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### FRESH WATER ALGAE OF BAREILLY (U.P.) INDIA

#### Iqbal Habib\* and U.K. Chaturvedi

Department of Botany, Government Degree College, Budaun – 243601.

Department of Botany, Bareilly College, Bareilly - 243005.

#### Abstract

22 taxa of different classes of algae have been dealt herewith. They were collected from several places situated in and around Bareilly district in Rohilkhand Division of Uttar Pradesh. All these taxa have been recorded for the first time from this part of state of India.

Keywords: Fresh Water Algae, Chlorophyceae, Phytomorphotaxonomy, Habitat.

#### INTRODUCTION

The present paper is part of a contemplated series on the Algae of Bareilly district (U.P.) which have been intensively studied by the authors for the last several years. With a view to further enrich our knowledge of algal flora of this state; the authors have collected the taxa from the banks of several rivers and ponds in and around Bareilly district.

Bareilly district is situated on 28.5°N latitude and 79.5°E longitude in the Rohilkhand Division of Uttar Pradesh. As the district is situated near the Terai Region and is surrounded by several rivers and ponds, therefore the climate of the area is very conducive for the luxurious growth of the algae. The forms recorded here are new additions to the algal flora of Bareilly district in Rohilkhand Division of Uttar Pradesh. This study will enrich our knowledge of algae growing in the country.

#### MATERIALS AND METHODS

Algal collections were made during November 2003 to October 2004 from several collecting points at fortnightly intervals. The samples were collected in polythene jars and preserved in 4% formalin for further study from fresh as well as preserved materials, camera-lucida diagrams have been drawn and photographs taken. The algal materials have been deposited in algal collections of the Botany Department, Government Degree College, Budaun (U.P.), India.

The identification was done from the standard floristic

accounts and monographs (Tiffany, 1930; Mishra, 1937; Singh, 1938; Iyenger, 1958, Randhawa, 1959; Goyal, 1964; Philipose, 1967; Rattan, 1968; Prasad and Dutta, 1970; Kant, 1975; Patel and Kumar, 1975; Sinha and Srivastava, 1980; Gonzalves, 1981; Prasad and Misra, 1985; Pandey and Habib 1987; Habib et al 1988a,b,c 1989, 1990, 2012; Shukla et al 1988 1989 a,b; Chaturvedi et al, 1990; Habib and Pandey, 1989, 1990 a, b, 1991; Habib, 1991 a,b,c, 1992, 1993; Pal and Santara, 1993; Kant and Gupta 1998; Misra and Srivastava, 2003; Das et al., 2009).

In all 22 taxa belonging to seven genera have been identified which are listed below, mentioning their occurrence and specimen number (Collection Number) within brackets.

#### SYSTEMATIC ACCOUNT OF THE TAXA

#### GENUS-SPIROGYRA LINK

#### Spirogyra hatillensis Transeau (Fig. 1, Plate 1)

Randhawa, 1959, p. 322, fig. 303.

Vegetative cells 115-132 x 105 – 408  $\mu$ m; 4 to 6 Chloroplast, Zygospores ellipsoid, 80-120 x 108 – 155 $\mu$ m; median spore wall brown, smooth. This is a new record for the country

Habitat: - In a pond near M.J.P. Rohilkhand University, Bareilly (BLY-112).

#### S. fennica Cedercreutz (Fig.2, Plate 1)

Randhawa, 1959, p. 389, fig. 445.

\*Corresponding Author: *iqbalhabib786786@gmail.com* MS received: September 3, 2012; Accepted: January 20, 2015 Vegetative cells 12-15 x 167  $\mu$ m; 1 Chloroplast, Zygospores ellipsoid, 20-28 x 48 - 50 $\mu$ m; median spore wall yellow brown, smooth.

Habitat: - In a pond near Dhopa Temple, Cantonment Area, Bareilly (BLY-119).

#### S. dubia Kuetzing (Fig. 3, Plate 1)

Randhawa, 1959, p. 382, fig. 317.

Vegetative cells 37-48.3 µm broad; 2-3 Chloroplast, Zygospores ellipsoid, 48-50 x 70 - 85µm; mesospore thick, smooth and brown.

Habitat: - In a pond near Trishul Airport, Bareilly (BLY-123).

#### S.ghosei Singh (Figs. 4&9, Plate 1)

Randhawa, 1959, p. 342, fig. 344 a-b.

Vegetative cells 100-102 x 348  $\mu$ m; 6-7 Chloroplast, Zygospores ovoid with rounded ends, 90 - 102 x 100 - 112  $\mu$ m; exospore thin reticulate, mesospore thick and brown and reticulate.

Habitat: - In a pond near IVRI, Izzatnagar, Bareilly (BLY-119).

#### S. submaxima Transeau (Fig.5, Plate 1)

Randhawa, 1959, p. 345, fig. 349 a-b. Vegetative cells 75-105 x 95-295 µm; with plane end walls, 6-8 Chloroplast, Zygospores lenticular, 75 - 100 x 55 – 65 µm; median spore wall brown, smooth. Habitat: - In a pond near Cantonment Shahjahanpur road, Bareilly (BLY-117).

#### S. irregularis Naegeli (Fig.7, Plate1)

Randhawa, 1959, p. 316, fig. 290.

Vegetative cells  $30 - 35 \times 60 - 220 \mu m$ ; 2-4 Chloroplast, Zygospores ellipsoid to cylindricellipsoid,  $30 - 34 \times 46 - 76 \mu m$ ; medium spore wall yellowish brown smooth.

Habitat: - In a pond near Bareilly Cantt. Area, Budaun Road, Bareilly (BLY-128).

*S. papulata* Jao (Fig. 8, Plate 1., Figs 2 & 6, Plate 3)

Randhawa, 1959, p. 312, fig. 205a-b.

Vegetative cells  $28 - 30 \times 60 - 166 \mu$ m; Chloroplast single 20-30 x 35-48 µm, median spore wall irregularly reticulate, golden yellow brown. This taxon is a new addition to Indian algal flora.

Habitat: - In a small ditches near river Nakatia, Shahjahanpur Road, Bareilly (BLY-113).

## S. chungkingensis Jao (Fig. 4, Plate 2., Fig. 8, Plate 4)

Randhawa, 1959, p. 330, fig. 318a-b.

Vegetative cells 20 - 24 x 84 - 168 µm; 3 Chloroplasts making 1 to 3 turns in the cells. Zygospores ellipsoid 35-39 x 54-68 µm; brownish and wrinkled.

Habitat: - In a pond near Bisalpur Road, river Nakatia, Bareilly (BLY-127).

#### S. margaritata Wollny (Figs. 7 & 9, Plate 2)

Randhawa, 1959, p. 326, fig. 312.

Vegetative cells 95 - 112 x 143 - 356 µm; 10-12 Chloroplast Zygospores ovoid, 90 - 110 x 145 + 185 µm; medium spore wall smooth brown.

Habitat: - In a pond near Pilibhit by pass Road, Bareilly (BLY-132).

#### S. aphanosculpta Skuja (Fig. 8, Plate 2)

Randhawa, 1959, p. 313, fig. 287a-b.

Vegetative cells 36 - 38 x 92–106.5  $\mu$ m; Chloroplastone, Zygospores ellipsoidal with more or less rounded ends, 40-42 x 60–63.8  $\mu$ m; medium spore wall yellow brown. This is being reported for the first time from India.

Habitat: - In a small pond near Saithal Tehsil, Bareilly (BLY-138).

#### S. westii Transeau (Figs.7&8, Plate 3)

Randhawa, 1959, p. 310, fig. 2789a-b.

Vegetative cells  $35 - 40 \times 68 - 148 \mu m$  with plane end walls; One Chloroplast, Zygospores ovoid, 56 x 85  $\mu$ m; medium spore wall finely wrinkled. This species is being reported for the first time from India.



(1). Spirogyra hatillensis Transeau, (2). Spirogyra fennica Cederereutz (3). Spirogyra dubia Kuetzing (4). Spirogyra ghosei Singh (5). Spirogyra submaxima Transeau (6). Zygnema pseudopectinatum Czurda (7). Spirogyra irregularis Naegeli (8). Spirogyra populate Jao (9). Spirogyra ghosei Singh



(1). Zygnemopsis quadrata Jao (2). Zygnema verrucosum Jao (3). Zygnemopsis quadrata Jao (4). Spirogyra chungkingensis Jao (5). Zygnemopsis quadrata Jao (6). Zygnema verrucosum Jao (7). Spirogyra margaritata Wollny (8). Spirogyra aphanosculpta Skuja (9). Spirogyra margaritata Wollny



(1). Scenedesmus quadricauda Meyen (Turpin) Breb. var. longispina G.M. Smith (2). Spirogyra papulata Jao (3). Zygnema pseudopectinatum Czurda (4). Pleurotaenium trabecular (Her.) Naeg. (5). Cosmarium nudum Turn. (6). Spirogyra papulata Jao (7). Spirogyra westii Transeau (8). Spirogyra westii Transeau (9). Pleurotaenium ehrenbergii (Breb.) De Bary var. undulatum Schaarschm.



(1). Spirogyra jatobae Transeau (2). Oedogonium maxicanum (Wittr.) Hirn. (3). Oedogonium amplum (Magn.et Wille) Tiffany (4). Oedogonium intermedium (Wittr.) Hirn. (5). Zygnema verrucosum Jao (6). Oedogonium intermedium (Wittr.) Hirn. (7). Oedogonium maxicanum (Wittr.) Hirn. (8). Spirogyra chungkingensis Jao (9). Oedogonium intermedium (Wittr.) Hirn.

Habitat: - In a small pond near M.J.P. Rohilkhand University, Bareilly (BLY-112).

#### S. jatobae Transeau (Fig. 1, Plate 4)

Randhawa, 1959, p. 377, fig. 417a-b.

Vegetative cells  $115 - 127 \times 105 - 180 \mu m$ , Chloroplast straight, Zygospores compressed spherical  $100 - 136 \times 70.85 \mu m$ ; medium wall yellow brown. This form is being reported for the first time from India.

Habitat: - In a small pond near Izzatnagar Road, Bareilly (BLY-142).

#### GENUS-ZYGNEMA TRANSEAU

Zygnema pseudopectinatum Czurda (Fig.6, Plate 1., Fig.3 , Plate 3)

Randhawa, 1959, p. 218, fig. 145q.

Vegetative cells  $20 - 28 \times 46 - 62 \mu m$ , Zygospores globose to ovoid,  $28 - 37.5 \times 38 41.5 \mu m$ ; medium spore wall brown thick reticulate. This alga is new record for India.

Habitat: - In a small pond near Trishul Airport road, Bareilly (BLY-142).

## Z. verrucosum Jao (Figs. 2 & 6, Plate 2; Fig. 5, Plate 4)

Randhawa, 1959, p. 222, fig. 153a,b.

Conjugation scalariform, Zygospores formed in the conjugating tubes, subglabose to ovoid  $32 - 37 \times 38 - 55 \mu$ m; outer spore wall smooth, yellow and densely granulate to vertucose.

Habitat: - In a small pond near M.J.P. Rohilkhand University, Bareilly (BLY-152).

#### GENUS-ZYGNEMOPS/S (SKUJA) TRANSEAU

## *Zygnemopsis quadrata* Jao (Figs. 1,3 &5, Plate 2)

Randhawa, 1959, p. 199, fig. 131.

Vegetative cells  $12 - 15 \times 25 - 28 \mu m$ , two chloroplasts, Zygospores in the conjugating tubes often extending into the gametangia, Zygospores compressed, ovoid outer wall smooth. Habitat: - In Dhopa Temple near Bareilly Cantt Area, Bareilly (BLY-111).

#### **GENUS-PLEUROTAENIUM NAEGELI**

## Pleurotaenium trabecular (Her.) Naeg. (Fig.4, Plate 3)

Agarkar and Agarkar, 1977, p. 25, fig. 4.

Long cell 39 – 45  $\mu m;$  lat. Cell 30 – 34  $\mu m;$  lat. Apex 23  $\mu m.$ 

Habitat: - Planktonic with other algae, near Nakatia river, Bareilly (BLY-162)

#### *P. ehrenbergii (Breb.)De Bary var. undulatum* Schaarschm. (Fig.9 , Plate 3)

Scott and Prescott, 1961, p.15, fig. 12, pl. 3.

Long cell 245µm; lat. Cell 20-22 µm; lat. Apex15µm.

Habitat: - Planktonic with other algae, fish pond near Izzatnagar, Bareilly (BLY-160).

#### GENUS-COSMARIUM CORDA

Cosmarium nudum (Turn.) Gutw. (Fig. 5, Plate 3)

Scott and Prescott, 1961, p. 63, figs. 1 & 2.

Cell 50-55  $\mu m$ ; broad and 45-50  $\mu m$ ; long isthmus 3-8  $\mu m$  wide

Habitat: - Planktonic with other algae, IVRI fish pond near Izatnagar, Bareilly (BLY-160).

#### GENUS-SCENEDESMUS MEYEN

Scenedesmus quadricauda var. longispina (Chodat) G.M. Smith (Fig. 1, Plate 3) Philipose, 1967, p. 285 fig. 187 b, c

Cell 2.5-5.5 µm; broad and 8.3-14.5 µm; long spines 7-9 µm long

Habitat: - Planktonic with other algae, in a fish pond near Izatnagar, Bareilly (BLY-160).

#### GENUS-OEDOGONIUM HIRN.

Oedogonium mexicanum (Wittrock) Hirn. (Fig. 2 Plate 4)

Gonzalves, 1981, p. 284 fig. 9. 163

The present alga resembles with the type description. The alga can be compared with *Oedogonium grande* (kuetz.) Hirn in its general appearance and in measurement. However, *Oedogonium mexicanum* is known to have characteristic cylindrical oogonia and their solitary occurrence.

