliaceae	Nimba (O), Nim (S)	Tree	About 10 ml of leaf/root-decoction given once a day for six months against both hyperglycaemia and gastric disorder. [Loc.-Mohana]	Kazeem *et al.* (2013) Perez *et al.* (2013) Gupta *et al.* (2016)
Bacopa monnieri (Linn.) Penn. [SJ-1015] Scrophulariaceae	Brahmi (O), Panikundi (Sao)	Herb	Leaf juice (15 ml) along with equal amount of leaf juice of 'Bela' (Aegle marmelos) is prescribed for one month to reduce blood sugar. [Loc.-Mohana]	---
Boerhaavia diffusa Linn. [SJ-1029] Nyctaginaceae	Puruni (O), Choic arak (Sao)	Herb	The leaf juice (10 ml) is used to reduce sugar in urine. The patient is also advised to take the leaves and tender branch tips as vegetables. [Loc.-Rayagada]	Pari and Satheesh (2004) Chopra *et al.* (1958) Kirtikar and Basu (1933)
Caesalpinia bonduc (Linn.) Roxb. [SJ-107] Caesalpiniaceae	Gila(O), Bagni (S, Kon).	Tree	Seeds (5g) are pounded and given in early morning with 100 ml goat milk for 15 days. [Loc.-Rayagada]	---
Carica papaya Linn. [SJ-201] Caricaceae	Amruta-bhanda (O), Bhanda(S)	Tree	Green fruits are boiled and made into a paste and given with a pinch of common salt and jeera powder for six months. [Loc.- Mohana]	Oke (1998)
Cassia auriculata Linn. [SJ-1021] Caesalpiniaceae	Tarwar (O, S)	Shrub	Leaf juice (10 ml) mixed with 5 g old jaggery given once daily for one month at early stage of the disease. [Loc.-Rayagada]	---
Catharanthus roseus (Linn.) G. Don. [SJ-1077] Apocynaceae	Sadabihari/Ainshakati (O,Kon)	Shrub	Fresh twig with two leaf buds is given daily for 7 days on empty stomach. During this administration, eating sugar is strictly prohibited. [Loc.- Gosani]	Ohadoma and Michael (2011)
Cissampelos pareira Linn. var. hirsuta (DC.) Forman [SJ-1044] Menispermaceae	Akanabindi (O),Telomalla (Sao), Pitu- sing (Kon)	Climber	About 60 g of the root is boiled in half a litre of water for 20-3bout 30-60 ml o min in a closed vessel. About 30-50 ml of this preparation is given two or three times daily to correct the kidney disorder caused by diabetes. [Loc.-Rayagada]	---
Clerodendrum philippinum Schauer [SJ-1067]	Brajamalli (O), Dilbari (Sao)	Small Shrub	Leaf juice (10 ml) mixed with equal amount of 'Tulsi' *(Ocimum sanctum)* juice is given once	Kar *et al.* (2015)

Verbenaceae			in a day for 3 days to reduce sugar content in blood. [Loc.-Mohana]	
Clerodendrum phlomidis Linn.f. [SJ-1088] Verbenaceae	Dankari (O), Panjot (S)	Large Shrub	Aqueous extract (10 ml) of leaf is hypoglycaemic and given twice a day for 3 days. [Loc.-Nuagada]	---
Clerodendrum serratum (Linn.) Moon [SJ-1017] Verbenaceae	Budha rasuna (O), Neta (Sao)		Paste of root (15 g) and 7 'Gola maricha' (*Piper nigrum*) is given in 3 doses at half an hour intervals to cure chest pain and heart palpitation due to acute diabetes. [Loc.-Mohana]	Kar *et al.* (2014)
Coccinia grandis (Linn.) Voigt. [SJ-1085] Cucurbitaceae	Kunduri (O), Bano-kundri (Kon,S)	Climber	Decoction of the twig of plant along with flowers and young fruits given once daily for seven days to lower sugar in blood. [Loc.-Gosani]	---
Cocculus hirsutus (Linn.) Diels. [SJ-2005] Menispermaceae	Musakani (O), Dahidahiya (S)	Twiner	Leaf juice (5 ml) mixed with equal amount of stem juice of 'guduchi' (*Tinospora cordifolia*) prescribed daily for 15 days. [Loc.-Mohana]	Badole *et al.* (2006)
Cressa cretica Linn. [SJ-1023] Convolvulaceae	Rodanti (O)	Herb	The infusion of the whole plant, sweetened with jaggery is taken thrice daily after meals for impotency and loss of weight caused by diabetes. [Loc.-Gumma]	---
Cucumis sativus Linn. [SJ-1090] Cucurbitaceae	Kakudi (O).	Herb	Seeds (2 g) made into a paste with fermented rice water and is given daily for 15 days to reduce the sugar level in blood. Those who suffer from diabetes and those who want to lose weight should make a liberal use of cucumber. [Loc.-Rayagada]	---
Curculigo orchiades Gaertn. [SJ-1007] Hypoxidaceae	Talamuli (O), Tarmuli (S)	Herb	Root or rhizome paste (10 g) with fermented rice water is recommended daily for seven days on empty stomach to reduce blood sugar. [Loc.-Gumma]	---
Cucurma longa Linn. [SJ-1059] Zingiberaceae	Haladi (O, Sao)	Herb	15-20 ml of fresh juice of the rhizome with equal amount of fruit juice of 'Aenla' *(Phyllanthus emblica)* given three times in a day for 15 days against glycosuria. [Loc.-Nuagada]	---
Cyamopsis tetragonoloba (Linn.) Taub. [SJ-1036] Fabaceae	Guanra (O, S).	Herb	Fruits fried in cow-ghee given to get relief from general weakness during the disease. [Loc.-Gosani]	---
Ficus racemosa Linn. [SJ-2012] Moraceae	Dimiri (O), Dumar(Kon)	Tree	A paste (50 g) made out of the boiled unripe fruit and equal quantity of fine rice, given with normal meal for 2-3 months to reduce the sugar level in urine. [Loc.-Nuagada]	---
Gmelina arborea Roxb. [SJ-1006] Verbenaceae	Gambhari (O), Gumna (Kon)	Tree	Juice of the young leaves with 2-3 drops of honey is given three times a day after food for 10 days to rectify the eyesight problems due to diabetes (i.e. diabetic retinopathy). [Loc.-Gosani]	---
Gymnema sylvestre (Retz.) R.Br. ex Schult. [SJ-1051] Asclepiadaceae	Gudamari (O).	Climber	Dried leaf powder (2-3 g) is given with water. Seven fresh leaves are prescribed daily in the morning in empty stomach for 15 days. [Loc.-Rayagada]	---
Helicteres isora Linn. [SJ-1003] Sterculiaceae	Modimodica (O), Petkamra(S).	Shrub	One teaspoonful root/bark powder given once daily for 15 days early in the morning before breakfast. [Loc.-Gosani]	---
Hemidesmus indicus (Linn.) R.Br. [SJ-1079] Violaceae	Sugandhi-lai (O), God mela (Kon)	Twiner	Powdered roots (5 g) given 2-3 times a day in a cup of hot cow-milk for one month to reduce sugar content in blood as well as urine. [Loc.-Nuagada]	---
Hybanthus enneaspermus (Linn.) F.V. Muel [SJ-1010] Violaceae	Madanamastaka (O), Birsuraj-mukhi (S)	Herb	20g of whole plant (including roots) ground with 3 'Gola marich' (*Piper nigrum*) and the paste given in the morning on empty stomach for one month. [Loc.- Gumma]	---
Hygrophila auriculata (Schum.) Heine	Koili-khia (O, S)	Herb	5 ml of leaf juice along with 5-10 drops of honey is given at evening for 15 days. [Loc.-	---

