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Euglenineae of Madhya Pradesh, India

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Abstract

The euglenoids alongwith water characteristics of sixty five water bodies of Morena, Gwalior, Shivpuri, Bhopal, Rewa, Pachmarhi, Panna, Bandhavgarh, Amarkantak and Ambikapur in Madhya Pradesh have been studies. Seventy six species were identified belonging to *Phacus*, *Trachelomonas*, *Euglena*, *Lepocinclis*, *Paranema* and *Strombomonas*. Generally, *Euglena* and *Phacus* appear first in the water bodies and there in an overlapping by *Trachelomonas* and *Lepocinclis*. Species such as *Euglena polymorpha*, *E. graciclis*, *E. viridis*, *E. proxima*, *Phacus meson*, *P. pyrum*, *P. Helicoidis*, *Trachelomonas armata*, *T. scabra* var. *longicaulia*. *T-superba* var. *swirenkiena* and *Lepocinclis ovum L. texta* were found in blooms in organically polluted waters with luxurient growth of macrovegetation. *Trachelomonas* and *Lepocinclis* were less frequent in lotic habitat.

Keywords: Physico-chemical characteristics, euglenoids, indicator species.

1. Introduction

The euglenoids are very fascinating but sensitive group of flagellated microorganisms. They occur in a variety of lotic and lentic environs ranging from pristine to polluted habitats. Not much attention has so far been paid on taxonomy and ecology of these organisms from Madhya Pradesh except for few casual references[1,9]. An attempt has, therefore been made presently to study the euglenoids inhabiting various waterbodies in this state.

2. Material and methods

The material was collected from sixty five waterbodies in morena, Gwalior, Shivpuri, Bhopal, Pachmarhi, Rewa, Panna, Bandhavgarh, Amankantak and Ambikapur in Madhya Pradesh thrice in a year extending over a period from 1985 to 1990 (Fig. 1; Table. 1). The samples were collected in Polyethylene bottles (1:1) and preserved in 5% formalin containing a few drops of glycerine. Simultaneously, water samples were also collected and analysed for various physico-chemical characteristics by following standard methods[10]. Identification of euglenoids was done with the help of standard books and research publications.

3. Results and discussion

The range of physico-chemical characteristics and distribution of euglenoid algae in various waterbodies in different locations in Madhya Pradesh has been given in table 2 and 3 respectively. The sensitivity of euglenoids towards physico-chemical characteristics of water makes them important indicators of water quality. In this study water temperature

Table 1
The location of water bodies surveyed

Place	Latitude	Longitude	Mean sea level	Water bodies
Morena	25° 15′ N	72° 22′ E	300 m	Saank river, Asaun river, Kuari river, Chambal river and water puddles.
Gwalior	26° 14′ N	78° 15′ E	205 m	Moti Jheel, Suraj kund, Rani tal, Chambal tal, Johar kund, Sawarkar sarovar, Matsya sarovar, Laxman talliya, Vivek nagar pond, Kalpi river, Tighra reservoir and Tekanpur lake and water puddles.
Shivpuri	25° 18′ N	77° 30′ E	464 m	Jadhav sagar, Chand pata lake (Sakhya sagar), Madhav lake, Chnatri tank and water puddles.
Bhopal	23° 16′ N	77° 25′ E	540–600 m	Bhoj wetland (Upper lake), Lower lake, Lendiya talab, Man sarovar, Motia talab and Munsi Hussain Khan ka talab
Pachmarhi	22° 28′ N	78° 26′ E	1067 m	Little fall, Big fall, Bhrant neer, Apsara Vihar, Pathar chata, Jambu deep, Lotus pool, Twynum pool and water puddles.
Rewa	24° 28′ N	82° 2′ E	318 m	Govind garh, Rani tal, Beehar river, Bicchiya river and water puddles.
Panna	24° 43′ N	80° 12′ E	427 E	Tal on Satna road, Tal behind Govt. College, Tal near bus stand and water puddles.
Bandhavgarh	23° 50′ N	81° 50′ E	823 m	Nala close to entry in National Park, Shesh Shaiya, Tank on Fort and water puddles.
Amarkantak	22° 38′ N	81° 40′ E	1065 m	Narmada origin place, Dugdh dhara, Kapil dhara, Old temple tank, Narmada water beel and water puddles.
Ambikapur	23° 6′ N	83° 9′ E	861 m	Joda Talab, Ring Talab, Mahamava talab, Majhli talab, Sagar talab, Bohri talab, Barage talab and water puddles.