Habitat: - Epiphytic on *Hydrilla and Ceratophyllum* sp. in river Nakatia, Bareilly (BLY-172).

## O. amplum (Magn. et Wille) Tiffany (Fig. 3, Plate 4)

Gonzalves, 1981, p. 249 fig. 9. 132

Vegetative cells 40–52 µm in diameter, 70-135 µm long; Oogonia ellipsoidal 80-92 µm; in diameter. Oospore spherical to ellipsoidal, 70-85µm in diameter.

Habitat: - Epiphytic on *Ceratophyllum* sp. in river Nakatia, Bareilly (BLY-170).

## O. intermedium (Wittr.) Hirn. (Figs. 4, 6 & 9, Plate 4)

Gonzalves, 1981, p. 168 fig. 9. 31A.

Vegetative cells 15–18  $\mu m$  in diameter, 35-75.5  $\mu m$  long;30-37.5  $\mu m$  in diameter Oospores20-35  $\mu m$  in diameter, 35-42  $\mu m$  long.

Habitat: - Epiphytic on *Hydrilla* sp in river Nakatia, Bareilly (BLY-171).

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### EFFECT OF TEMPERATURE AND BODY SIZE ON THE METABOLIC RATE OF ENDOTHERMS (*MUS MUSCULUS* – MOUSE) AND ECTOTHERMS (*HEMIDACTYLUS FRENATUS* – LIZARD)

#### **Rishan Singh**

School of Biological and Conservation Sciences, University of KwaZulu-Natal, Durban, South Africa, 4041

#### Abstract

An experiment was conducted to determine whether temperature and body size affects the metabolic rate of endotherms (mouse) and ectotherms (lizard). From the results obtained, it was deduced that the rate of oxygen consumption was higher in the mouse (endotherm) than in the lizard (ectotherm), and that these differences were attributed to their relative body size and mass. The differences attributed by mass were seen when the mass specific rate of oxygen consumption line graphs were obtained. These graphs revealed that an animal with a larger mass (mouse) would potentially consume more oxygen for metabolism compared to a smaller animal (lizard), since the smaller animal would require less oxygen for metabolism because its body temperature is affected (or influenced) by external temperature.

Keywords: Ectothermy, Endothermy, Behaviour, Tolerance.

#### INTRODUCTION

Ectotherms (or thermoconformers), by definition, are animals that are incapable of regulating their own body temperatures to a certain extent only because their body temperatures fluctuate with the surrounding environment temperature (Perissonotto, 2005). Lizards, for example, tend to burrow into the soil when the environmental temperature rises above the optimum during midday in order to prevent excessive heat loss (McFarland, 1985). Therefore, they maintain their body temperatures by moving away from unfavourable environments to preferred ones, where they can depend on the environment to insulate their bodies (Perissonotto, 2005). This behavioural or adaptation mechanism in response to body heat loss (or gain), is influenced by whether heat loss or gain occurs through conduction, convention, (solar) radiation or evaporation (Perisonotto, 2005). Behavioural responses in ectotherms, depend on changes in solar radiation in order to maintain their body temperatures (Hayes, 2010). It's thus known that the metabolic rate of ectotherms compared to endotherms, would be much lower since endotherms are independent on solar radiation for enhancing their ability to oxidise food for carbon dioxide and energy production. Endotherms, the thermoregulators as we have established, are so-named because of their inherent ability to regulate their body temperatures regardless of surrounding temperature fluctuations in localities they reside in (Farmer, 2003; Perissonotto, 2005). In Mice, for example, body temperature is maintained close to the upper lethal limit (i.e. the limit at which the likelihood of death is minimal) because uncontrolled heat dissipation is prevented by their high metabolic rates, which provides them with an additional internal source of energy (Perissinotto, 2005; Schmidt-Nielsen, 1997). Their first source of body insulation and energy is provided by their fur coverings.

Carbohydrates, proteins and fats are the source of fuels that animals consume to maintain a constant metabolic rate (Schmidt-Nielsen, 1997). Metabolic rate refers to the amount of energy (of fuel) that's used per unit in time by living (humans and animals) organisms to produce high energy molecules, such as Adenosine Triphosphate (ATP), and carbon dioxide through the oxidation of food (fuels) (Schmidt-Nielsen, 1997; Brown *et al.*, 2004). The amount of carbon dioxide dissipated during energy metabolism ultimately relies on the amount and type of food consumed (Schmidt-Nielson, 1997; Hayes, 2010). Furthermore, it has been found that the metabolic rate of an animal is influenced by

\*Corresponding Author: *rshnsingh1@webmail.co.za* MS received: January 14, 2014; Accepted: February 16, 2015

the amount of oxygen it consumes and its body size (Cohen et al., 1993; Schmidt-Nielsen, 1997). In small animals, for example, the large surface to volume ration causes more heat loss (and a lower thermal inertia) that's compensated for by an increased oxygen consumption to body size ration (Cohen et al., 1993; Boratynski and Koteja, 2009). In larger animals, the inverse relation has been reported. In animals with a wide temperature tolerance range, a rapid rate of oxygen consumption has been noted. Therefore, the rate of oxygen consumption by an animal can provide some insight about the animal's metabolic rate (Singh, personal deduction, 2015). However, as a point of note, some animals are independent of oxygen to metabolise food i.e. anaerobic animals (Mentel and Martin, 2010). These animals generate carbon dioxide independent of mitochondrial respiratory chain events by different terminal electron acceptors (e.g. fumerate forming succinate and propionate and the execution of acetate) being activated (Tilens et al., 2002; Tilens et al., 2010). Also, the different enzymes involved in oxidation differentiate anaerobic metabolism from aerobic metabolism by using mitosomes, hydrogenosomes and anaerobic mitochondria (Tilens et al., 2002; Atteia et al., 2006; Embley and Martin, 2006; Giezen, 2009).

In this study, two variables were investigated (i.e. body size vs. metabolic rate and temperature vs. metabolic rate) to analyse the metabolic rate of a mouse and lizard to varying temperatures. A comparison of the results obtained for the lizard and mouse were compared to each other to justify current findings about the effect an animal's body size could have on the rate of oxygen consumption, and thus metabolic rate. Although this type of work has been performed in other parts of the world, this paper reports findings of a study performed in a South African laboratory that conforms with the views of other zoologists.

#### MATERIALS AND METHODS

In this study, a mouse (40.4g; endotherm) and lizard (4.1g; ectotherm) were used (the use of these animals were ethically approved by the University of KwaZulu-Natal's Biological Sciences Department Co-ordinator in compliance with the rules of the university on the

use of animal subjects for research). The animals had been fasted for 6 hours prior to performing the experiment, so that the metabolic rate being measured was attributed to the temperature gradients instead of the breakdown of food and other biomolecules by the animals. The mouse and the lizard were weighed and thereafter placed in plastic containers which were sealed with a lid. The containers (volume noted in millilitres) initially had the same oxygen concentration as the room air and they were submerged (containing or with the animals) into the water bath at different temperatures (0, 15, 20, 25, 30, and 35 °C). Each submergence lasted for approximately 5 minutes. After 5 minutes had elapsed, a sample of ambient air was drawn slowly into the oxygen (using a syringe) analyser through a rubber tube. CO, was drawn into the oxygen analyser to quantitate the amount of O<sub>2</sub> consumed by the animals. The CO<sub>2</sub> was absorbed into the oxygen analyser by potassium hydroxide crystals and soda lime. A value was then displayed on the O<sub>2</sub> analyzer and this value is presented in the appendix. After a further 5 minutes, another air sample was drawn from the sealed chamber and injected into the O<sub>2</sub> analyzer. The value was thereafter recorded. The experiment was then repeated until six reading were obtained for each animal. The values obtained were recorded and 3 graphs were drawh. These graphs were: the volume of oxygen consumed by the animal vs. temperature, the rate of oxygen consumption vs. temperature and the mass specific rate vs. temperature. These graphs were used to explain the metabolic rate in relation to ectothermy and endothermy. For calculation purposes, it was assumed that 1g represents 1ml. Four calculations were made based on the results of the experiment. The following equations were used in the calculations for the lizard and the mouse and these calculations are duly referred to in the appendix. The equations, though, have been presented below:

The volume available in the container was calculated using:

Volume available in the container = Volume of container - volume of animal The volume of oxygen consumed by the animal:

Volume of  $O_2$  consumed by the animal = (initial value – final value / 100) × volume available in the container

The rate of oxygen consumed by the animal:

Rate of oxygen consumed = volume of oxygen in the container  $\times$  60/5  $\times$  1000

The mass specific rate:

Mass specific rate = rate of oxygen consumed / mass of the animal

#### RESULTS

As can be seen in Figure 1 (below), the mouse consumes less oxygen as the temperature increases from 0 °C to 20 °C. From 10 °C to 20 °C, oxygen consumption by the lizard is more or less constant. These differences are known to be attributed to the fact that endotherms require metabolic energy to maintain a constant body temperature against a thermal gradient (as mentioned) such as a temperature rise, whereas ectotherms conform to ambient temperature by means of their temporal behavioural patterns (as mentioned).



Figure 1: Volume of oxygen consumed (µl/g) by the mouse (endotherm) and lizard (ectotherm) in relation to changing temperatures.

From the relationship between oxygen consumption rate and temperature, it's evident from Figure 2 that the rate of oxygen consumed by the mouse was much higher overall, though a slight decline was observed at 20 °C, with some variation occurring thereafter. However, the rate of oxygen consumption at 10 °C for the lizard was 0 µl/h. All of the other readings for the lizard were extremely low compared to the mouse across the temperature gradient. This result proved that larger animals (i.e. mouse) consume oxygen at a faster rate compared to smaller ones.



Figure 2: The rate of oxygen consumption (µl/h) at increasing temperatures for the mouse (endotherm) and the lizard (ectotherm).

The relationship between mass specific rate of oxygen consumed and temperature changes in the mouse and lizard show some fluctuations as is shown in Figure 3 (below). The mass specific rate at 10 °C for the mouse was the highest, with the lowest reading being recorded at 20 °C. Similarly, the mass specific rate of oxygen consumed for the lizard was variable across the

temperature gradient beginning from 15 °C. At 10 °C, the lizard had a mass specific oxygen consumption rate of 0  $\mu$ l/h/g. This result proved that the mass specific rate of oxygen consumed was greater for the mouse than the lizard since mice generally have a larger mass than lizards do.



Figure 3: The mass specific rate of oxygen consumed verses temperature changes in the mouse (endotherm) and lizard (ectotherm).

#### DISCUSSION

The results obtained, highlight the process of adaptation evidently. The mouse was found to have a higher metabolic rate since, as it's known, an increased oxygen uptake increases its metabolic rate being an endotherm. This was in keeping with other studies performed in Germany, the United States of America, China and Scotland (read the article by Hayes (2010) and Speakman (2013)). The oxygen consumption of the mouse was found to be inconstant, as it is expected, since endotherms maintain a constant body temperature. However, with increasing temperature, the oxygen consumption by the mouse increased as well as decreased. This is evident from Figure 1. The volume of oxygen consumed for the mouse was greater than the lizard over a period of time. This was attributed to suggestions by Hayes (2010) who highlighted that ectotherms and endotherms interact with their environments in different ways.

Ectotherms, as mentioned, regulate their body temperatures to a limited extent only (Perissinotto, 2005), and that some lizards burrow into the sand during midday when the temperature reaches above the optimum (Schmidt-Nielson, 1997). This implies that true homeostasis occurs in endothermic animals such as in mice as they are able to regulate their own body temperatures (Schmidt-Nielson, 1997; Hayes, 2010). In Figure 1, the volume of oxygen consumed by the mouse between 10 and 20 °C decreased from 17.65173 µl/g to 7.4128 µl/g. This was probably attributed to the mouse being exposed to distressing environmental (temperature set point) conditions as is highlighted in Hayes (2010) and Speakman (2013). The mouse is a mammal, and therefore it requires a favourable habitat to perform metabolic processes optimally (Perissinotto, 2005). Due to temperature extremities, the enzymes controlling the metabolic rate in the mouse were probably less active, and hence reduced the speed of biochemical reactions (Singh, personal deduction, 2015). Between 20 °C and 25 °C, the volume of oxygen consumed by the mouse reached its peak. Therefore, this was the optimum temperature at which metabolic activity was at its best. It also indicated that the mouse had completely adapted to the new environment over time between these temperatures (Gillooly *et al.*, 2001). Between 30 °C and 35 °C, a slight levelling off in oxygen consumption was noticed in the mouse. This could have been due to the mouse conjuring calmness to the new temperature gradient in order to maintain its metabolic rate (Perissinotto, 2005).

Ectotherms are known to generate their body heat through metabolism (Schmidt-Nielson, 1997), and they require less energy to maintain their own body temperatures with elevated surrounding temperatures (Perissinotto, 2005). However, ectotherms still need to control heat loss (this is the only way for them to maintain a constant body temperature, Perissinotto, 2005) otherwise a heat loss may result in their metabolic rate decreasing as a result of some enzymes that control certain important metabolic processes becoming denatured and/or inactive (Singh, personal deduction, 2015). Heat loss through evaporation is one way by which endotherms regulate their metabolic rate so that their body temperatures, during increased surrounding temperatures, are maintained constant (Schmidt-Nielson, 1997; Hayes, 2010). It is commonly reported in the literature that an increase in temperature leads to an increase in metabolic activity, because of the high rate of oxygen consumption (Schmidt-Nielson, 1997). This was found to be indeed the case in the present study, and in those of the countries previously mentioned (read articles by Hayes (2010) and Speakman (2013)), and it was found to be to different extents (increases and decreases). This could have been due to experimental errors such as the time taken for the water bath to warm up to the desired temperature, the container (containing the animal) being opened and closed at different levels during each temperature reading, and improper sealing of the container with the lid prior and after air being injected into the oxygen chamber (Singh, personal deduction, 2015). The volume of oxygen consumed by the lizard at 10 °C was negative.