[SJ-1039] Acanthaceae			Nuagada]	
Ichnocarpus frustescens (Linn.) R.Br. [SJ-1011] Apocynaceae	Suam-lai (O), Onol-sing (Kon)	Shrub	Fresh juice of leaf and fruit along with two black pepper (*Piper nigrum*) given early in the morning on empty stomach. [Loc.-Gosani]	---
Lablab purpureus Linn. [SJ-1054] Fabaceae	Shimba (O)	Herb	Tender pods cooked and eaten give relief in diabetes. [Loc.-R. Udayagiri]	---
Lawsonia inermis Linn [SJ-1013] Lythraceae	Manjuati (O), Mindi (S, Kon)	Shrub	Decoction of equal quantity of flowers and seeds (2-5 g each) is given once a day for 10-15 days to reduce the sugar level in urine. [Loc.-Nuagada]	---
Macrotyloma uniflorum (Lam.) Verdc. [SJ-1002] Fabaceae	Kolatha (O)	Herb	50 g of seeds are boiled with water for about half an hour. The water is taken in empty stomach every day to control blood sugar level. [Loc.-R. Udayagiri]	---
Madhuca indica Gmel. [SJ-1075] Cucurbitaceae	Mahula (O), Aba (S), Mahua (Kon)	Tree	Decoction of bark (15 g) is prescribed internally in diabetes mellitus with beneficial results. [Loc.-Nuagada]	---
Momordica charantia Linn. [SJ-1024] Cucurbitaceae	Kalara (O), Kirla (Kon)	Herb	Decoction of the fruits is given to the patients in the morning in empty stomach at least for one month. The patient is also advised to take the fruit as vegetable in his daily diet. A mixture of 'Jamu' *(Syzygium cumini), 'Gudamari' (Gymnema sylvestre), 'Nimba' (Azadirachta indica)* and Kalara (leaves only) in the ratio 1:1:1:2 is an effective remedy for diabetes. [Loc.-Mohana]	Mahmoud *et al.* (2017) Ma *et al.* (2017)
Moringa oleifera Lam. [SJ-1045] Moringaceae	Sajana (O), Mungaara (Kon), Munga arak (S)	Tree	Fruit juice (15-20 ml) along with little old jaggery given once daily for 7 days. Patients are advised to take fruits and leaves as vegetables in daily diet at least 15 days per year. [Loc.-Kasinagar]	---
Murraya koenigii (Linn.) Spreng. [SJ-1068] Rutaceae	Bhrusunga (O), Puspa (Bond), Mirsinga (Kon)	Shrub	Eating 7 fresh fully-grown curry leaves every morning for three months is said to prevent diabetes due to hereditary factors. It also cures diabetes due to obesity. As the weight drops, the diabetic patients stop passing sugar in urine. [Loc.-Kasinagar]	Narayan and Sastry (1975) Yadav *et al.* (2002) Kesari *et al.* (2005)
Naringi crenulata (Roxb.) Nicolson [SJ-2020] Rutaceae	Benta(O), Kumbali (Sao)	Small tree	Aqueous extract of fruit pulp of this plant along with seeds (5 g) of 'Methi' (*Trigonella foenum- graecum)* is prescribed for 7 days to keep diabetes in control. [Loc.-R. Udayagiri]	Mekap *et al.* (2016)
Oxalis corniculata Linn. [SJ-1005] Oxalidaceae	Ambiliti(O), Tandi/Chatamarak (S)	Herb	A tablespoon of fresh juice mixed with butter of cow's milk is given once daily for 15 days to curb excessive thirst caused by diabetes or severe heat. [Loc.-Gosani]	Mekap *et al.* (2016)
Pistia stratiotes Linn. var. cuneata Engl. [SJ-1025] Araceae	Borajhanji (O), Takapana (Kon)	Shrub	The juice (10 ml) of young plants mixed with equal amount of green coconut milk is given to reduce sugar content in blood. [Loc.-Rayagada]	---
Paspalum scrobiculatum Linn. [SJ-1065] Poaceae	Kodua (O), Janhe (S), Gara-kode (Kon)	Herb	Mature grains (10 g) of this plant are made into a paste with the latex (1 ml) of banyan prop roots (Ficus benghalensis) and given once daily for 7 days to lessen the excessive appetite during diabetes. [Loc.-R. Udayagiri]	---
Phyllanthus emblica Linn. [SJ-1047] Euphorbiaceae	Aenla (O), Meral (Kon), Ener (S)	Tree	5 g paste of fresh leaves given daily for one month in empty stomach to reduce sugar in blood. Paste prepared from equal quantity of boiled fruits of this plant and the fruits of 'Bahada' *(Terminalia bellirica)* given with 50 ml cow's milk twice daily one hour before food. [Loc.- Kasinagar].	Nampoothiri *et al.* (2011)
Phyllanthus fraternus Linn. [SJ-1019]	Bhuinanla (O), Bariamla (S)	Herb	Juice of the whole young plant given in every stages of the disease. [Loc.-Kasinagar]	---