fluctuated between 9°C and 37°C and thus the sampled waterbodies are categorised as oligothermal to euthermal[11]. Low multiplication rate of euglenoids in reported in waters having temperature below 25°C[12, 13]. However, the present study does not exhibit any such affinity as *Phacus curvicauda*, *P. meson*, *P. Orbicularis*, *P. orbicularis* var. *caudatuas*, *P. helikoides*, *Euglena acus*, *E. polymorpha* were noticed to be dominant during winter season (December, January) in Vivek Nagar pond at Gwalior and Jadhav Sagar at Shivpuri when water temperature was less than 14°C though these species have been found to thrive in summer (water temperature 39°C) as well.

In the present study, dissolved oxygen varied from 2.83 $mg.l^{-1}$ to 16.1 $mg.l^{-1}$ with higher concentration in shallow waterbodies. According to several workers oxygen deficiency promotes growth of euglenoids[13–15]. Some waterbodies though had good concentration of dissolved oxgyen (6.12 $mg.l^{-1}$ to 16.1 $mg.l^{-1}$) but supported blooms of euglenoids such as *Euglena acus*, *E. Polymorpha*, *Phacus meson*, *P. curvicauda*, *P. helikoides*, *P. orbicularis*, *P. orbicularis* var. *caudatus*, *P. acuminatus* in Vivek Nagar pond; *Trachelomonas horrida*, *T. armata* and *Lepocinclis texta* in Surajkund and *Euglena acus*, *E.*