This value was recorded as 0 since negative volume of oxygen consumptions don't really exist. This implied that the lizard was not breathing at 10 °C. The maximum temperature at which the maximum oxygen was consumed by the mouse was between 20 °C and 25 °C. This means that at any higher temperatures, the rate of metabolism and thus oxygen consumption would probably decrease due to enzymes losing their biocatalytic properties (i.e. the point after the turning point) (Singh, personal deduction, 2015).

In figure 2, it can be observed that the rate of oxygen consumed is higher in the mouse than in the lizard. At 10 °C, the rate of oxygen consumption by the lizard was 0.000 µl/h. At this point, no oxygen was being consumed by the lizard. This could be due to external outliers and factors which include: people standing around the experimental container, shock of the animal due to the changing temperature of the environment (during the experiment shock or fright was observed in the mouse, particularly when it started producing faeces and urine in the container (Singh, personal deduction, 2015)). The decreased volume of oxygen consumption by the lizard between 10 °C and 20 °C (see figure 1) highlights this shock. Between 15 °C and 20 °C, the lizard began to consume oxygen and this indicated that the process of adaptation had been completed. Figures 1 and 2, show all the signs of ectothermy and endothermy and support the report by Hayes (2010).

In this study, it is evident that the mass of the animal affects the metabolic rate of the animal by influencing the amount of oxygen consumed by it (figure 3) (Speakman, 2013). The mouse has a larger body size and therefore, as confirmed by previous reports (Cohen, 1993; Boratynski and Koteja, 2009), it would have a higher metabolic rate compared to the lizard. This is attributed to the active uptake of oxygen at a much faster rate in the mouse than compared to the lizard (see Figures 2 and 3). It can therefore be concluded that temperature and metabolic rate in ectotherms and endotherms are affected by temperature and body size. This South African study therefore conforms with published literature on this topic.

#### APPENDIX

	Mouse		·\	Lizard	
Temperature in degrees celsius	Initial O <sub>2</sub> consumption	Final O <sub>2</sub> consumption	Temperature in degrees celsius	Initial O <sub>2</sub> consumption	Final O <sub>2</sub> consumption
10	26.05	22.24	10	27.63	27.66
15	25.36	22.32	15	27.60	27.55
20	26.40	24.80	20	27.82	27.77
25	26.10	23.22	25	27.85	27.72
30	27.59	25.27	30	27.81	27.76
35	27.14	24.93	35	26.50	26.34
Volume of cont	ainer = 503.7		Volume of con	tainer = 407.3	
Volume of anim	nal = 40.4		Volume of anir	nal = 4.1	
Volume availab	le = 463.3		Volume availal	ble = 403.2	

Table 1: Oxygen consumption values in the experiment as initial and final values for the mouse and lizard

## Table 2: Oxygen consumed by the lizard (ectotherm) and the mouse (endotherm) at different temperature gradients in $\mu$ l/g

Temperature in degree Celsius	Mouse	Lizard
10	17.65173	0.000
15	14.08432	0.2016
20	7.4128	0.2016
25	13.34304	0.52416
30	10.74856	0.2016
35	10.23893	0.64512

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## Table 3: Oxygen consumed by the lizard (ectotherm) and the mouse (endotherm) at different temperature gradients in $\mu$ I/g

Temperature in degree Celsius	Mouse	Lizard
10	211820.76	0.000
15	169011.84	2419.2
20	88953.6	2419.2
25	160116.48	6289.92
30	128982.72	2419.2
35	122867.16	7741.44

Table 4: Mass specific rate in  $\mu$ l/h/g in the lizard (ectotherm) and the mouse (endotherm) at different temperature gradients

Temperature in degree Celsius	Mouse	Lizard
10	5243.09	0.000
15	4183.46	590.05
20	2201.82	590.05
25	3963.28	1534.13
30	3192.64	590.05
35	3041.27	1888.16

#### **Mouse calculations**

#### Calculations for the volume of oxygen consumed at different temperatures

10 °C: Volume of oxygen consumed	=	(26.05-22.24/100) × 463.3
	=	17.65173 µl/g
15 °C: Volume of oxygen consumed	=	(25.36-22.32/100) × 463.3
	=	14.08432 µl/g
20 °C: Volume of oxygen consumed	=	(26.40-24.80/100) × 463.3
	=	7.4128 µl/g
25 °C: Volume of oxygen consumed	=	(26.10-23.22/100) × 463.3
	=	13.34304 µl/g
30 °C: Volume of oxygen consumed	=	(27.59-25.27/100) × 463.3
	=	10.74856 µl/g
35 °C: Volume of oxygen consumed	<b>z</b>	(27.14-24.93/100) × 463.3
,	=	10.23893 µl/g

### <u>Calculations for the rate of $O_2$ consumed at different temperatures</u>

10 °C: Rate of O <sub>2</sub> consumed	=	17.65173 × 60/5 × 1000
	=	211820.76 µl/h
15 °C: Rate of O <sub>2</sub> consumed	=	14.08432 × 60/5 × 1000
	. =	169011.84 µl/h
20 °C: Rate of O <sub>2</sub> consumed	= 、	7.4128 × 60/5 × 1000
	=	88953.6 µl/h
25 °C: Rate of O <sub>2</sub> consumed	=	13.34304 × 60/5 × 1000
	=	160116.48 µl/h
30 °C: Rate of O <sub>2</sub> consumed	=	10.74856 × 60/5 × 1000
	=	128982.72 µl/h
35 °C: Rate of O <sub>2</sub> consumed	=	10.23893 × 60/5 × 1000
	=	122867.16 µl/h

### Calculations for the mass specific rate at different temperatures

10 °C: Mass specific rate	=	211820/40.4
	=	5243.09 µl/h/g
15 °C: Mass specific rate	=	169011.84/40.4
	=	4183.46 µl/h/g
		,

20 °C: Mass specific rate	=	889.53.6/40.4
	=	2201.82 µl/h/g
25 °C: Mass specific rate	=	160116.48/40.4
	=	3963.28 µl/h/g
30 °C: Mass specific rate	=	128982.72/40.4
	=	3192.64 µl/h/g
35 °C: Mass specific rate	=	122867.16/40.4
	=	3041.27 µl/h/g

#### Lizard calculations

Calculations for the volume of oxygen consumed at different temperatures

10 °C: Volume of oxygen consumed	=	0 µl/g
15 °C: Volume of oxygen consumed	=	(27.60-57.55/100) × 463.3
	=	0.2016 µl/g
20 °C: Volume of oxygen consumed	=	(27.82-27.77/100) × 463.3
	=	0.2016 µl/g
25 °C: Volume of oxygen consumed	=	(27.85-27.72/100) × 463.3
	=	0.52416 µl/g
30 °C: Volume of oxygen consumed	=	(27.81-27.76/100) × 463.3
	=	0.2016 µl/g
35 °C: Volume of oxygen consumed	=	(26.50-26.34/100) × 463.3
	=	0.64512 µl/g

### <u>Calculations for the rate of $O_2$ consumed at different temperatures</u>

10 °C: Rate of O <sub>2</sub> consumed	=	0 × 60/5 × 1000
	=	0 µl/h
15 °C: Rate of $O_2$ consumed	=	0.2016 × 60/5 × 1000
	=	2419.2 μl/h
20 °C: Rate of O <sub>2</sub> consumed	=	0.2016 × 60/5 × 1000
	=	2419.2 μl/h
25 °C: Rate of O <sub>2</sub> consumed	=	0.52416 × 60/5 × 1000
	=	6289.92 µl/h
30 °C: Rate of O <sub>2</sub> consumed	=	0.2016 × 60/5 × 1000
	=	2419.2 µl/h
35 °C: Rate of O <sub>2</sub> consumed	=	0.64512 × 60/5 × 1000
	=	7741.44 µl/h

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#### Calculations for the mass specific rate at different temperatures

10 °C: Mass specific rate	=	0/40.4
	=	0 μl/h/g
15 °C: Mass specific rate	=	2419.2/4.1
	=	590.05 µl/h/g
20 °C: Mass specific rate	=	2419.2/4.1
	<b>—</b> •	590.05 μl/h/g
25 °C: Mass specific rate		6289.92/4.1
	=	1534.13 µl/h/g
30 °C: Mass specific rate	=	2419.2/4.1
	=	590.05 µl/h/g
35 °C: Mass specific rate	=	7741.44/4.1
	=	1888.16 µl/h/g

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### **DESMIDS FROM JHANSI (U.P.) INDIA**

#### Iqbal Habib

Department of Botany, Government Degree College, Budaun-243601, India

#### Abstract

The present communication deals with morphotaxonomic enumeration of twenty five taxa of Desmids were collected from around Jhansi of Uttar Pradesh State in India during the period 2011-2012. Notes on forms showing slight variations in morphological attributes have also been given. All these taxa have been recorded for the first time from this part of state.

Keyword: Desmids, Freshwater Algae, Habitat, Morphotaxonomy, Planktonic.

#### INTRODUCTION

Our knowledge regarding the occurrence and distribution of Desmids in India is inadequate. Ivengar and VimalaBai (1941), Suxena and Venkateswarlu (1968), Nurul Islam (1970), Agarkar and Agarkar (1973, 1977), Suxenaet al., (1973), Bharati and Bongale (1975), Prasad and Mehrotra (1977 a, b), Patel and Kumar (1979), Sinha and Srivastava (1980), Pandey and Pandey (1983),Prasad and Misra (1985,1992),Hegde(1986),Pandey and Habib (1987), Chaturvedi et. al (1987, 1990), Pandeyet al. (1988), Habib et. al. (1989 a, b, 2011), Pal and Santara (1990), Habib and Pandey (1990), Habib (1989, 1990, 1991 a,b ,1992a,b, 1993 a,b,c,d,1994, 1995, 1997,2007a,b,c,d,e,2009), Habib and Chaturvedi (1993, 1995, 1997, 2014), Misra and Srivastava (2003), Tripathi et.al.(2012) Habib and Barkha (2012) studied the Desmid flora from different parts of the country. The present communication enumerates twenty five taxa of Desmids collected from different localities situated in around Jhansi district of Uttar Pradesh.

#### MATERIALS AND METHODS

During the period 2011-2012 collections were made from several localities of Jhansi districtof UttarPradesh. The algal collections were keptin bottles and preserved in 4% formalin. Identificationsof differenttaxaaremostly based onstandard floristic accounts by West and West (1904-12), West et. al. (1922), Tiffany and Britton (1952), Scott and Prescott (1961), Croasdale and Gronblad (1964), Croasdale (1965), Gronblad andCroasdale

\*Corresponding Author: *iqbalhabib786786@gmail.com* MS received: October 19, 2012; Accepted: July 31, 2015 (1971), Croasdale and Scott (1976). The algal materials have been deposited in Algal Collection of the Botany Department, Government Degree College, Budaun (U.P.) where the taxa were actually studied. In all twenty five taxa belonging to family Desmidiaceae have been identified which are listed below mentioning their occurrence and Accession Number within brackets.

### SYSTEMATIC ENUMERATION AND DESCRIPTIONS

FAMILY - DESMIDIACEAE

- GENUS : Closterium Nitzsch
- 1. Closteriumgracile Breb. (Fig.5).

Scott and Prescott, 1961, pl. 2, fig. 16.

Cells 4-7  $\mu m$  broad, 115-130  $\mu m$  long, apices 2-4  $\mu m$  wide.

**HABITAT:** Planktonic in a small pond near Lalitpur Road, August, 2011 (JHS-73). The present taxon resembles the type but for smaller size.

2. C.lineatum Ehr. (Fig.4).

Croasdale and Gronblad, 1964, p. 157.

Cells 30-45 µm broad, 450 - 550 µm long, apices 4-7 µm wide **HABITAT**: Planktonic in a small pond near Karera Road, September, 2011 (JHS-15). The present taxon agrees well with the type but for the slightly broader cells.

3. C.lunula(Mull.) Nitzsch.var. massartii (Wildem.) Krieger (Fig.1).

Scott and Prescott, 1961, p. 12, pl. 1, fig. 29.

Cells 80-90 µm broad, 650 - 680 µm long, apices 10-12 µm wide

**HABITAT**: Planktonic in a small pond, near Khajraho Road, June, 2011(JHS-23). The present alga is slightly larger than the type.

4. C.parvulum Naeg.var. cornutum(Pluyf.) Krieger

Scott and Prescott, 1961, p. 13, pl. 2, fig. 9.

Cells 20-30  $\mu m$  broad, 120-125  $\mu m$  long, apices 4-6  $\mu m$  wide.

**HABITAT**: Planktonic in road-side ditches near SundarVihar colony, November, 2011(JHS-29). The present desmid resembles the type specimen but for smaller size.

#### GENUS : Pleurotenium Naegeli, 1849.

5. Pleuroteniumehrenbergii(Breb.) DeBary var. undulatumSchaarschm

Suxenaet al., 1973, p. 323, figs. 25-26.

Cells 20 - 22  $\mu m$  broad, 225 - 230  $\mu m$  long, apices 12-14  $\mu m$  wide.

**HABITAT**: Planktonic in a small pond near Elite Cinema Hall, September, 2011 (JHS-12). This is shorter form than the type in dimension.

#### GENUS – Euastrum Ehrenberg 1832.

6. EuastrumevolutumNordst. var. glaziovii(Boerg.) West et West.

Prasad and Mehrotra, 1977a, p. 344, fig. 4.

Cells 25-28  $\mu m$  broad, 40-44  $\mu m$  long, isthmus 5-6  $\mu m$  wide.

**HABITAT**: Planktonic in a small pond near DRM Office, February, 2011 (JHS-42). The present alga agrees well in all essential character with the type but for the slightly larger dimension.