Euphorbiaceae				
Portulaca oleracea Linn. [SJ-1080] Portulacaceae	Balibalua (O), Dali ara (Kon)	Herb	A teaspoon of its seed given every day with hot water for 2-3 months to treat diabetes. [Loc.- R. Udayagiri]	---
Psidium guajava Linn. [SJ-1027] Myrtaceae	Pijuli (O), Chaulia (S).	Tree	Juice (about 10 ml) of vegetative as well as reproductive buds given daily, once in the evening for at least one month. [Loc.- Kasinagar]	---
Pterocarpus marsupium Roxb. [SJ-1052] Fabaceae	Piyasala(O),Hid (Sao), Murga (S), Bia (Kon)	Tree	Heartwood soaked overnight with water and the filtrate (10 ml) is given daily for one month. Seeds of this plant is also used but found less efficient than the wood. [Loc.- Kasinagar]	---
Pterocarpus santalinus Linn.f. [SJ-1055] Fabaceae	Rakta-chandana (O, S)	Tree	Heartwood rubbed on a piece of stone and the paste (about 5 g) given with a glass of water to lessen excessive urination. [Loc.-Gumma]	---
Pueraria tuberosa DC. [SJ-1012] Fabaceae	Handiphuta (O), Tirra (Sao)	Climbing shrub	2 g each of root powder of this plant and 'Satabari' (*Asparagus racemosus*) mixed with a banana and 100 ml milk is given once in a day for one month. [Loc.-R. Udayagiri]	---
Rhinacanthus nasutus (Linn.) Kurz. [SJ-1048] Acanthaceae	Kaura-saga (O).	Shrub	Juice of the leaves (5-10 ml) along with the fruit juice (10 ml) of 'Aenla' *(Phyllanthus emblica)* is given. Stem powder is also given with hot water for 10 days. [Loc.- Kasinagar]	---
Scirpus grossus Linn.f. [SJ-1062] Cyperaceae	Kesara-mula (O), Jomekasari (S)	Herb	Tuber powder (5 g) of this plant along with 2 ground nut seeds is given daily for one month to check loss of weight during the disease. [Loc.-Gumma]	---
Sida cordifolia Linn. [SJ-1031] Malvaceae	Bisiripi(O), Huringmindi-lata (Kon)	Shrub	Root powder (2-3 g) with one glass of milk given daily is effective within a short period. [Loc.-R.Udayagiri]	---
Solanum viginiarum Linn. [SJ-1060] Solanaceae	Ankaranti (O),Rangani janum (S)	Shrub	One gram of powdered root is given twice a day with 250 ml goat's milk. This treatment should be continued till the weakness due to this disease is completely over. [Loc.- Kasinagar]	---
Sphaeranthus indicus Linn. [SJ-1020] Asteraceae	Bhuinkadamba(O), Koirab (Kon), Belaunga(S)	Herb	Paste (15 g) of the aerial part of this plant given with little old jaggery twice a day for 3 days to check the excessive urination. [Loc.-Gumma]	---
Striga densiflora (Benth.) Benth. [SJ-1009] Myrtaceae	Phuruphuria (O,S)	Herb	Fruits (5 g) are powdered and taken with warm water for 15 days to cure the disease. [Loc.- Gosani]	---
Syzygium cumini (Linn.) Skeels [SJ-1050] Myrtaceae	Jammu (O), Neredu (S)	Tree	10 g each of the leaves of this plant and 'Gudamari' *(Gymnema sylvestre)* are boiled in 50 ml of water till it reduces to about 500 ml. The filtered extract is then given along with 5 g of jaggery daily for two months. [Loc.- R.Udayagiri]	Brahmachari and August (1961) Rahman and Zaman (1989)
Talinum triangulare Willd. [SJ-1001] Portulacaceae	Bilati poi (O), Kana phul (Kon)	Herb	Powder (5 g) or decoction (20 ml) of whole plant or root mixed with date palm juice (10 ml) is given to cure diabetes. [Loc.-Gumma]	---
Terminalia arjuna (Roxb. ex DC.) Wt. &Arn. [SJ-1058] Combretaceae	Arjuna (O), Kowa (Sao), Kahua (S).	Tree	Bark powder (1g) mixed with the decoction (10 ml) of the fresh bark and 5 drops of honey given on empty stomach twice daily for 7 days. [Loc.- Rayagada]	Biswas *et al.* (2011) Khaliz *et al.* (2013)
Tinospora cordifolia (Willd.) Hook f. & Thoms. [SJ-1033] Menispermaceae	Guluchi-lata (O),Gursilai (Kon), Gurach (S).	Herb	15-20 ml stem juice with 2drops of honey is given twice a day for 15 days. Stem powder (5 g) of this plant and 2-3 g of 'Pippali' powder *(Piper longum)* are prescribed for 7 days for oral ulcers of diabetic patients. [Loc.- Nuagada]	Sangetha *et al.* (2013) Rajalakshmi and Anita (2016)
Toddalia asiatica (L.) Lam. [SJ-2025] Rutaceae	Tundapoda (O), Kanj (S)	Scandent Shrub	Leaf powddder (10 g) of this plant mixed with stem juice of 'Gulduchi' *(Tinospora cordifolia)* is given with 50 ml cow milk to	Mekap *et al.* (2016)