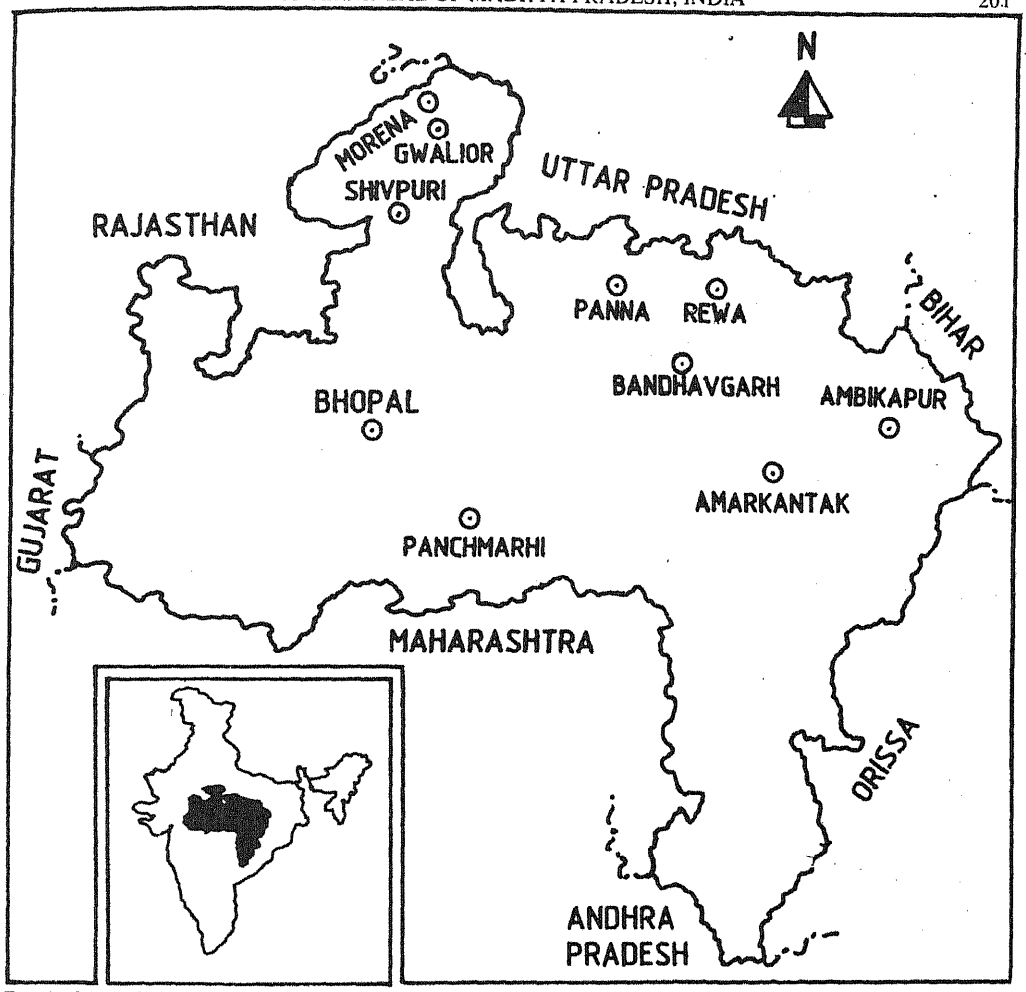

FIG. 1. Map of Madhya Pradesh showing location of sampling sites.

gracilis, *Phacus orbicularis*, *P. caudatus* and *Lepocinclis ovum* in Jadhav Sagar. Similar observations are on record in relation to certain euglenoids[16]. It was, however, noted that during summer and winter seasons in some waterbodies, water surface was covered by blooms of *Microcystis aeruginosa* and *M. flos-aquae* and angiosperms like *Lemna panci-costata*, *Spirodella polyrhiza* and *wolffia arrhiza*. Low photosynthetic activity due to their shading effect decreased the dissolved oxygen and increased the carbondioxide concentration. But during this period the euglenoids did not grow so very well (upto 384 org.l^{-1}), though increased concentration of carbondioxide has been shown to promote the growth of euglenoids[12,13,16,17].

All the waterbodies in Madhya Pradesh were found to be alkaline indicating greater photosynthetic activity except some waterbodies of Pachmarhi namely; Big fall, Twynum pool and pH-(6.0); Bhranteer and Pather chata (6.5) ; Apsara Vihar (6.7) and at Rewa, Govindgarth and (6,8) which had weakly acidic water. This may be due to the presence of

Table 2
Range of physico-chemical characteristics of certain water bodies in different district of Madhya Pradesh

Sampling stations	water temp.	conductivity	Dissolved oxygen	Free CO_2	Chemical oxygen demand	pH	Total alkalinity	Total hardness	Chloride	Calcium	Magnesium	Phosphate
Morena	21–16	198–396	8.9–13.8	Nil–13.9	8.0–48.0	7.0–8.2	104–214	106–144	59–114	23.2–35.3	11.7–18.5	.031–.060
Gwalior	10–35	66–1320	3.6–16.1	Nil–32.0	12.0–108.0	7.1–9.3	134–626	120–482	19–264	31.3–114.6	20.1–89.6	.031–5.6
Shivpuri	13–30	297–594	7.2–14.2	Nil–13.2	16.0–36.0	7.3–8.1	160–286	187–285	104–154	45.2–70.5	18.1–26.6	.46–.218
Bhopal	12–37	264–726	9.8–11.6	Nil–8.8	4.0–36.0	7.5–9.1	166–360	108–240	58–138	16.8–54.5	16.1–25.3	.098–.656
Pachmarhi	09–27	*	5.7–11.9	*	*	6.0–9.7	*	*	19–120	*	*	*
Rewa	21–32	120–480	10.1–12.9	6.6–26.4	4.0–40.0	6.8–8.3	30–222	30–254	59–86	15.9–52.9	11.7–20.1	.010–.350
Panna	10–31	330–726	7.3–13.8	Nil–2.9	24–56.0	7.1–8.4	150–214	150–234	89–167	48.9–84.9	5.31–6.81	.196–.535
Bandhavgarh	12–29	330–528	8.5–15.8	Nil–0.9	20–36.0	7.7–8.7	122–196	104–194	63–114	40.1–68.9	0.97–5.41	.050–.080
Amarkantak	10–34	198–330	8.9–13.4	Nil	8.0–48.0	8.3–8.6	84–142	108–126	42–70	20.0–33.7	14.2–10.2	.031–.070
Ambikapur	14–34	462–1254	6.4–8.7	Nil	24–48.0	7.7–9.0	160–344	234–400	133–228	67.3–115.4	16.1–27.3	.020–.045