#### GENUS – Cosmarium Corda 1834.

#### 7. Cosmariumbioculatum Breb.(Fig.2).

Suxena and Venkateswarlu, 1968 a, p. 33, figs. 25a,b.

Cells 16-18 µm broad, 14-16 µm long, isthmus 4-5 µm wide.

**HABITAT**: Planktonic in a small pond near, NCC, 56 UP Battalion, September, 2011 (JHS-65). The present desmid resembles the type species but for smaller size.

## 8. C. botrytis Menegh.var. gemmiferm (Breb.) Nordst.(Fig.6).

Croasdale, 1965, p. 316, pl. 6, fig. 1.

Cells 55-60 µm broad, 70-75 µm long, isthmus 15-18 µm wide.

**HABITAT**: Planktonic in road-side ditches near Railway Hospital, August, 2011 (JHS-79). The present taxon agrees well with the type but for the slightly broader cells.

#### 9. C. Conspersum Ralfs var. Scottii Croasdaleet Scott

Croasdaleet Scott 1976, p. 531, pl. 9, fig. 11.

Cells 50-55 µm broad, 60-65 µm long, isthmus 20-22 µm wide.

HABITAT: Planktonic in a small pond near Railway Junction, December, 2011 (JHS-99). This is a shorter form than the type.

#### 10. C. Difficle Lutkem (Fig.3).

Agarkar and Agarkar, 1977, p. 29, fig. 50.

Cells 18-20 µm broad, 30-32 µm long, isthmus 5-8 µm wide.

HABITAT: Planktonic in a small pond near Agrasen Public School, July, 2011 (JHS-08). The present alga is slightly broader from the type.

11. C. Globosum Bulnh.var. wollei West et West (Fig.8)

Scott and Prescott, 1961, p. 59, pl. 26, figs. 10-11.

Cells 25-28 µm broad, 30-33 µm long.

HABITAT: Planktonic in a small pond near, St. Marks School, July, 2011 (JHS-95). This is a larger form than the type in dimension.

12. C. Granatum Breb. var. Ocellatum West et West (Fig.9).

Prasad and Mehrotra, 1977b, p. 57, pl. 1, fig. 24.

Cells 25-30 µm broad, 40-43 µm long, isthmus 7-8 µm wide.

HABITAT: Planktonic in road-side ditches, near Railway Junction, August, 2011 (JHS-79). The present alga agrees well with the type but for the slightly broader cells.

#### 13. C. Impressulum Elfv.

Prasad and Mehrotra, 1977b, p. 58, pl. 2, fig. 61.

Cells 15-20 µm broad, 20-22 µm long, isthmus 4-5 µm wide.

HABITAT: Planktonic in a small pond, near Tender High School, July, 2011 (JHS-25). The present desmid agrees well with the type but for the slightly broader cells.

14. C. Lundellii Delp.var. corruptum(Turn.) West etWest (Fig.7).

Scott and Prescott, 1961, p. 61, pl. 5, fig. 9.

Cells 40-45 µm broad, 50-55 µm long, isthmus 10-13 µm wide.

- HABITAT: Planktonic in a small pond near HyderColony, August, 2011 (JHS-32). The present alga is slightly larger than the type.
- 15. C. Phaseolus Breb. var. Elevatum Nordst.

Agarkar and Agarkar, 1973, p. 13, pl. 6, fig. 66.

Cells 20-30 µm broad, 22-25 µm long, isthmus 3-5 µm wide.

**HABITAT**: Planktonic in a small pond near PWD Inspection Bungalow, August, 2011 (JHS-85). The present taxon agrees well with the type but for the slightly broader cells.

16. C. Platydesmium (Nordst.) Nordstet Schmidle

Gronblad and Croasdale, 1971, p. 16, pl. 6, fig. 79. Cells 40-45  $\mu$ m broad, 45-50  $\mu$ m long, isthmus 20-22  $\mu$ m wide.

**HABITAT**: Planktonic in a small pond near Modern Public School, July, 2011 (JHS-04). The present alga agrees well with the type in all essential characters but for having slightly broader cells.

#### 17. C. Punctulatum Breb. var. Seriatum Krieger

Gronblad and Croasdale, 1971, p. 17, pl. 7, fig. 97.

Cells 18-20 µm broad, 14-17 µm long, isthmus 5 -7 µm wide.

HABITAT: Planktonic in a small pond near Railway Junction, July, 2011 (JHS-78). The present taxon resembles the type specimen but for larger size.

## 18. C. Pyramidatum Breb.var. transitorium Heimerl(Fig.10).

Bharati and Bongale, 1975, p. 137, pl. 5, fig. 39.

Cells 38-42 µm broad, 85-95 µm long, isthmus 10-12 µm wide.



Fig.1 : Closteriumlunula (Mull.) Nitzsch.var.massartii (Wildem.) Krieger Fig.2: Cosmariumbioculatum Breb. Fig.3 : Cosmariumdifficle Lutkem Fig. 4 : Closteriumlineatum Ehr. Fig.5: Closteriumgracile Breb. Fig.6: Cosmarium botrytis Menegh.var. gemmiferm (Breb.) Nordst. Fig.7 : C. lundellii Delp.var. corruptum (Turn.) West et West Fig.8: Cosmariumglobosum Bulnh.var. wollei West et West Fig.9 : Cosmariumgranatum Breb. var. Ocellatum West et West Fig.10 : Cosmariumpyramidatum Breb.var. transitorium Heimerl

HABITAT: Planktonic in a small pond near Govt. Museum, July, 2011 (JHS-76). The present desmid resembles the type but for larger size.

#### 19. C. Quinarium Lund

Gronblad and Croasdale, 1971, p. 17, fig. 98.

Cells 23-27  $\mu m$  broad, 30-32  $\mu m$  long, isthmus 10-12  $\mu m$  wide.

**HABITAT**: Planktonic in a small pond, Sunder ViharColony, July, 2011 (JHS-27). This is a shorter form than the type in dimension.

#### 20. C. Sexanatum Gutw.

Prasad and Misra, 1985, p. 344, pl. 1, fig. 8.

Cells 45-48  $\mu m$  broad, 50-52  $\mu m$  long, isthmus 6 - 7  $\mu m$  wide.

**HABITAT**: Planktonic in a small pond near Raj Palace, October, 2011 (JHS-13). The present alga is slightly larger than the type.

#### 21. C. Subauriculatum West et West var. Bogoriense Bern.

Gronblad and Croasdale, 1971, p. 17, pl. 5, fig. 57.

Cells 45-52 µm broad, 48-52 µm long, isthmus 28-30 µm wide.

**HABITAT**: Planktonic in a small pond near BarwaSagar, August, 2011 (JHS-77). The present taxon resembles the type but for the larger cells.

#### 22. C. Trachyplerum Lund

Suxenaet al. 1973, p. 329, figs. 54a-c.

Cells 22-25  $\mu m$  broad, 30-32  $\mu m$  long, isthmus 4-6  $\mu m$  wide.

**HABITAT**: Planktonic in a small pond near Datia Road, September, 2011 (JHS-83). The present desmid is slightly broader from the type.

GENUS – Arthrodesmus Ehrenberg, 1838.

#### 23. Arthrodesmusconvergens Ehr.

Scott and Prescott, 1961, p. 74, pl. 34, figs. 8-10.

Cells 23-25 µm broad, 30-32.5 µm long, isthmus 5-7µm wide.

**HABITAT**: Planktonic in a small pond near Lohagarh Road, July, 2011 (JHS-91). The present alga is slightly broader from the type.

#### GENUS – StaurastrumMeyen

#### 24. Staurastrumbineanum Rabenh.

Prasad and Mehrotra, 1977b, p. 66, pl. 2, fig. 66.

Cells 42-45  $\mu m$  broad, 20-23  $\mu m$  long, isthmus 5-7  $\mu m$  wide.

HABITAT: Planktonic in small pond nearAmargarh Road, August, 2011(JHS-66). This is a shorter form than the type.

#### 25. S. Sebaldi Reinsch.

Prasad and Mehrotra, 1977b, p. 72, pl. 3, fig. 79.

Cells 28-30  $\mu m$  broad, 18-23  $\mu m$  long, isthmus 3-5  $\mu m$  wide.

**HABITAT**: Planktonic in a small pond near NivariRoad, August, 2011 (JHS-44). This is a shorter form than the type.

#### DISCUSSION

The author surveyed the area around Jhansi district in U.P. and during that time the author collected twenty five desmids taxabelonging to class Chlorophyceae and family Desmidiaceae. The present paper deals with the Desmid flora only which were collected in the year 2011-12. In the present study the author found the dimensions and measurements of the taxa slightly larger or in some cases smaller than the types shown in the standard monographs and other floristic accounts of authors. The author feels it is due to the edaphic conditions and conducive environment prevailing there. In fact the main purpose of the author is to survey the desmid flora

growing in the south eastern part of the country and to make Atlas of it through the publication of several research papers. Out of 25 taxa the genus *Cosmarium* with 16 species outnumbered other species while *Closterium* were next to it in their number. The taxa *Pleurotenium*, *Euastrum* and *Arthodesmus* were poor in distribution and were reported by one species each while *staurastrum* was found to have only two species.

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### MALE GENITALIC ATTRIBUTES OF FOUR TYPE SPECIES OF SUBFAMILY ENNOMINAE (LEPIDOPTERA: GEOMETRIDAE)

V. K. Walia\* and Sharanpreet

Department of Zoology, Panjab University, Chandigarh – 160014.

#### Abstract

Male genitalic attributes of four type species, namely Ascotis selenaria selenaria [Denis & Schiffermüller], Leptomiza calcearia calcearia (Walker), Mimomiza cruentaria cruentaria (Moore) and Petelia medardaria Herrich-Schäffer pertaining to subfamily Ennominae under family Geometridae of order Lepidoptera are described and illustrated in detail. Furthermore, generic characters of the genera dealt in the present paper have also been documented.

Key words: Geometridae, Ennominae, Type species, Sairighat, Male genitalia.

#### INTRODUCTION

As many as 151 species of family Geometridae under order Lepidoptera were collected from Sairighat (1540 msl, N31° 03.779' E077° 02.200') in the Indian state of Himachal Pradesh between April to October during 2000 to 2007. Out of these, 25 species are type species of their respective genera.

Present communication deals with detailed observations on the male external genitalia of four species out of these, namely Ascotis selenaria selenaria [Denis & Schiffermüller], Leptomiza calcearia calcearia (Walker), Mimomiza cruentaria cruentaria (Moore) and Petelia medardaria Herrich-Schäffer pertaining to subfamily Ennominae of family Geometridae.

Identification and nomenclature of these species have been confirmed from Indian repositories like F.R.I., Dehradun and I.A.R.I., New Delhi and relevant literature (Hampson, 1895; Holloway, 1993; Scoble, 1999). Terminology given by Klots (1956, 1970) has been followed for naming different male genitalic structures.

#### MATERIALS AND METHODS

The geometrid moths were collected by installing a light lure system at the forest rest house of Sairighat in Himachal Pradesh. The light lure system consisted of a white sheet measuring 3x2 meters, tied vertically between two poles and illuminated by two mercury lamps of 160 watts each. Collected geometrid moths

were killed in the killing bottles charged with ethyl acetate vapours. The killed moth specimens were stretched on a thermocol sheet. For dissecting male and female external genitalia, entire abdomen was gently separated and potashed in 10% KOH for 30-35 minutes in an oven kept at 55ÚC. Later on, each potashed abdomen was thoroughly washed and dissected in distilled water.

#### **RESULTS AND DISCUSSION**

#### Genus Ascotis Hübner

Hübner, [1825] 1816, Verz. Bekannter Schmett.: 313.

**Generic diagnosis:** Frons roughly scaled. Antennae of male serrate and fasciculate. Labial palpi slightly reaching beyond frons, roughly scaled, porrect. Forewing with fovea in male.  $R_1$ ,  $R_2$  from cell, free;  $R_3$ ,  $R_4 \& R_5$  stalked;  $Cu_1$  from before lower angle of cell. Hindwing with termen crenulate; Rs and  $Cu_1$  from before upper and lower angles of cell respectively. Hind tibiae dilated in male with a fold containing tuft of hair, bearing two pairs of spurs.

### Type-species: Geometra selenaria Denis & Schiffermüller

#### Ascotis selenaria selenaria [Denis & Schiffermüller]

Denis & Schiffermüller, 1775, *Ankündung syst. Werkes Schmett. Wienergegend*: 101, (*Geometra*).

**Male genitalia** (Fig. 1): Uncus dome-like; gnathos with median broadened part scobinate; tuba analis with subscaphium distinct; socii absent; tegumen broadly U-like, nearly equal to vinculum in size; valvae with costa sclerotised, dorso-distal half of valvae bearing strong backwardly directed setae; sacculus distinct, produced into an arm bearing 6-7 short and blunt spines at tip; coremata absent. Aedeagus (Fig. 2) somewhat slender, narrowed abruptly and pointed at distal end; vesica adorned with a large smooth margined sclerotised plate and a serrate margined plate; opening of ejaculatory duct latero-proximal.

Material examined: Sairighat N31° 03.779' E077° 02.200'; 1540 msl (Forest Rest House), Himachal Pradesh. 1컵, 9.iv.2002; 1컵, 10.iv.2002; 1컵, 8.vi.2002; 2컵컵, 2.viii.2002; 1컵, 3.viii.2002; 1컵, 17.viii.2002; 1컵, 4.vi.2003; 1컵, 6.vi.2003; 1컵, 9.vii.2007;1컵, 8.ix.2007.

#### Genus Leptomiza Warren

Warren, 1893, Proc. zool. Soc. Lond. 1893: 406.