			reduce blood sugar. [Loc.- Gosani]	
Trichosanthes dioica Roxb. [SJ-1083] Cucurbitaceae	Potala (O).	Herb	Juice of the leaves and roots (5 ml) is given daily on empty stomach for 10 days against excessive urination and sugar in urine. [Loc.-Gosani]	---
Triumfetta rhomboidea Jacq. [SJ-1046] Tiliaceae	Bacchua (O), Jhinjhirita (S).	Shrub	Leaf powder (3g) is taken daily with cold water for 15 days against diabetes. [Loc.-Gumma]	---
Woodfordia fructicosa (Linn.) Kurz. [SJ-1022] Lythraceae	Dhatuli (O), Ichak (S), Dhatki(Kon)	Shrub	Dried flowers (2-3 g) along with 100 ml of fermented rice water is given once in a day for one month to treat diabetes. [Loc.-Gosani]	---

(O-Odia, Sao-Saora, S-Savara, Kon-Kondha; Loc. - Locality; SJ. - Name of the first author in abbreviated form).

Most of the plant species reported are herbs or shrubs and a few of them are tree species (Fig. 3). This aspect has made the survey as well as collection of plant material bit easy and also towards species conservation. Moreover, the survey also revealed that leaf was the major plant part used (Fig. 4) which is in agreement with earlier studies. The collection and processing of leaves is easy and does not damage the plant substantially as compared to the collection of roots, tubers or the whole plant. The present study could identify a good number of candidate plants with folklore claims which need further investigation for anti-diabetic treatment.

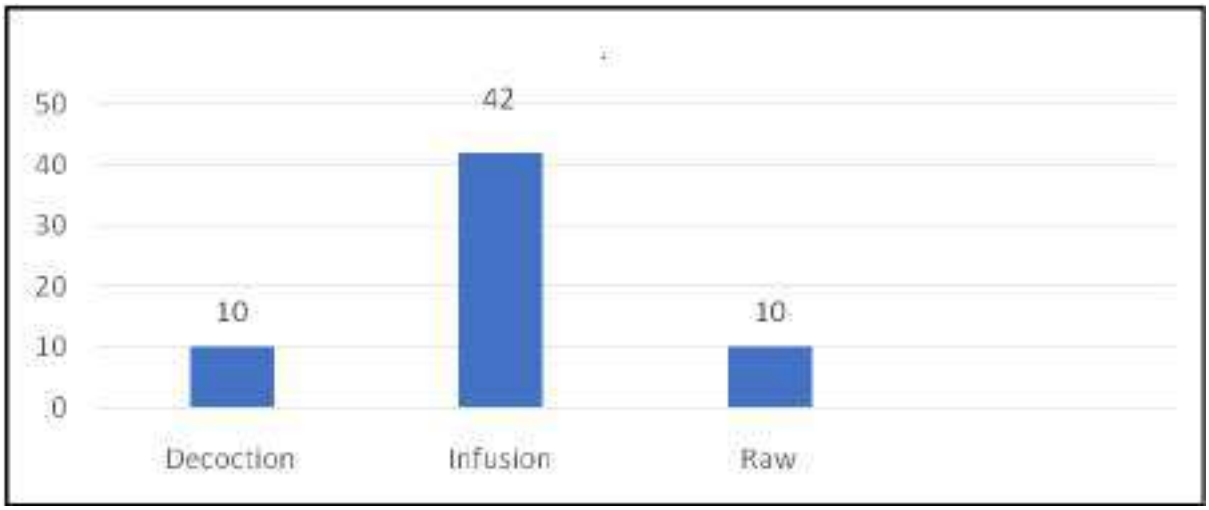

Fig. 2. Traditional formulations adopted by the tribal healers in the preparation of herbal remedies.

Fig. 3. Frequency of Habit of the Anti-diabetic medicinal plants.

MOP: more than one part

The cure of diabetes is a global problem as the synthetic medicines developed does not give the assurance that the patient can totally recover from diabetes (Li *et al.*, 2004). Therefore, alternative therapy of using indigenous plants and herbal formulations has taken a forefront (Satyanarayan *et al.*, 2006). The traditional medicine has paved a bright future in treatment of diabetes and to explore the importance of traditional herbs and folklore claims.