All the values are in mg.l^{-1} except water temp. (°C) and conductivity (u S).
* = Not observed

Table 3
Distribution of Euglenoids in certain waterbodies of Madhya Pradesh

Euglenoid species	Morena (1)	Gwalior (2)	Shivpuri (3)	Bhopal (4)	Pachmarhi (5)	Rewa (6)	Panna (7)	Bandhavgarh (8)	Amarkantak (9)	Ambikapur (10)
Euglena sp.[1]	**	**	**	**	–	**	**	**	*	*
E. acus[1]	**	****	****	***	*	***	***	*	**	****
E. acus var. *rigida*	–	–	–	–	–	–	*	**	–	*
E. acus var. *robusta*	–	–	–	–	–	*	–	–	–	–
E. deses	–	–	–	–	–	**	*	–	–	–
E. elastica[1]	**	****	****	***	**	***	***	*	*	–
E. gracilis[1]	***	****	****	***	–	****	***	*	–	****
E. intermedia	–	–	****	***	*	***	****	**	–	–
E. limnophyla	–	*	**	–	–	*	–	–	–	–
E. Oxyuris[1]	–	***	*	*	***	*	***	*	*	–
E. Oxyuris var. *minor*	–	**	–	–	**	*	–	–	–	–
E. polymorpha	–	****	–	–	–	****	**	–	–	–
E. proxima	–	*	**	*	**	*	–	–	*	–
E. spirogyra[1]	–	*	*	–	–	–	–	*	**	–
E. sanguinea	–	**	–	–	–	–	–	–	–	–
E. tripteris	–	****	****	***	–	–	****	–	–	–
E. viridis	–	**	*	**	–	*	**	*	–	–
Phacus sp.	–	–	–	*	**	*	*	**	–	*
P. acuminatus	–	****	****	****	–	–	–	–	–	–
P. acuminatus var. *americana*	–	–	–	–	*	–	–	–	–	–
P. ankylonoton	–	**	–	–	–	*	**	–	–	–
P. anamolus	–	–	–	–	–	–	*	*	–	–
P. brachykentron	–	–	*	–	*	*	–	*	**	–
P. caudatus	–	*	**	**	–	–	*	–	–	*
P. curvicauda	*	****	****	***	*	***	****	**	*	****
P. epihippion	–	**	**	*	–	*	–	–	–	–
P. helikoides	–	****	****	–	–	****	***	–	–	–
P. inconspicuum	–	*	–	–	–	–	–	–	–	–
P. indicus	–	*	**	*	–	–	–	–	–	–
P. lemmermannii[1]	–	**	–	–	–	–	–	–	–	–
P. longicauda[1]	**	**	*	*	*	*	***	**	*	*
P. meson[1]	–	****	****	***	–	–	**	**	*	–
P. musculus	–	**	–	–	–	–	–	*	–	–
P. nordstedfii[1]	–	***	–	–	–	–	**	*	**	*
P. orbicularis[1]	*	****	****	***	–	****	–	–	–	–
P. orbicularis var. *caudatus*	–	****	–	–	–	–	****	*	–	–
P. onyx	–	**	–	–	–	–	–	–	–	–
P. pyrum	–	****	****	–	–	****	–	–	–	–