**Generic diagnosis**: Frons with short frontal tuft; labial palpi long, reaching well beyond frontal tuft; 3<sup>rd</sup> segment porrect. Antennae minutely ciliated in male. Hind tibiae not dilated in male, both pairs of spurs present. Forewing with outer margin dentate at M<sub>1</sub> and M<sub>3</sub>; R<sub>1</sub>, R<sub>2</sub> free, from cell; R<sub>3</sub> to R<sub>5</sub> stalked from well before upper angle of cell; Cu<sub>1</sub> from before lower angle of cell. Hindwing with outer margin angled at M<sub>3</sub>; Rs and Cu<sub>1</sub> from before upper and lower angles of cell respectively.

#### Type-species: Hyperythra calcearia Walker

#### Leptomiza calcearia calcearia (Walker)

Walker, 1860, *List. Specimens lepid.Insects Colln Br. Mus.* **20**: 132, (*Hyperythra*).

Male genitalia (Fig. 3): Uncus sickle-shaped, strongly sclerotised, reaching beyond valvae; gnathos swollen medially, bearing three short spines; socii conelike, bluntly pointed at tip; tuba analis well-defined, with subscaphium moderately distinct; tegumen shorter than uncus; vinculum nearly twice as long as tegumen; juxta Y-like, distal ends of two arms adorned with long setae; transtilla moderately sclerotised; valvae simple; coremata present. Aedeagus (Fig. 4) slender, pointed distally; vesica adorned with patches of innumerable spines; opening of ejaculatory duct proximal.

Material examined: Sairighat N31° 03.779' E077° 02.200'; 1540 msl (Forest Rest House), Himachal Pradesh. 1ざ, 21.x.2000; 1ざ, 24.x.2000; 1ざ, 29.x.2000; 1ざ, 30.x.2000; 1ざ, 15.x.2001.

#### Genus Mimomiza Warren

Warren, 1894, Novit. zool. 1: 444.

**Generic diagnosis:** Frons roughly scaled, frontal tuft present; labial palpi rough scaled, reaching beyond frontal tuft; 3<sup>rd</sup> segment porrect. Antennae bipectinate in male to four-fifth length. Hind tibiae not dilated in male, with two pairs of spurs. Forewing with  $R_r$ ,  $R_2$ from cell, free;  $R_3$  to  $R_5$  stalked from before upper angle of cell; Cu<sub>1</sub> from before lower angle of cell. Hindwing with Rs and Cu<sub>1</sub> from before upper and lower angles of cell respectively.

#### Type-species: Cimicodes cruentaria Moore

Mimomiza cruentaria cruentaria (Moore)

Moore, 1868, *Proc. zool. Soc. Lond.* **1867(**3): 616, (*Cimicodes*).

**Male genitalia** (Fig. 5): Uncus hood-like, abruptly narrowed and pointed at tip; socii sparsely setose; gnathos beak-like, pointed; tuba analis well-defined; tegumen slightly shorter than uncus; transtilla strongly sclerotised; furca U-like, bearing long and strong thorn-like process on each side; valvae simple, its dorsal edge densely setose; coremata present. Aedeagus (Fig. 6) gradually narrowing to a point at distal end; vesica bearing numerous microscopic spines near distal end; opening of ejaculatory duct proximal.

Material examined: Sairighat N31° 03.779' E077° 02.200'; 1540 msl (Forest Rest House), Himachal Pradesh. 1ざ, 6.iv.2001; 1ざ, 5.x.2002; 2ざさ, 5.vi.2003; 1ぢ, 6.vi.2003.







Figs. 5-6: *Mimomiza cruentaria cruentaria* (Moore): 5 - Male genitalia (ventral view); 6 - Aedeagus; Figs. 7-8: *Petelia medardaria* Herrich-Schäffer: 7 - Male genitalia (ventral view); 8 - Aedeagus.
02.200'; 1540 msl (Forest Rest House), Himachal Pradesh. 1<sub>3</sub>, 6.iv.2001; 1<sub>3</sub>, 5.x.2002; 2<sub>33</sub>, 5.vi.2003; 1<sub>3</sub>, 6.vi.2003.

Genus Petelia Herrich-Schäffer

Herrich-Schäffer, 1855, Syst. Bearbeitung Schmett. Eur. 6: 109, 122.

**Generic diagnosis**: Frons rough scaled, with a frontal tuft; labial palpi reaching beyond frontal tuft;  $3^{rd}$  segment porrect. Antennae bipectinate upto two-third length in male. Fore tibiae with a long process and tuft of hair; hind tibiae not dilated in male, both pairs of spurs present. Forewing with R<sub>1</sub> from cell, free; R<sub>2</sub> to R<sub>5</sub> stalked from before upper angle of cell; Cu<sub>1</sub> from before lower angle of cell. Hindwing with Rs and Cu<sub>1</sub> from before upper and lower angles of cell respectively.

# Type-species: Petelia medardaria Herrich-Schäffer

#### Petelia medardaria Herrich-Schäffer

Herrich-Schäffer, [1856], Samml. Neuer oder wenig bekannter aussereur. Schmett. (1)1: (23-25): wrapper, pl. 94, fig. 534, (*Petelia*).

Male genitalia (Fig. 7): Uncus two-humped, its distal bent half densely setose on dorsal surface, tip curved and sharply pointed; socii small, setose; gnathos absent; juxta Y-like; valvae broad, simple; coremata present. Aedeagus (Fig. 8) slender; vesica with cornutus crown-like, also bearing innumerable denticles of variable sizes; opening of ejaculatory duct proximal.

**Material examined**: Sairighat N31° 03.779' E077° 02.200'; 1540 msl (Forest Rest House), Himachal Pradesh. 233, 30.x.2000; 13, 18.viii.2001; 13, 15.ix.2001; 13, 23.ix.2003; 13, 24.ix.2003; 13, 3.ix.2005; 13, 5.ix.2005; 13, 5.ix.2007.

# DISCUSSION

Male external genitalia of four species of subfamily Ennominae belonging to family Geometridae showed characteristic shape of various component parts and even absence or presence of few structures. For example, uncus was dome-like in Ascotis selenaria selenaria [Denis & Schiffermüller], sickle-shaped in Leptomiza calcearia calcearia (Walker), hood-like in Mimomiza cruentaria cruentaria (Moore) and twohumped in Petelia medardaria Herrich-Schäffer. Likewise, gnathos was present in Ascotis selenaria selenaria [Denis & Schiffermüller], Leptomiza calcearia calcearia (Walker) and Mimomiza cruentaria cruentaria (Moore) and absent in Petelia medardaria Herrich-Schäffer. It was on this ground that Pierce (1914) divided family Geometridae into division Gnathoi and Agnathoi. These attributes can be incorporated in the revised characterization of various genera.

Abbreviations used in figures-: AED = aedeagus; COR = coremata; CRN = cornutus; DU. EJ = ductus ejaculatorius; FUR = furca; GN = gnathos; msI = meters above sea level; SOC = socius; TG = tegumen; TU. AN = tuba analis; UN = uncus; VIN = vinculum; VLV = valva.

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# A SYSTEMATIC ACCOUNT OF CHLOROCOCCALES FROM MEERUT

Iqbal Habib

Department of Botany, Government Degree College, Budaun - 243601, India

## Abstract

The present communication deals with morphotaxonomic enumeration of thirty two taxa of chlorococcalean algae collected from different localities situated in and around Meerut district of Uttar Pradesh state during 2011-2012. Notes on forms showing slight variations in their morphological attributes have also been given. All these taxa are being recorded for the first time from this part of state of India.

Key words: Fresh water, Algae, Chlorophyceae Chlorococcales, Morphotaxonomy.

# INTRODUCTION

Considering the vastness of the country, our knowledge concerning the occurrence and distribution of chlorococcales in India is meagre. Biswas (1949); Bharati (1962); Philipose (1967); Patel (1970); Laal (1976); Patel and Isabella (1977, 1980); Shashi and Anand (1978); Sinha and Srivastava (1980); Patel et al. (1980); Pandey et al. (1983); Pandey and Gangwar (1986); Prasad et al. (1986); Patel and Daniel (1990); Mathur and Pathak (1990); Srivastava and Odhwani (1990); Prasad and Misra (1992); Jose and Patel (1992); Habib (1991, 1997, 2007a, b, 2010, 2013); Chaturvedi and Habib (1996); Habib et al. (1998); Habib and Chaturvedi (2009); Misra et al (2009); Habib and Barkha (2011, 2013a,b) Tripathi et al (2013) studied the chlorococcales from different parts of the country. During the course of present study on algal flora of Meerut, a number of taxa of chlorococcales have been collected and are presented in this communication. In all thirty two taxa are being described morphotaxonomically.

## MATERIALS AND METHODS

Algal collections were made during 2011-2012 from freshwater bodies in and around Meerut district of Uttar Pradesh. The algae growing in nature were collected in polythene bottles and preserved in 4% formalin. The algal materials were studied from fresh as well as preserved materials. Identifications are mostly based on monographic or floristic account by Tiffany and Britton (1962); Prescott (1962) and Philipose (1967). The numbers in brackets at the end of description of each taxon indicate the code number of the materials deposited at Department of Botany, Government Degree College, Budaun (U.P.), where the taxa were actually studied. In all thirty two taxa belonging to order chlorococcales have been identified which are listed below mentioning their occurrence and accession number within brackets.

#### SYSTEMATIC DESCRIPTIONS OF THE TAXA

CLASS : CHLOROPHYCEAE

ORDER : CHLOROCOCCALES

FAMILY : CHLOROCOCCACEAE

# GENUS : CHLOROCOCCUM MENEGHINI EMEND STARR

Chlorococcum infusinum (Schrank) Meneghini (Fig.2)

Philipose, 1967, p. 73, fig. 1.

Cells spherical, solitary or in irregular colonies Chloroplast a hollows spherical with a notch on one side with a single pyrenoid. Diameter of the cells 14-20  $\mu$ m.

HABITAT : Planktonic in road side ditches near

\*Corresponding Author: *iqbalhabib786786@gmail.com* MS received: September 17, 2012; Accepted: September 9, 2015 Telephone Exchange, Shastri Nagar, November 2011 (MRT-74). This is a shorter form the type in diamension.

# FAMILY: CHLOROCOCCACEAE

# **GENUS: TREBOUXIA PUYMALY**

# Trebouxia humicola (Treboux) West et Fritsch

Philipose, 1967; p. 75, fig. 4.

Cells spherical, cellwall thin, chloroplast completely filling the cell and with wrinkled margin, pyrenoid one, central nucleus one cells 25-30 µm in diameter.

**HABITAT**: Planktonic in a small pond near Forest Department, Civil Lines, August 2011 (MRT-87). The present algae is slightly smaller than the type.

# FAMILY: CHLOROCOCCACEAE

# **GENUS : CHARACIUM BRAUN EX KUETZING**

# Characium nasutum Rabenhorst (Fig.14).

Philipose, 1967, p. 83, fig. 6.

Cells 16-18 µm broad and 25-30 µm long

HABITAT: Planktonic in small pond near Roadways, Sohrab Gate, July 2011 (MRT-77). The present desmid is slightly broader from the type.

# FAMILY: CHLOROCOCCACEAE

# GENUS:KORSHIKOVIELLA SILVA

# Korshikoviella gracilipes (Lambert) Silva (Fig.7).

Philipose, 1967, p. 88, fig. 16.

Cells 8-10 µm broad, 20-25 µm long

**HABITAT**: Planktonic with other algae near Mandi Samiti, Delhi Road, April 2011 (MRT-16). The present taxon resembles the type but for the larger cells.

# FAMILY: CHLOROCOCCACEAE

GENUS: DICANTHUS KORSH

# Diacanthos belenophorus Korsh (Fig.8).

Korshikov, 1951, p. 263, fig. 217.

Cells 3-6  $\mu m$  broad and 28-30  $\mu m$  long; Spines 3-6  $\mu m$  long

HABITAT: Planktonic in a roadside pools, near Avas Vikas Colony, Shastri Nagar, Garh Road, March 2011 (MRT-26). This is a shorter form than the type.

# FAMILY: CHLOROCOCCACEAE

# **GENUS: SCHROEDERIA LEMMERMANN**

Schroederia indica Philipose (Fig.4).

Philipose 1967, p. 90, figs. 19a-e.

Cells 3-6  $\mu m$  broad and 30-33  $\mu m$  long; spines 6.5  $\mu m$  long

**HABITAT**: Planktonic in a pond near District Hospital, Ahmad Road Ghanta Ghar, July 2011 (MRT-85). The present taxon is slightly larger than the type.

# FAMILY: MICRACTINICEACE

# GENUS: GOLENKINIA CHODAT

# Gloenkinia radiata Chodat

Philipose, 1967, p. 102, fig. 27.

Cells spherical, cell membrane covered with numerous long bristle, chloroplast cup-shaped with a single pyrenoid. Cells 12-15  $\mu$ m broad. Bristles 20-25  $\mu$ m long.

**HABITAT**: Planktonic in a small pond near Court Road, Civil Lines, October 2011 (MRT-92). The present alga agrees well within the type but for the slightly broader cells.

# FAMILY: HYDRODICFYACEAE

GENUS : PEDIASTRUM MEYEN

Pediastrum duplex Meyen

Philipose, 1967, p. 121-122, fig. 43a,b.

Cells 12-14 µm broad, 13-16 µm long.

**HABITAT**: Planktonic in a small pond near GIC, Khoonipul, April 2012 (MRT-96). This is a shorter form than the type.

# P. ovatum (Ehr.) A. Braun

Philipose, 1967, p. 115-116, fig. 37.

Cells 12-15 µm broad and 15-18 µm long.

**HABITAT**: Planktonic in a small pond near Vikas Bhawan, Civil Lines, May 2012 (MRT-99). The present taxon is slightly broader from the type.