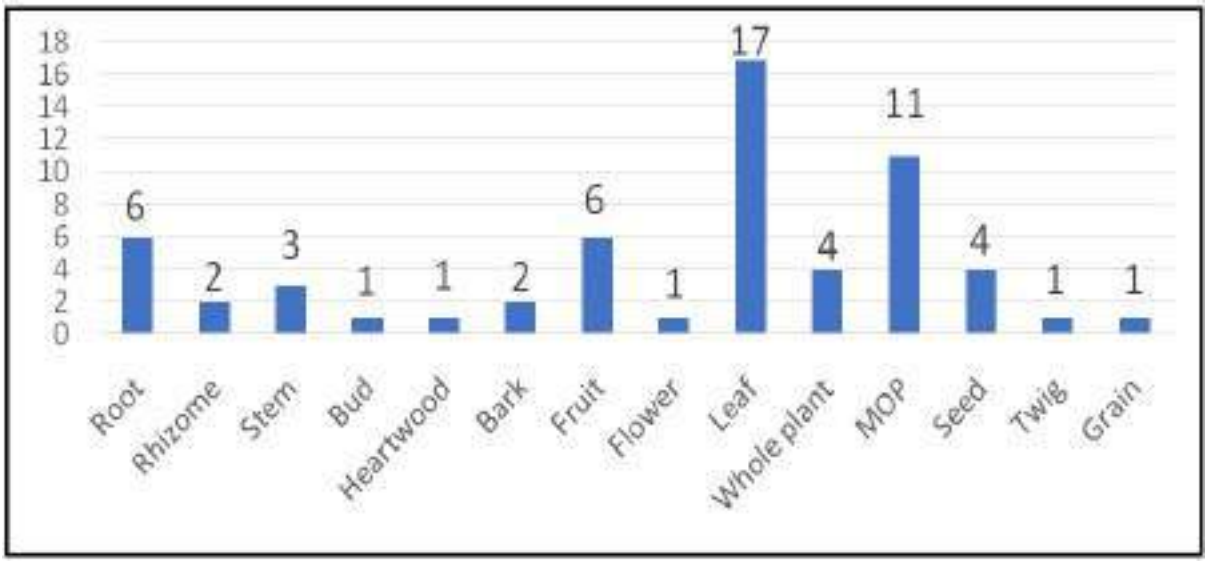

Fig. 4. Frequency of plant part (s) used during preparation of herbal medicines.

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POTENTIAL MEDICINAL PLANTS USED AGAINST *DIABETES MELLITUS* : A REVIEW

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Abstract

The rapid increase in incidence of *Diabetes mellitus* is becoming a serious threat to the people all over the world. It is considered as one of the most common non-communicable diseases globally. Till recent times the treatment of the disease by allopathic or synthetic drugs either has undesired side effects or are not cost effective to the population. Hence, the present paper reviews on the herbal formulations of plants with their mechanism of action and pharmacological test results. A total of 50 plants belonging to 40 genera under 29 families are found useful against Diabetes. The majority of the medicinal plants under review in the present article belongs to the family Menispermaceae and Verbenaceae followed by Combretaceae and Moraceae. It is said that the herbal approach of management of disease may have late response but it corrects the related metabolic abnormalities. Therefore, now-a-days much attention is drawn towards identification of plants and their pharmacological evaluation for herbal formulations before recommended to prove their efficacy in human system.

Key words : Medicinal plants, *Diabetes mellitus*, Herbal formulations, Physiological effects.

Introduction

Diabetes (Madhumeha) was known to Indian 'Ayurveda' since about 3000 years affecting the populace of both developed and developing countries since time immemorial. It was "Sushruta", the great Indian physician who diagnosed diabetes during 1000 B.C. Based on different medicinal systems such as 'Ayurveda', 'Unani' and 'Siddha' the knowledge of medicinal plants has been accumulated since many centuries. Diabetes is either genetically inherited or is caused by the deficiency in production of insulin by the pancreas or by the defect in production of insulin. One of the common manifestations of the metabolic disorder of *Diabetes mellitus* is hyperglycemia (WHO, 1980). Chronic hyperglycemia can cause damage to eyes, heart, nerves, kidneys and blood vessels (Mayfield, 1998). Though there are many synthetic drugs developed for patients suffering from diabetes, none of them proved to be effective and had undesirable side effects (Li *et al.*, 2004). Therefore, there was a need to acquire knowledge about the different indigenous plants and herbal formulations to cure diabetes (Satyanarayana *et al.*, 2006). Many folklore indigenous Indian medicinal plants have been found to be effective in management of diabetes. It is advantageous to use herbal drugs as they are easily available and have very low side effects. The ethno-botanical survey reports about 800 plants that possess anti-diabetic potential (Alarcon *et al.*, 1998; Nanda and Satapathy, 2001; Satapathy *et al.*, 2001 & 2003; Satapathy and Chand, 2010). This study reviews some important traditional herbs having anti-diabetic activity which can help researchers and physicians to make more success in the field of herbal medications. Plants have been an exemplary source of many currently available herbal drugs whose adequate herbal formulations form the modern day cure for *Diabetes mellitus*. The anti-diabetic or anti-hyperglycemic effects of these plants is dedicated to the ability of these plants to facilitate the metabolites in insulin dependent processes or to restore the function of the pancreatic tissue by increasing the insulin output. Hence, the treatment of *Diabetes mellitus* with herbal

Table 1: List of Medicinal plants with anti-diabetic properties.