Euglenoidspecies	Morena (1)	Gwalior (2)	Shivpuri (3)	Bhopal (4)	Pachmarhi (5)	Rewa (6)	Panna (7)	Bandhavgarh (8)	Amarkantak (9)	Ambikapur (10)
P. pleuronectes	–	*	–	–	–	–	*	–	–	–
P. platalea	–	*	**	**	–	–	–	–	–	–
P. pseudoswirenkoi	–	**	–	–	–	–	–	–	–	–
P. quinquimarginatus	–	**	–	–	–	–	**	–	–	–
P. suecicus	–	–	–	–	–	–	*	–	–	–
P. tortus[1]	–	*	**	***	**	*	**	–	–	–
Trachelomonas sp.[1]	*	**	*	**	***	**	*	*	–	–
T. armata	–	****	****	–	–	****	***	**	–	–
T. armata var. *longispina*	–	–	–	–	*	–	*	–	–	–
T. charkowiensis	*	****	****	***	–	****	–	–	–	–
T. cylindrica	–	*	*	**	–	–	**	**	–	–
T. fluviatilis	–	*	–	–	–	–	–	–	–	–
T. fluviatilis var. *ragosa*	–	–	–	–	–	–	–	–	–	*
T. granulosa	–	**	–	–	*	*	*	*	–	–
T. hispida	*	*	**	–	–	–	*	–	–	–
T. hispida var. *coroneta*	–	***	–	–	–	–	**	–	–	–
T. hispida var. *punctata*	–	*	–	–	–	–	–	–	–	–
T. horrida	–	**	**	–	–	**	**	*	**	–
T. lacustris[1]	–	**	–	**	–	–	–	**	*	*
T. playfairii	–	*	–	–	–	–	–	–	–	–
T. rotunda	**	****	****	****	**	****	***	**	**	****
T. scabra var. *longicaulis*	–	–	–	–	–	*	–	–	–	–
T. superba	*	**	*	*	–	*	**	*	–	**
T. superba var. *spinosa*	–	–	*	–	–	–	–	–	–	–
T. superba var. *swirenkiana*	*	****	****	*	–	–	***	**	–	–
T. tombowika	–	*	–	–	–	**	–	–	–	–
T. varians	**	**	*	*	–	–	–	–	–	–
T. volvocina var. *punctata*	–	*	–	–	–	–	–	–	–	–
Lepocinclis sp.	–	**	*	**	–	*	**	–	–	–
L. acuta	–	*	***	–	*	–	–	–	–	–
L. fusiformis	–	*	*	**	–	*	*	**	–	*
L. fusiformis var. *major*	–	*	**	–	–	*	–	–	–	–
L. playfairiana	–	***	–	–	–	–	–	–	–	–
L. ovum	–	****	****	–	–	***	–	–	–	–
L. texta	–	****	–	–	–	–	–	–	–	–
L. sphanophila	–	–	*	–	–	–	–	–	–	–
Paranema sp.	–	**	–	–	–	*	*	–	–	–
Strombomonas sp.	–	–	–	–	–	–	*	–	–	*

1 = Present in running water system also; – = Absent; * = (<100 org.l^{-1}); ** = (<500 org.l^{-1}); *** = (<1000 org.l^{-1}); * = (>1000 org.l^{-1});

decaying vegetation as it increases the concentration of carbondioxide and thus decreases pH. Low pH is conductive to euglenoids growth 18,19. Our findings are however, not in agreement with the above workers because in above mentioned waters of Pachmarhi and Rewa with low p Hhad low population of euglenoids (376 org.l^{-1}) including Euglena acus, E. intermedia, E. limnophyla, E. elastica, Phacus ephippion, P. acuminatus, var. americana, P. brachykeniron, P. longicauda, P. curvicauda, Trachelomonas armata var. longispina, T. granulosa T. scabra var. longicollis, Lepocinclis sp., L. ovum and Paranema sp. (Table-3). In the present study , pH ranging between 7.0 to 9.3 seem to be suitable for euglenoids. Little fall at Pachmarhi water with pH 9.0 was an exception with scanty euglenoid population.

In the present study, chloride and chemical oxygen demand varied from 19 mg.l^{-1} to 264 mg.l^{-1} to 108 mg.l^{-1} respectively. Increased concentration of chloride indicates the beginning of eutrophication in waterbodies. It was found that both these parameters (chloride $r = 0.44$; chemical oxygen demand $r = 0.70$ influenced the growth of euglenoids signiificantly in the present investigation and in other reports as well[2, 12, 13, 16].