# P. simplex Meyen var. duodenarium (Bailey) Rebenhorst

Philipose, 1967, p. 115, fig. 36 g.

Cells 9-10 µm broad and 20-23 µm long

**HABITAT**: Planktonic in a small pond near PWD colony, Civil Lines, January 2012 (MRT-97). The present taxon agrees well with the type but for the slightly broader cells.

# P. tetras (Ehr.) Ralfs (Fig.11&13).

Philipose, 1967, p. 128, fig. 45a-c.

Cells 10-12 µm broad and 15-18 µm long.

HABITAT: Planktonic in a small pond near ADM Colony, October 2011 (MRT-5). This is a shorter form than the type.

# FAMILY : HYDRODICFYACEAE

# GENUS: SORASTRUM KUETZING

# Sorastrum spinulosum Naegeli (Fig.6)

Philipose, 1967, p. 132-133, fig. 47.

Cells 8-10 µm in diameter, 20-22 µm long, spines, 2-4 µm long.

**HABITAT**: Planktonic with other algae near Meerut College, June 2011 (MRT-13). The present taxon agrees well with the type but for the slightly broader cells.

# FAMILY : HYDRODICFYACEAE

# **GENUS: HYDRODICTYON ROTH**

# Hydrodictyon reticulatum (Linn.) Lagerheim (Fig.17).

Philipose, 1967, p. 134, fig. 48.

Cells 170-180  $\mu m$  broad and 1-2  $\mu m$  long; nets up to 20 cm long

**HABITAT**: Planktonic in a small pond near Telephone Exchange, Civil Lines, December 2011 (MRT-15). The present taxon agrees well in all essential characters with the type but for the slightly larger dimensions.

# GENUS : TETRAEDRON (A.BRAUN) HANSGIRG

# Tetraedron muticum (A. Braun) Hansgirg

Philipose, 1967, p. 137, fig. 51.

Cells 7.5-21.5 µm in diameter

HABITAT: Planktonic in a small pond near DM Office Road, Civil Lines, November 2011 (MRT-27). The present alga resembles the type but for smaller size.

## T. regulare Kuetz

Philipose, 1967, p. 145, figs. 60a-d,f.

Cells 28-30 µm in diameter. Spines 4-6 µm long

**HABITAT**: Planktonic in a small pond near LIC Office, Saket, September 2011 (MRT-37). The is a longer form than the type.

# T. gracile (Reinsch.) Hansgirg

Philipose, 1967, p. 154, figs. 69a-c.

Cells with processes, 30-35  $\mu m$  in diameter, without processes 15-2  $\mu m$  in diameter.

#### HABIB

**HABITAT**: Planktonic in a small pond near Avas Vikas Colony, Shastri Nagar November 2011 (MRT-49). This is a shorter form than the type.

# SUBFAMILY : TETRAEDRONOIDEAE

# GENUS : POLYDRIOPSIS SCMIDLE

# Polydriopsis spinulosa (Schm.) Schmidle (Fig.5).

Philipose, 1967, p. 164, fig. 78c.

Cells solitary, tenagenal to cruciate with 5 angles, sides of cells usually concave cells without spines  $20-25 \,\mu m$  in diameter. Spines  $20-32 \,\mu m$  long. Chloroplast parital with a single pyrenoid.

**HABITAT**: Planktonic in a small pond near Avas Vikas Colony, Shastri Nagar, December 2011 (MRT-63). This is a shorter alga than the type in dimension.

# SUBFAMILY: OOCYSTOIDEAE

# **GENUS: OOCYSTICS NAEGELI**

# Oocystis pusila Hansgirg var. minor Skuja

Philipose, 1967, p. 184, fig. 97.

Cells much larger than in the type, measuring 8-10  $\mu m$  broad and 15-18  $\mu m$  long.

**HABITAT**: Planktonic in a pond near Forest Department, Civil Lines, September 2011 (MRT-83). The present taxon agrees well with the type but for the slightly broader cells.

# O. gigas Aros

Philipose, 1967, p. 183, fig. 94a.

Cells 30-35 µm broad and 40-46 µm long.

**HABITAT**: Planktonic in a pond near Vikas Bhawan, Civil Lines, March 2011 (MRT-32). This is a larger form than the type.

## GENUS: GLAUCOCYST/S ITZIGSOHN

Glaucocystis cingulata Bohlin

Philipose, 1967, p. 188, fig. 102a.

Cells 15-20  $\mu m$  broad and 25-45  $\mu m$  long

**HABITAT**: Planktonic in a small pond near LIC Office, Civil Lines, February 2012 (MRT-72). This is a shorter form than the type.

# GENUS: BOTRYOCOCCUS WEST & WEST

# Botryococcus protuberana west & west (Fig.15)

Philipose, 1967, p. 1197, fig. 109.

Cells 8.5-12.5 µm broad and 12.5-18.5µm long, Colonies 48-85µm in diameter.

**HABITAT**: Planktonic in a small pond near Forest Department, Civil Lines, October 2011 (MRT-100). The present taxon agrees well with the type but for the slightly broader cells.

# GENUS : NEPHROCYTIUM NAEGELI

# Nephrocytium Iunatum W. West (Fig.9).

Philipose, 1967, p. 189, fig. 103.

Cells 4-6 µm broad and 17-19 µm long.

HABITAT: Planktonic in road-side ditches near Bus Stand, Sohrab Gate, March 2012 (MRT-98). The present alga is slightly broader from the type.

## N. agardhianum Naegeli

Philipose, 1967, p. 189, fig. 104.

Cells 5-8 µm broad and 26-28 µm long.

**HABITAT**: Planktonic in a small pond, near Avas Vikas Colony, Shastri Nagar, December 2011 (MRT-66). This is a larger form than the type in dimension.

## N. obesum West et West

Philipose, 1967, p. 191, fig. 106.

Cells 20-27 µm broad and 30-35 µm long.

HABITAT: Planktonic in a small pond near Forest



Fig.1: Dimorphococcus lunatus A. Braun Fig.2: Chlorococcum infusinum (Schrank) Meneghini Fig.3: Tetrastrum elegans Playf Fig.4: Schroederia indica Philipose Fig.5: Polydriopsis spinulosa (Schm.) Schmidle Fig.6: Sorastrum spinulosum Naegeli Fig.7: Korshikoviella gracilipes (Lambert) Silva Fig.8: Diacanthos belenophorus Korsh Fig.9: Nephrocytium lunatum W. West Fig.10&16: S. dimorphus (Turp.) Kuetz f. tortus smith Fig.11&13: P. tetras (Ehr.) Ralfs Fig.12: Scenedesmus armatus (Chodat) Smith var. bicaudatus (Guglielmetti) Chodat Fig.14: Characium nasutum Rabenhorst Fig.15: Botryococcus protuberana west & west Fig.17: Hydrodictyon reticulatum (Linn.) Lagerheim Fig.18: S. quadricauda (Turpin) Breb.

HABIB

Department, Civil Lines, September 2011 (MRT-17). The present taxon is slightly broader than the type.

# FAMILY : DICTYOSPHAERIACEAE

# GENUS: DIMORPHOCOCCUS A. BRAUN

# Dimorphococcus lunatus A. Braun (Fig.1)

Philipose, 1967, p. 205, figs. 115a,b.

Cells 8-12 µm broad and 12-18 µm long.

**HABITAT**: Planktonic in a small pond near Avas Vikas Colony, Ghanta Ghar, December 2011 (MRT-81). The present alga is slightly broader than the type.

# FAMILY: SELENASTRACEAE

# **GENUS: SELENASTRUM REINSCH**

# Selenastrum bibraianum Reinsch

Philipose, 1967, p. 219, fig. 127.

Cells 5-8 µm broad and 30-32 µm long

**HABITAT**: Planktonic in a small pond near Telephone Exchange, Shastri Nagar, November 2011 (MRT-100). This is a shorter form than the type.

# FAMILY: COELASTRACEAE

# GENUS: COELASTRUM NAEGELI

# Coelastrum microporum Naegeli

Philipose, 1967, p. 228, fig. 135.

Cells 4-6 µm in diameter

**HABITAT**: Planktonic in a small pond near Meerut College, Civil Lines, September 2011 (MRT-53). The present taxon is slightly broader than the type.

FAMILY: SCEENEDESMACEAE

SUBFAMILY: CRUCIGENIOIDEAE

**GENUS: CRUCIGENIA MORREN** 

# Crucigenia quadrata Morren

Philipose, 1967, p. 241, fig. 152.

Cells 3-5 µm in diameter.

**HABITAT**: Planktonic in a small pond near Forest Department, Civil Lines, March 2012 (MRT-98). The present taxon agrees well with the type in all essential characters but for having slightly broader cells.

# GENUS : TETRASTRUM Playf.

Tetrastrum elegans Playf (Fig.3).

Patel et al. 1980, p.85.

Cells 6-8 µm in diameter, Seta 15-18µm long.

HABITAT: Planktonic in a small pond near Meerut College, Civil Lines, September 2011 (MRT-53). The present alga is slightly larger than the type.

# FAMILY: SCEENEDESMACEAE

# SUBFAMILY: SCNEDESMOIDEAE

GENUS: SCENEDESMUS MEYEN

# Scenedesmus armatus (Chodat) Smith var. bicaudatus (Guglielmetti) Chodat (Fig.12)

Philipose, 1967, p. 262, figs. 171 d,f,m.

Cells 2-6  $\mu m$  broad and 8-10  $\mu m$  long, spines 5-8  $\mu m$  long

HABITAT: Planktonic in a road side ditches near GGIC Road, Chhota Mawana, December 2011 (MRT-4). This is a larger form than the type.

# S. dimorphus (Turp.) Kuetz f. tortus smith (Fig.10&16)

Philipose, 1967, p. 219, figs. 160a-c.

Cells 2-5 µm broad and 25-28 µm long

HABITAT: Planktonic in a road-side ditches near Bus

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stand, Sohrab Gate, January 2012 (MRT-69). The present taxon resembles the type but for smaller size.

#### S. quadricauda (Turpin) Breb. (Fig.18).

Philipose, 1967, p. 251, fig. 160d.

Cells 3-5 µm broad and 26-30 µm long.

**HABITAT**: Planktonic in a small pond near Forest Department, Civil Lines, July 2011 (MRT-39). The present taxon agrees well with the type in all essential characters but for slightly broader cells.

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#### DISCUSSION

The author surveyed the area around Meerut district in U.P. and during that time the author collected 30 chlorococcalean taxa belonging to order Chlorococcalean flora only which were collected in the chlorococcalean flora only which were collected in the year 2011-12. In the present study the author found the dimensions and measurement of the taxa slightly larger or in some cases smaller than the typed shown in the standard monographs and other floristic accounts of authors. The author feels it is due to the edaphic condition and conducive environment prevailing there in face the main purpose of the western part of the publication of several research papers.

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# DETECTION OF TIN(II) WITH 6-CHLORO-3-HYDROXY-7-METHYL-2-(2'-PHENYL)-4-OXO-4H-1-BENZOPYRAN AS AN ANALYTICAL REAGENT BY SPECTROPHOTOMETRIC METHOD

Ramesh Kataria<sup>\*1</sup>, Suresh Kumar Sharma<sup>2</sup> and Asha Rani<sup>3</sup>

Department of Chemistry & Centre of Advanced Studies in Chemistry, Panjab University, Chandigarh,

<sup>2</sup>Department of Chemistry, DAV College, Abohar, Punjab

<sup>3</sup>Department of Chemistry, MLN College, Yamunanager, Haryana

#### Abstract

A rapid, sensitive, inexpensive and selective method for the detection of tin(II) has been worked out with 6- chloro-3- hydroxy -7- methyl- 2- (2'- phenyl)-40x0-4H-1-benzopyran as a Sn(II)-CHMPB coloured complex in acid medium. The formed Sn(II)-CHMPB complex was extracted in dichloromethane and shown maximum absorbance in the range of 427-432 nm. The method obeys Beer's law in the range 0.0-1.4 ig Sn(II)/ml with molar absorptivity, specific absorptivity and Sandell's sensitivity are 7.59 ×10<sup>4</sup> L mol<sup>-1</sup> cm<sup>-1</sup>, 0.639 ml g<sup>-1</sup> cm<sup>-1</sup> and 0.0016 ig cm<sup>-2</sup> at 430 nm, respectively. The stoichiometry of extracted Sn(II)-CHMPB complex was found 1:2 (M: L) under the optimum conditions of the procedure. The method is free from the large number of foreign ions. The interference of some foreign ions was successfully masked with suitable masking agents. The developed system has been effectively applied for the detection of the tin in a variety of synthetic samples corresponds to bertheir alloy, chinese speculum and ceco alloy, and some other technical samples including gun metal and tin can.

Keywords: tin, 6-chloro-3-hydroxy-7-methyl-2-(2'-phenyl)-4-oxo-4H-1-benzopyran, extraction, spectrophotometric.