Medicinal plants & Family	Plant part(s) used	Extract type	Experimental animal	Physiologic effects	References
Aegle marmelos (L.) Correa (Rutaceae)	Fruit/ leaf	Aqueous extract	Rats	Lower blood sugar level by lowering insulin resistance.	Mudi *et al.* (2017), Ansari *et al.* (2017), Panaskar *et al.* (2013).
Allium cepa L. (Amaryllidaceae)	Bulb	Aqueous extract (300 mg/kg)	Rats	Reduce blood glucose levels, serum cholesterol and serum lipids.	Ozougwu (2011).
Alpinia galanga (L.) Willd. (Zingiberaceae)	Rhizome	Alcoholic extract	Rats	Control blood sugar level, reduce urine albumin.	Kaushik *et al.* (2013).
Anacardium occidentale L. (Anacardiaceae)	Leaf	Raw	Rats	Hypoglycemic.	Sokeng *et al.* (2001).
Annona squamosa L. (Annonaceae)	Leaf	Aqueous extract	Unknown	Hypoglycemic, anti-diabetic.	Teonard *et al.* (2015), Gupta *et al.* (2005).
Aristolochia indica L. (Aristolochiaceae)	Aerial part	Chloroform extract	Swiss albino mice	Hypoglycemic, anti-diabetic.	Karan *et al.* (2012).
Artocarpus hetero-phyllus Lam. (Moraceae)	Stem	Ethanolic extract	Rats	Revert loss of weight, increased urea and creatinine.	Ajiboye *et al.* (2018).
Asparagus racemosus Willd. (Asparagaceae)	Root	Ethanolic extract	Rats	Stimulates secretion of islet cells and clonal β-cells.	Somania *et al.* (2012), Hannan *et al.* (2007).
Azadirachta indica A. Juss (Meliaceae)	Leaf	Aqueous extract	Rats	Reduce blood glucose level, lipid peroxidation.	Kazeem *et al.* (2013), Perez Gutierrez & de Jesus Martinez Ortiz (2013), Gupta *et al.* (2016).
Boerhaavia diffusa L. (Nyctaginaceae)	Leaf	Aqueous extract	Rats	Acts by increasing insulin, sensitivity and reducing blood glucose level.	Pari and Satheesh (2004), Chopra *et al.* (1958), Kirtikar & Basu (1933).
Bougainvillea spectabilis L. (Nyctaginaceae)	Leaf	Ethanolic extract	Unknown	Antihyperglycemic activity due to insulin sensitivity.	Purohit & Sharma (2006).
Brassica juncea (L.) Czern. (Brassicaceae)	Seed	Aqueous extract	Rats	Hypoglycemic activity.	Thirumalai *et al.* (2011).
Bryophyllum pinnatum (Lam.) Oken (Crassulaceae)	Leaf	Aqueous extract	Rats	Hypoglycemic effect.	Ojewole (2005).
Canavalia ensiformis DC. (Fabaceae)	Seed	Aqueous extract	Unknown	Hypoglycemic effect.	Asolkar *et al.* (1992).
Calotropis gigantea (L.) R.Br. ex Schult. (Apocynaceae)	Leaf/ flower	Aqueous extract	Rats	Lower serum glucose level.	Rathod *et al.* (2011), Choudhary *et al.* (2012).
Carica papaya L.	Fruit	Aqueous extract	Rats	Lower blood sugar level.	Oke (1998).
Casearia esculenta Roxb. (Flacourticeae)	Root	Aqueous extract	Rats	Hypoglycemic and antihyperglycemic effect.	Yoganarasimhan (2000), Prakasam (2004).
Catharanthus roseus (L.) G.Don (Apocynaceae)	Leaf	Methanolic extract	Rats	Hypoglycemic effect.	Ohadoma & Michael (2011).
Clerodendrum inerme (L.) Gaertn. (Verbenaceae)	Aerial part	Methanol extract	Wistar albino rats	Antidiabetic activity, Reduction in blood sugar.	Panigrahi *et al.* (2015)
Clerodendrum philippinum Schauer. (Verbenaceae)	Leaf	Methanol extract	Wistar albino rats	Antidiabetic activity.	Kar *et al.* (2015)

Table 1 contd....