Phosphate is recognised as a key nutrient in the production of phytoplankton especially euglenoids. In the present study, phosphate content varied from 0.010 mg.l^{-1} to 5.6 mg. l^{-1} and the waterbodies under study can be scaled as mesotrophic to eutrophic following the scheme of Lee *et al*[20]. Higher concentration (> 0.045 mg.l^{-1}) of phosphate seem to be favourable for euglenoids especially *Euglena acus*, *E. polymorpha*, *E. gracilis*, *E. intermedia*, *E. tripteris*, *E. elastica*, *Phacus pyrum*, *P. helikoides*, *P. curvicauda*, *P. orbicularis*, *P. orbicularis* var. *caudatus*, *P. meson*, *P. acuminatus*, *Trachelomonas charkowiensis*, *T. armata*, *T. superba* var. *swirenkiana*, *T. rotunda*, *Lepocinclis ovum*, *L. texta* in the case of Vivek Nagar pond, Surajkund (Gwalior); Jadhav Sagar (Shivpuri); Ring talab (Ambikapur) and Ranital (Rewa). They develop in nutrient rich waters (Silicate > 6.0 mg.l^{-1}; Nitrate – > 0.04 mg.l^{-1}; phosphate > 0.045 mg.l^{-1}; calcium – > 35.6 mg.l^{-1}; Magnesium – > 9.4 mg.l^{-1}; Sodium > 21.5 mg.l^{-1}; Potassium – > 7.6 mg.l^{-1}) but with the growth of macrovegetation. Munawar[13] and Puttaiah and Somashekar[15] also found that increased concentration of phosphate is necessary for the growth of euglenoids. A positive correlation ($r = 0.91$; $r = 0.85$; $r = 0.40$) exists between phosphate, magnesium and calcium and euglenoid population in the present study.

Variation in the chemical composition of natural waters might be an important factor in regulating the composition, abundance and geographical and periodical distribution of phytoplankton[21]. Our data are also in agreement with the above consideration because the small to medium stagnant waterbodies with rich nutrients show the dominance of euglenoids. In all seventy six taxa were recorded which include seventeen species of *Euglena*; twenty seven species of *Phacus*; twenty two species of *Trachelomonas*; eight species of *Lepocinclis* and one species each of *Paranema* and *Strombomonas* (Table-3). As far as seasonal distribution of euglenoids is concerned the data suggests that late monsoon, late winter and summer season are favourable for the growth of euglenoid populations (Table-4). It was also noted that in lotic habitats *Trachelomonas*, *Lepocinclis*, *Paranema* and *Strombomonas* occur in less numbers as compared to their occurrence in lentic habitats. It may be due to the continuous flow of water.

Table 4
Mean value of Euglenoids during different season at various localities (org.l^{-1})

Locality	Euglenoids org.l^{-1}					
	Monsoon season		Winter season		Summer season	
	early	late	early	late	early	late
Morena	14132	21196	10780	9188	17203	13517
Gwalior	86630	202137	132800	68416	141004	120116
Shivpuri	20429	37939	17216	11968	29905	20783
Bhopal	65388	86676	64880	36496	76032	62208
Pachmarhi	29031	35481	29996	17620	43776	33024
Rewa	27280	46448	25344	20736	28753	26543
Panna	30413	54067	30640	23120	43499	30229
Bamdhavgarh	17634	25374	20964	11292	20766	19170
Amarkantak	12447	24161	13348	5724	30992	16688
Ambikarpur	41688	48936	35020	23348	43315	28877

The euglenoids appear to grow in waterbodies in a very precise sequence. *Euglena* and *Phacus* spp. are first to appear and there is an overlapping by the *Trachelomonas* and *Lepocinclis* spp. In the present study *Phacus meson*, *P. orbicularis*, *P. orbicularis* var. *caudatus*, *P. helikoides*, *Euglena polymorpha* and *Trachelomonas granulosa* in winter season; *P. pyrum*, *P. acuminatus*, *P. caudatus*, *E. viridis*, *E. gracilis*, *E. tripteris*, *E. elastica*, *T. hispida*, *T. charkowiensis*, *T. sphagnophila* in monsoon as well as in summer. *L. texta* in summer season but *E. acus*, *P. curvicauda* and *L. ovum* were observed during different seasons in blooms in different waterbodies.

Euglenoids have been investigated as possible indicators of water quality[22]. It was noted that no single species was present only in clean water though Palmer[22] has commented that *Euglena spirogyra* and *Phacus longicauda* are inhabitants of clean water. *E. acus*, *P. curvicauda* and *L. ovum* were observed during different seasons in blooms in different waterbodies.

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