#### INTRODUCTION

Tin concentration in earth's crust is about 2.2 mg per kilogram, in sea water it is about 0.01 microgram per liter, and the most commercial source of tin is its oxide ore, cassiterite or tin stone in association with granitic rocks [Agrawal et al.]. Tin is also present in trace amount in most of the food items but its concentration is higher in case of canned food [Boutakhrit et al.]. The study of tinplate used in packing of food and beverages confirm the tin contamination into the food content [Manzoori et al.]. According to World Health Organization the recommended limit for tin in canned food is 250 mg/kg. But literature revealed that the intake of food/beverage containing tin more than 200 mg/kg can cause gastrointestinal effects [Blunden et al.]. Tin is a toxic metal predominantly when present in major concentrations especially in food and can be responsible for gastrointestinal symptoms provoking abdominal cramps, nausea, diarrhea, vomiting, headache and bloating fever [Jian et al.]. Inspite of its toxicity tin has wide application in industries as a coating material, alloying agent, stabilizer and pesticides in agriculture

[Agrawal et al.]. Owing to the ever growing importance of tin in food and electronic industries, it has aroused a considerable interest amongst the researchers to work out for its analysis. The literature studies have disclosed that a large number of analytical complexing agents like Morpholine dithiocarbamate [Madhavi et al.], dibromo-hydroxyphenylfluorone [Yan, 2003], benzopyran derivatives [Kataria et al. 2014 & 2006, Sharma et al. 2007], arsenazo-M [Cai et al.], pyrocatechol violet[Tang et al., Abbasi-Tarighat 2013, Madrakian et al. and Costa et al.], mixture of 3,3',5,5'-tetramethylbenzidine dihydrochloride and N-bromosuccinimide [Wei et al.], diacetyl - monoxime -p- hydroxy- benzoyl- hydrazone [Varghese et al.] and phenylfluorone [Huang 2013, Wang et al.], have been frequently used in the analysis of tin using UV-visible spectrophotometer. In the reported complexing agents [Yan 2003, Costa et al.] are non selective as they have the problem of interference, and some of them are time taking, as they need time to develop the full colour [Costa et al., Wang et al.]. Some of the reagents [Yan 2003, Cai et al., Abbasi-Tarighat 2013, Madrakian et al., Wei et al.] require the use of the plasticizer, surfactants, and critical pH adjustment. With a outlook to conquer these complications, a complexing agent i.e. 6-chloro-3-hydroxy-7-methyl-2-(2'-phenyl)-4-oxo-4*H*-1-benzopyran has been proposed for the detection of trace amount of tin(II) using UV-visible spectrophotometric technique. The method has been successfully applied in the analysis of trace tin from various synthetic samples corresponds to bertheir alloy, chinese speculum and ceco alloy including gun metal and tin can.

#### **EXPERIMENTAL**

## **Apparatus and Reagents**

*Apparatus*: A (model-140-02, Shimadzu) with matched cells of 10 mm was used for the usual absorbance measurements and spectral studies.

*Reagents and Solutions*: All the chemicals were used of analytical grade with highest purity during the development of the method. 6-Chloro-3-hydroxy-7methyl-2-(2'-phenyl)-4-oxo-4*H*-1-benzopyran (CHMPB) was synthesized by the reported method [Jeffery et al. 1989] and dissolved in ethanol to give 0.2% (w/v) solution. Dichloromethane was distilled and the fraction distilling at 39-41°C was used for Sn(II)- CHMPB complex extraction. The molecular formula of CHMPB is  $C_{16}H_{11}O_3Cland$  its structure is given below:



*Tin and other metals ions Standard Solution*: The standard stock solution of Sn(II) of strength 1 mg ml<sup>-1</sup> of the metal ion, and other metal ions were prepared by

the reported method [Kataria et al. 2014]. The stock solution of Sn(II) standardized by the SnO<sub>2</sub> method gravimetrically [Gupta et al.] and their lower concentration of Sn(II) solution at  $\mu$ g ml<sup>-1</sup> level was prepared by appropriate dilution containing 0.5 mol l<sup>-1</sup> HCl final acidity.

## Synthetic and Industrial Samples

Dissolution of Alloys Samples: The Synthetic samples correspond to Bertheir alloys, Chinease speculum and Ceco alloy were prepared by mixing tin solution with solutions of various metal ions in suitable proportions as shown in Table 1. The samples of Gun metal and Tin Can used for analysis were also prepared by the reported method [Kataria et al. 2014].

## Procedure

To 1 ml solution containing 10 µg Sn (II) in 0.5 M hydrochloric acid taken in 100 ml separating funnel and 1ml of CHMPB 0.2% (w/v) in ethanol, were added followed by enough deionized water to raise the aqueous volume to 10 ml and then equilibrated with 10 ml of dichloromethane for 60 second, the two layers were allowed to separate and the solvent phase was drawn in to a 50 ml beaker and any suspended droplet of water were removed by adding 0.5 g of anhydrous sodium sulphate. The extract was transferred to 10 ml volumetric flask and the volume was made up to the mark with the pure solvent. After mixing the solution, the absorbance of the coloured complex was measured at 430 nm against a similarly prepared reagent blank. The effect of anions on the absorbance of the complex was studied by adding initially a known amount of sodium or potassium salt to the aqueous solution containing metal ion and the rest of the procedure was same. The absorbance of different cations was measured individually under the optimum conditions as chosen for tin and also their influence was observed on the absorbance of tin complex. The calibration curve was plotted between the absorbance and variable concentration of Sn(II) under identical conditions of the procedure of solution containing Sn(II) up to 14 µg per 10 ml of the aqueous volume.

Modifications of the method for the samples containing Fe and Mo: For each of 0.5 mg Fe(III) and 0.05 mg

Sample composition		
Matrix*	Sn added, µg	Sn found**, µg
Ba(5), Ru(0.01), Co(0.05)	10	9.97
Se(1), Ag(0.1), Os(0.05)	7	7.10
Th(0.10), Cd(1), Mo(0.001)ª	9	8.92
Cu(0.36), Zn(0.125), Pb(0.01)⁵	8	7.97
Cu(0.0664), Sb(0.007) <sup>c</sup>	4	3.88
Cu(0.149), Pb(0.0765), Ni(0.0022), Fe(0.00072) <sup>a,d</sup>	13	13.15
Gun Metal	4.9 <sup>e</sup> %	4.42 %
Tin Can	-	0.157% <sup>f</sup>

Table 1: Analysis of samples by the proposed method

\* Amount of metal ion shown in parentheses is in mg. \* \*Average of triplicate analyses. all the presence of 10 mg ascorbic acid. b.c.d Correspond to bertheir alloy, chinease speculum and ceco alloy respectively. Certified value Confirmed by SnO<sub>2</sub> method.

Mo(VI), 10 mg ascorbic acid were added prior to the addition of CHMPB in 10 ml of a aqueous volume under optimum conditions of the procedure.

# **RESULTS AND DISCUSSION**

Spectral Characteristic: Under the optimum conditions of the method, Sn(II) forms a coloured complex with 6chloro-3-hydroxy-7-methyl-2-(2'-phenyl)-4-oxo-4*H*-1benzopyran in HCl acid medium which can be extracted quantitatively into dichloromethane solution and shows absorbance maximum in the range of 427-432 nm where the reagent blank had minimum absorbance as shown in figure 1. Therefore all the measurements were carried out 430 nm. The formation of Sn(II) - CHMPB complex influenced by all other important parameters in the form of absorbance is shown in Table-2.

*Choice of solvent*: Extraction of Sn(II) – CHMPB complex was done with different solvents like benzene, dichloromethane, chloroform, carbon tetrachloride and

HCI <sup>a</sup> (M)	0.032	0.035	0.037	0.039	0.04-0.1	
Absorbance	0.450	0.550	0.590	0.620	0.640	
CHMPB⁵(ml)	0.2	0.4	0.6	0.8	0.9-1.5	
Absorbance	0.260	0.480	0.580	0.630	0.640	
Equilibration time <sup>c</sup> (sec)	0.0	20	30	40	50-300	
Absorbance	0.120	0.450	0.590	0.620	0.640	

Table 2: Effect of various	parameters on the	absorbance of S	Sn(II)-CHMPR	complex
				CONDICA

Conditions: (a) Sn(II) = 10  $\mu$ g; HCI = variable; CHMPB (0.2% (m/v) in ethanol) = 1 ml; aqueous volume = solvent volume = 10 ml; solvent = dichloromethane; equilibration time = 60 sec;  $\lambda_{max}$  = 430 nm (b) HCI = 0.05 M; at room temperature; other conditions being the same as in (a) except for the variation in CHMPB concentration; also b = 6-chloro-3-hydroxy-7-methyl-2-(2'-phenyl)-4-oxo-4H-1-benzopyran (CHMPB) (c) 0.2% CHMPB in ethanol = 1 ml; other conditions being the same as in (b) except for the variation in equilibration time.

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Fig. 1. Absorption spectrum of Sn(II)-CHMPB complex into dichloro-methane. A - 1.0  $\mu$ g Sn(II) ml<sup>-1</sup> measured against reagent blank, B - reagent blank measured against dichloromethane.

n-Butonal. Out of which dichloromethane shows maximum absorbance and stability hence, dichloromethane was preferred as the most suitable extractant for the Sn(II)-CHMPB complex. A single equilibration with equal volume (10ml) of dichloromethane transfer the Sn(II)-CHMPB complex to the organic phase.

Effect of HCI Concentration: The absorbance of the Sn(II)-CHMPB complex varies with hydrochloric acid concentration were observed in Table 2. It is evident from Table 2 that the absorbance was observed maximum in the range of 0.04-0.1 M HCI, but decreases when acid concentrations increases greater than 0.1 M. So 0.05 M HCI was chosen to provide suitable acidity.

*Effect of reagent concentration*: The absorbance of the solution of Sn(II) was found 0.0 when solution contains no reagent. It, however, increases to 0.190 when 0.1 ml of (0.2% 6-chloro-3-hydroxy-7-methyl-2-(2'-phenyl)-4-oxo-4*H*-1-benzopyran in ethanol) reagent solution was added and thereafter it show a gradual increase added from 0.1 to 0.9 ml. However further increase in reagent concentration from 0.9 ml to 1.5 ml cause no change in absorbance. On further increase of reagent concentration, absorbance starts decreasing. Therefore 1.0 ml of reagent concentration was

recommended for achieving maximum absorbance for further investigation of the method.

Effect of Equilibration Time: The absorbance of Sn(II)-CHMPB under optimum procedure of other parameters was found varied with time of equilibration. The absorbance was reported 0.120 without shaking and increases gradually on increasing the shaking time and it remains constant 50 to 300 second after that slightly decrease in the absorbance was observed by increasing the shaking time. In order to save time 60 second was selected for the extraction of Sn(II)-CHMPB complex into dichloromethane.

Stability of Sn(II)-CHMPB complex: The absorbance of the Sn(II)-CHMPB complex was found to stable up to more than 2 h in dichloromethane. So we can say that Sn(II)-CHMPB complex is quite stable under the optimized conditions.

Beer's law obedience and other statistical parameters: Under the optimum conditions of the procedure Beer's law obedience curve was constructed at 430 nm. The Sn(II)-CHMPB complex obeys Beer's law in the range 0-1.4 µg Sn(II) ml<sup>-1</sup>. However, the ringbom plot[Ringbom 1938] between percentage transmittance and log ppm of tin shows the best possible concentration for determination of the metal ion to be 0.20-1.34 ppm. The molar absorptivity, specific absorptivity and Sandell's sensitivity of Sn(II)-CHMPB complex have been computed and are found to be 7.59 × 10<sup>4</sup> L mol<sup>-1</sup> cm<sup>-1</sup>, 0.639 ml g<sup>-1</sup>cm<sup>-1</sup> and 0.0016 µg cm<sup>-2</sup> at 430 nm, respectively. The reproducibility of the presented method was tested by performing ten sets of experiments keeping 10 µg amount of Sn(II) in 10 ml aqueous solution in each set; the relative standard deviation of the method calculated is 0.45 %.

Stoichiometry of the Sn(II)-CHMPB complex: Job's method of continuous variations as modified by Vosburgh and Cooper for a two-phase system[Job 1928, Vosburgh et al.] was used to determine the ratio of Sn(II)-CHMPB in the extracted species using their equimolar solution (8.425×10<sup>4</sup> M) at wavelengths 430 nm. The observed data supported the metal-to-ligand ratio of 1:2 in the extracted species. This has been further clarified by the mole ratio method[Yoe et al.] by taking the concentration of Sn(II) as 4.218×10<sup>4</sup> M and

measuring the absorbance again at 430 nm. The most plausible structure of the Sn(II)-CHMPB complex is given as under:



Sn(II)-CHMPB Complex

# Effect of diverse ions

The interference of various foreign anions and cations on the extraction of the Sn(II)-CHMPB complex were studied. Different amounts of alkali metal salts of different anions and metal ion solution were added individually to a solution containing 10  $\mu$ g of Sn(II) prior to the addition of CHMPB and the general procedure was applied. The amount of diverse ions which cause a ±1% variation in absorbance was taken as its tolerance limit. While the determination of 10  $\mu$ g of tin, the tolerance limits of various anions were as follows (100 mg each) of bromide and sulphosalicylic acid; (60 mg) of iodide; (50 mg of each) of sulphate and chloride; (40 mg) of nitrate; (60 mg) of chloride; (10 mg) of ascorbic acid. Oxalate and fluoride interferes very seriously even in traces.

Among the cations: Ba(II) and Ca(II) (20 mg each); Ni(II) and Co(II) (10 mg each); Co(II), Mg(II), Zn(II) and Hg(II) (5 mg each); U(VI), Cd(II) and Ce(IV) (3mg each); Pb(II, Al(III), and Os(VIII) (2 mg each); Th(IV) and Bi(III) (1mg each); Ru(III) and Cr(VI) (0.5 mg each) were within the tolerance limit under the optimum conditions of the procedure. Fe(III) and Mo(VI) causes the interference but Fe(II) was masked with 10 mg ascorbic acid up to 0.5 mg and of Mo(VI) also masked with same amount ascorbic acid up to 0.05 mg.

## CONCLUSION

The proposed method is quite sensitive and sufficiently selective. The method is simple and requires only maximum 5 min for the single determination. The

developed procedure has been successfully applied for the detection of the tin in various synthetic samples corresponds to bertheir alloy, chinese speculum and ceco alloy, and some other technical samples including gun metal and tin can.