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Medicinal plants & Family	Plant part(s) used	Extract type	Experimental animal	Physiologic effects	References
Clerodendrum serratum L. (Verbenaceae)	Leaf	Methanol extract	Wistar albino rats	Antidiabetic activity.	Kar *et al*. (2014)
Clerodendrum viscosum Vent. (Verbenaceae)	Leaf	Methanol extract	Wistar albino rats	Decrease hyperglycemia, Antidiabetic activity.	Panigrahi *et al*. (2015)
Cocculus indica Wight. & Arn. (Menispermaceae)	Fruit	Alcoholic extract	Unknown	Hypoglycemic, restores β-cells.	Kumar *et al*. (1993)
Cocculus hirsutus (L.) Diels (Menispermaceae)	Leaf	Aqueous extract	Rats	Antihyperglycemic effect.	Badole *et al*. (2006).
Coscinium fenestratum Goetgh. (Menispermaceae)	Stem	Alcoholic extract	Rats	Regulates glucose homeostasis.	Punitha *et al*. (2005).
Emilia sonchifolia (L.) DC. ex Wight. (Asteraceae)	Whole plant	Crude extract	Rats	Hypoglycemic effect.	Monago & Ugbomeh (2004).
Ficus benghalensis L. (Moraceae)	Bark	Aqueous extract	Unknown	Antihypoglycemic effect.	Bramachari *et al*. (1961), Geetha *et al*. (1994), Cherian *et al*. (1993).
Ficus religiosa L. (Moraceae)	Bark	Aqueous extract	Rats	Antidiabetic activity.	Pandit *et al*. (2010), Kirana *et al*. (2009), Kirana *et al*. (2011).
Momordica charantia L. (Cucurbitaceae)	Fruit	Juice	Rats	Antidiabectic & antioxidant activity.	Mahmoud *et al*. (2017), Ma *et al*. (2017).
Murraya koenigii (L.) Spreng. (Rutaceae)	Leaf	Aqueous extract	Rats	Hypoglycemic effect.	Narayana *et al*. (1975), Yadav *et al*. (2002), Kesari *et al*. (2005).
Naringi crenulata (Roxb.) Nicolson (Rutaceae)	Leaf	Methanol extract	Wistar albino rats	Antidiabetic activity.	Mekap *et al*. (2016)
Nelumbo nucifera Gaertn. (Nelumbonaceae)	Rhizome	Ethanolic extract	Rats	Hypoglycemic effect.	Kato *et al*. (2015), Mukherjee et *al*. (1997).
Nyctanthus arbori-tristis L. (Oleaceae)	Flower	Aqueous extract	Mice	Decrease blood sugar levels.	Rangika *et al*. (2015).
Oxalis corniculata L. (Oxalidaceae)	Whole Plant	Methanol extract	Wistar albino rats	Antidiabetic activity.	Mekap *et al*. (2016).
Phyllanthus emblica L. (Euphorbiaceae)	Fruit	Aqueous extract	Unknown	Antidiabetic, antioxidant, free-radical scavenging property.	Nampoothiri *et al*. (2011).
Piper longum L. (Piperaceae)	Dry fruit	Crude extract	Rats	Antihyperglycemic and antilipidic peroxidative effect.	D'souza *et al*. (2014).
Polyalthia longifolia var. Pendula (Annonaceae)	Root bark	Methanol extract	Wistar albino rats	Antihyperglycemic, Antidiabetic activity.	Ghosh *et al*. (2011).
Polyalthia longifolia var. Pendula (Annonaceae)	Stem bark	Methanol extract	Wistar albino rats	Antidiabetic activity.	Ghosh *et al*. (2009).
Polyalthia longifolia var. Angustifolia (Annonaceae)	Stem bark	Methanol extract	Wistar albino rats	Antidiabetic activity.	Ghosh *et al*. (2010).

Table 1 contd....

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Medicinal plants & Family	Plant part(s) used	Extract type	Experimental animal	Physiologic effects	References
Polyalthia longifolia var. Angustifolia (Annonaceae)	Stem bark	Chloroform extract	Wistar albino rats	Antidiabetic activity.	Ghosh *et al*. (2008).
Sida rhombifolia L. (Malvaceae)	Aerial part	Methanol extract	Wistar albino rats	Antidiabetic activity.	Ghosh *et al*. (2011).
Sida rhombifolia L. (Malvaceae)	Root	Methanol & aqueous extract	Wistar albino rats	Antidiabetic activity.	Ghosh *et al*. (2009).
Sida acuta L. (Malvaceae)	Root	Aqueous extract	Wistar albino rats	Antidiabetic activity.	Jena *et al*. (2011).
Streblus asper Lour. (Moraceae)	Stem bark	Petroleum ether extract & the isolated compound, α-amyrin acetate.	Albino rats	Antidiabetic activity.	Karan *et al*. (2013).
Streblus asper Lour. (Moraceae)	Root	Petroleum ether extract	Swiss albino mice	Antidiabetic activity.	Karan *et al*. (2012).
Syzyguim cumini (L.) Skeels (Myrtaceae)	Leaf, seed, fruit, bark	Crude extract	Unknown	Antihyperglycemic effect.	Bramachari *et al*. (1961), Rahman *et al*. (1989).
Terminalia bellirica (Gaertn.) Roxb. (Combretaceae)	Fruit	Methanolic extract	Unknown	α-amylase and β-amylase inhibitor activity.	Latha & Daisy (2013).
Terminalia chebula Retz. (Combretaceae)	Seed	Chloroform extract	Rats	Anti diabetic and reno-protective.	Rao *et al*. (2004).
Terminalia catappa L. (Combretaceae)	Fruit	Petroleum ether, methanol & aqueous extract	Rats	Antidiabetic effect.	Nagappa *et al*. (2003).
Tinospora cordifolia (Willd.) Hook.f. & Thoms. (Menisperm-aceae)	Stem	Methanolic extract	Wistar rats	Reduce blood sugar level, HBA1c level.	Sangeta *et al*. (2013), Rajalakshmi & Anita (2016).
Toddalia asiatica (L.) Lam. (Rutaceae)	Leaf	Methanol extract	Wistar albino rats	Reduction in blood glucose level.	Mekap *et al*. (2016).
Trigonella foenum-graecum L. (Fabaceae)	Seed	Dry powder	Rats	Improves blood sugar level and anti oxidant activity.	Sankar *et al*. (2012), Pradeep & Srinivasan (2018).
Vetiveria zizanioides (L.) Nash (Poaceae)	Root	Ethanol extract	Wistar albino rats	Antidiabetic activity	Karan *et al*. (2012).
Zingiber officinale Roscoe. (Zingiberaceae)	Fruit	Aqueous extract	Rats	Reduce blood glucose level, total serum lipids, total serum cholesterol.	Ozougwu & Eyo (2011).

formulations/drugs aims on protecting β-cells and maintaining the glucose levels. Plants contain many secondary metabolites like glycosides, alkaloids, terpenoids, flavonoids, carotenoids etc. that frequently implies having anti-diabetic effect.

A detailed and comprehensive literature review was made by searching various websites as well as relevant research papers published besides the study materials available at different educational and research institutes including Centurion University of Technology and Management, Odisha, India. Various proceedings, scientific journal articles on medicinal plants, herbal

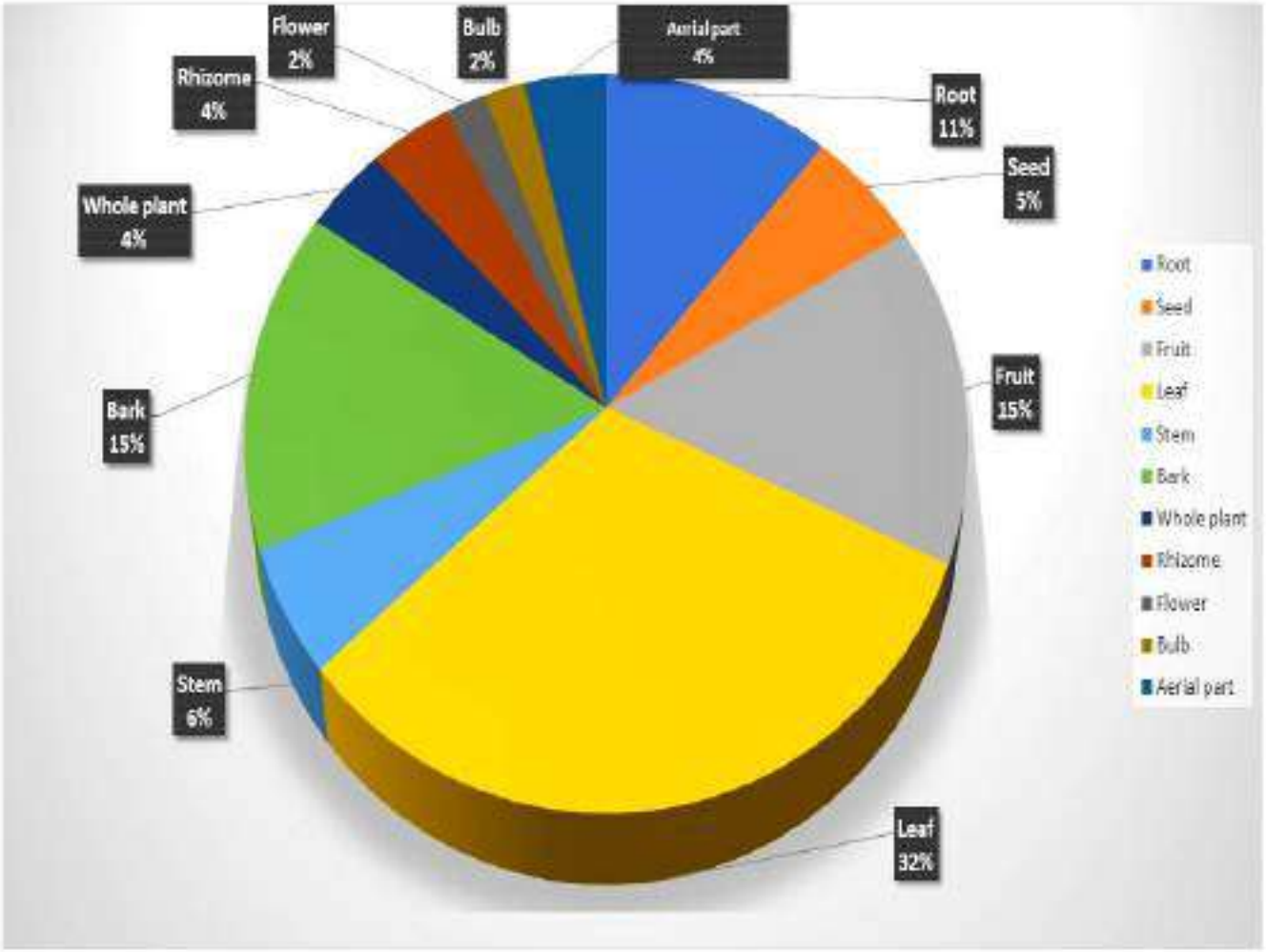

Fig. 1: Percentage of the various plant parts used as medication.

practices and formulations and recommendations and communiqués of World Health Organisation documents were referred with regards to the medicinal plants having anti-diabetic properties. The search keywords such as medicinal plants, *diabetes mellitus*, herbal formulations, anti-diabetic drug plants, physiological effects etc. were used for finding out related research articles for the preparation of updated review article.

The results of the review study revealed the reports on the use and evaluation of fifty potential medicinal plants with anti-diabetic properties and compiled in details of their folklore claims and experimental status (Table 1). The present review article enumerates the updated information and documentation of the indigenous medicinal plants used for the treatment of *Diabetes mellitus*. The results of the present exhaustive literature survey indicated that the data on 50 plants belonging to 40 genera under 29 families involved in treating the disease. It was also found that majority of the plant species used against diabetes belonged to the angiospermic family Menispermaceae and Verbenaceae followed by Combretaceae and Moraceae. Analysis of the data indicated that all the parts of the plants have been used for the treatment of the disease; however leaf is more frequently used (32%) followed by fruit and bark (15% each), root (11%), stem (6%), seed (5%), whole plant, rhizome, and aerial part (4% each), flower and bulb (2%) (Fig. 1).

Conclusion

Traditional system of treatments are now-a-days accepted all over the world as they are considered to be less toxic and free from side effects than the synthetic drugs (Dhanabal *et al.*, 2004). The medicinal plants have played a pivotal role for multinational drug industries and research institutes for the discovery biologically active compounds used as potential drugs. The information concised in the present revised article may be of immense help to drug manufacturers for further extensive scientific evaluation leading to novel herbal approach for management and control of *diabetes mellitus* in future.

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