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# DOMAIN NAME DISPUTES AND RESOLUTION IN THE INTERNATIONAL AND NATIONAL SCENARIO: A LEGAL STUDY

## Jyoti Rattan

Department of Laws, Panjab University, Chandigarh

## Abstract

Internet spread exponentially towards the end of twentieth century and has played a commendable role in our lives. There is no going slow in future too. The essentiality of Internet in almost every facet of our lives is being realized to such an extent that in knowledge society of twenty first century we cannot survive without Internet. However, for internet communication we need electronic address or domain name (DN). Significantly, domain name has its own problems i.e. domain Name deputes. Cybersquatting and typosquatting are important DN disputes. The Internet Corporation for Assigned Names & Numbers (ICANN), a non-profit making body mainly concerned with the Domain name system management and Sets rules for arbitrating disputes over domain ownership. However, with the growth of internet DN disputes are also increasing. Need of the hour is to and take some precautions at the time of distribution of DN and reduce such disputes.

# METHODOLOGY

It is theoretical study based on international and national instruments, reports, article and the internet.

Keywords: Cybersquatting, typosquatting, Internet Corporation for Assigned Names & Numbers (ICANN)

# INTRODUCTION

Internet spread exponentially towards the end of twentieth century and has played a commendable role in our lives. There is no going slow in future too. The essentiality of Internet in almost every facet of our lives is being realized to such an extent that in knowledge society of twenty first century we cannot survive without Internet. It has been rightly pointed out by the United Nations that rapid increase in the number of globally active Internet users makes the Internet an ideal marketplace and advertising location. More than traditional mass communication media, the Internet offers users the opportunity to actively seek the desired information for them. Persons or entities planning to use the Internet as a global marketplace or communication platform must enable potentially interested parties to locate them in cyberspace. For electronic communication every entity should have its own unique electronic address, which led to the concept of domain name. However, with the increasing use of the Internet many problems also arose relating to electronic address and domain name.1 Let's analyse the concept of domain name, domain name disputes and their resolution.

# DOMAIN NAME

Every computer or server connected to the internet has

\*Corresponding Author: jyotirattan@gmail.com MS Received: May 7, 2014, Accepted: November 16, 2015 its own unique address commonly known as Internet Protocol Address [IP Address]<sup>2</sup> which is all numeric number such as the number 193.5.93.80.<sup>3</sup> Significantly, presently we have IPv6.<sup>4</sup> As it is easy to remember a person by his name rather than his number and IP Address is generally long and it and it is not eye and ear catching, hence came the concept of Domain Name.

It is important to note that there is no legal definition of domain name. However, it is an alpha-numeric string granted by DN Registrar or any competent authority as an electronic address on internet. However, it does not correspond to original IP address but it is a substitute of IP address or it is a proxy name of IP address. In the last 20 years, domain name has become a kind of ecommerce mark in the digital medium. These are digital business addresses for business contract and transaction. Examples: <u>www.yahoo.com</u>, <u>www.gmail.com</u> and <u>www.rediff.com</u>.<sup>5</sup>

# DOMAIN NAME HIERARCHIES

Domain name consists of different parts or levels separated by dot (.) indicating hierarchy.<sup>6</sup> In every domain name three parts are essentials: Top-level Domain (TLD) or First-level Domain (Suffix); Second Level Domain (SLD) and Host (Prefix). For example: in www.yahoo.com, < .com> is a First level domain (TLD) e.g., gTLD; <.yahoo> is a Second level Domain Name and <.www> is host. However, there can be non essential parts in a Domain Name i.e., third level, fourth level and other level sub-domain.<sup>7</sup> Accordingly, there are compulsory and non compulsory hierarchies and lets briefly analyse them.

## Compulsory hierarchies:

# Top-level Domain (TLD) or First-level Domain

This part is on extreme right of domain name. It is important to note that this part of the domain name is common all over the globe and we have two TLDs: generic TLD (gTLD) and Country Code TLD (cc TLD) or Geographical TLD.

Generic TLD (gTLD): Generic TLDs are commonly misunderstood to be for "U.S.-only" as initially these were used in U.S.A only but subsequently with the growth of internet these gTLDs were used all over the world. Therefore, at present these are international in

nature, so only one of each exists in the entire world. Further, gTLD consist of a three character code and indicate the primary function of the organization or their generic behavior. Earlier there were seven generic TLDs which were used all over the globe which are: <.edu> for Educational Institutions (i.e., www.princeton.edu and www.it.northwestern.edu): <.org> for Miscellaneous and non-profit or non commercial organizations(i.e., www.wipo.org and ww.eklavya.org); <.com> for Commercial Use(i.e., www.yahoo.com and www.wipro.com); <.net> for Network providers (i.e., www.rs.internic.net www.whois.net); <.gov> for Government (i.e., www.whitehouse.gov); <.mil> For Military Organisation (i.e., www.army.mil); < int> for International treaty organizations/Internet databases (i.e. www.nato.int).8

However, in 2000, seven new gTLDs are approved by ICANN which are:<sup>9</sup>

gTLD	Use	Examples
<.biz>	For Business	www.xicom.biz
<.info>	For information sites	www.andhrauniversity.info
<.coop>	For cooperatives	www.xyz.coop
<.aero>	For aeronautical industries	www.aai.aero
<.name>	For individuals	www.abc.name
<.pro>	For certified professionals	www.apple.pro
<.museum>	For museums	www.abc.museum

#### Table 1: New g TLD

Country Code TLD (cc TLD) or National TLD (nTLD) or Geographical TLD: Geographical TLDs are country specific. Country Domain consists of two characters which represents different countries/regions all around the world. These codes have been standardized by the International Standard Organization (ISO 3166). Till 2007 there were 239 recognized ccTLD listed in International Standard Organization (ISO 3166).<sup>10</sup> Some examples of country domains are;<sup>11</sup>

## **Table 2: Country Code**

Country code (cc)	Country
<.in>	India
<.cn>	china
<.au>	Australia
<.fr>	France
<.uk>	United Kingdom
< us>	United States
<.jp>	Japan
<.it>	Italy

#### Second Level Domain (SLD)

Second level domain is the part directly to the left of the top level domain in an e-address on internet. However, this part is to be chosen by the person registering the name (client or registrant). It is important to note that two identical SLDs cannot exist under the same TLD. For example, even though both the Delta Faucet Company and Delta Airlines would like the "delta.com" domain name, only one Delta company can have Delta.com. Unfortunately both Delta Faucet Company and Delta Airlines could not get this domain name as Delta Financial of Woodbury, New York had already registered delta.com as its domain name. Therefore, instead of using delta.com, Delta Airlines uses deltaairlines.com, while Delta Faucet Company uses deltafaucet.com.<sup>12</sup> Some of the commonly used host (computer) names are www, ftp, mail, pcl, network, smtp, www2, news, admin, etc. These names are usually given according to the services they provide, like mail is the name given to the host that runs an organization electronic mail service. However, www is the most commonly used host. For example: Web server www.zeetv.com and FTP server ftp: //ftp.microsoft.com.<sup>13</sup>

# Non Compulsory hierarchies: Second Level Sub Domain:

Second level sub-domain generally comes between Second Level Domain and First (Top Level) Level Domain. India has a country code top level domain (ccTLD), <.in> as listed in the ISO-3166. The second level sub domains registered under the <.in> domain are: <.ernet> for the academic and research network;

Host (Prefix):

The second level sub domains	Use
registered under the <.in> domain	
<.nic>	for the government's network,
<.net>	for Internet Service Providers,
<.res>	for the research community,
<.ac>	for the academic community,
<.co>	for commercial organizations,
<.gov>	for the government offices and machinery,
<.mil>	for military organizations and
<.org>	for organizations which do not get covered under any of
	the above sub-domains.

# Table 3: Second Level Sub Domain under <in> Registry

For example:14



It is important to note that Second Level Sub Domains in India under <.in ccTLD> are roughly parallel to gTLDs e.g., <.co> in India correspond to <.com> gTLD and <.ac> in India correspond to <.edu> gTLD. However, some other Second Level Sub Domains in India are exactly parallel to gTLDs e.g., <.gov>,<.mil>,<.org> &<.net>. <sup>15</sup>

#### Third/fourth etc. Level Domain /sub-Domain:

It is important to note that higher level/s may be added to a domain name to make it more specific. These parts of the domain name giving additional indication or information come between host and SLD and are called sub-domains (Third level or fourth level and so on). A higher level domain /sub domain provides a space for registering organization names or organization acronyms. Each organization after registering its domain name may plan its own hierarchy under the registered domain name. Therefore, it is not compulsory that every DN shall have third level/ fourth level domain/ sub-domain. However, these are the parts directly to the left of the second level domain in an e-address on internet.

For Example: Domain name of Punjab University, Chandigarh is www.puchd.ac.in and it has its own hierarchy such as;

Other examples are: <u>www.uiet.puchd.ac.in;</u> www.uils.puchd.ac.in and www.botany.puchd.ac.in.lt is important to note that DNS could be represented as an





inverted tree with root at the top. After the root comes the TLD or First Level Domain (Level 1) and there can be multiple levels (subtrees). In the hierarchy, next comes SLD (Level 2). However between the ccTLD and SLD there can be Second level sub domain. After SLD there may be levels 3 & 4. However last domain (level) attached to host (prefix) is also known as leaf domain.

Significantly, domain names are read from right to left i.e. from TLD to Sublevel Domain. However as we move form right to left we move from general to specific as each level points to more specific area of the internet. For example www.laws.puchd.ac.in clearly shows that domain name is registered in India as an academic institution. www.danceindiadance.zeetv.co.in clearly shows that domain name is registered in India as a commercial organisation.

## DOMAIN NAME DISTRIBUTION

The allocation of IP address & domain names worldwide is done centrally. Earlier, the Network Solutions Inc. (NSI) has been registering domain names since 1992and it worked successfully till 1998. However, in 1999, the Internet Corporation for Assigned Names & Numbers (ICANN), a non-profit, private sector Corporation based in Marina del Rey, California, USA substituted NSI and took the responsibility of the domain name system management. The main functions of ICANN are: sets rules for giving the numbered IP addresses/protocol parameters; Domain name system management; Adding new suffixes to the directory; and Sets rules for arbitrating disputes over domain ownership.<sup>16</sup>

There is a specific registration procedure involved in distribution of domain name. Under the ICANN, there is the Central Internet Authority called the Internet Assigned Numbers Authority (IANA) that allocates IP addresses and domain names through Inter Network Information Centre (InterNIC) or there are Regional Registries to whom registration and allocation functions are delegated. Accordingly, IANA allocates numbers to Regional Registries i.e. The American Registry for internet number (ARIN) for North America, the Caribbean and Sub-Saharan Africa; The Roseau IP European (RIPE) for Europe, middle East and parts of Africa; and the Asia Pacific Network Information Centre (APNIC) for Asia/Pacific Region. India is covered under APNIC regional registry.

Domain Name Distribution in India: In India, the National Internet Exchange of India (NIXI) is a non-profit company registered, under Section 25 of India's company Act, 1956 with the objective of improved internet services in India which was promoted by Department of Information & Technology (DIT) and The Internet Service Providers Association of India.

It had been set up to facilitate exchange of domestic internet traffic within the country by Internet Service Providers in India. NIXI has also been entrusted with the responsibility of setting up of <.in> country code top-level domain (<.in> ccTLD) Registry by the Government of India. For this purpose <.in> registry had been created by NIXI. However, it is important to note that <.in> registry is an autonomous body under NIXI with primary responsibility of maintaining <.in> ccTLD and ensuring its operational stability, reliability and security. In addition it will also implement any new policy evolved by the Government of India & Ministry of Communications and Information Technology, Department of Information Technology (DIT).<sup>17</sup>

Initially, the period from January 1 to January 21, 2005 was marked as sunrise period for registration which was specifically meant for owners of registered Indian trademarks or service marks to obtain <.in> domain names so that their marks should not be misused by the general public. After the sunrise period, the registry was thrown open for open registration by the general

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public. As on December, 2006, more than 2,00,000 domain names have been registered.<sup>18</sup>

It is important to note that <.in> registry does not carry out registration itself. However, it is done through accredited Registrars and following are accredited Registrars authorized to register domain names under <.in> registry.<sup>19</sup> Significantly, Government Registrars are: **gov<.in>, mil<.in>:** National Informatics Centre (NIC) is the exclusive registrar for gov<.in> and mil<.in> domain names. And **ac<.in>, edu<.in>, res<.in>:** ERNET is the exclusive registrar for ac<.in>, and res<.in> domain names.<sup>20</sup>

# **DOMAIN NAME DISPUTES**

It is significant to note that like NSI, ICANN and its accredited registrars are also responsible for the registration of 'second-level domain' name on a first come, first served basis and do not evaluate or pre screen whether 'second-level domain' name is same, or deceptively similar to, a registered trademark or already registered domain name. Undoubtedly, distribution of domain name without pre screening has resulted in growth of e-commerce all over the world but at the same time it gave the opportunity to some persons to pirate the names of others, hence may lead to different domain name disputes. Imprtanty domain name disputes are: 'cybersquatting'; 'typosquatting'; Identical SLD in domain names registered by different registries in Different Countries and Reverse Domain Name Hijacking (R.D.N.H.).

## 'cybersquatting'

cybersquatting' is registering various famous names or trademarks as domain names with the hope of selling them at profit. Therefore, a cybersquatter is an internet user who has registered multiple 'domain names' with the hope of selling them to the business house who own trademarks identical to registered domain names; or the famous person (celebrity) whose name is identical to registered domain names. For Examples: Sony is the trademark of a company. Before domain name was registered by the Sony Company, Mr. A registered www.sony.com so that it can sell that domain name to Sony company at heavy price. Here Sony company will have fear that its trademark could be misused by the present domain name owner (Mr. A). Therefore in such situation only option with the trademark owner, Sony company is to pay handsome amount to the current domain name owner and get the same for his company or organization.21

The French filmstars Isabelle Adjani and Alain Delon as well as estate of Jimi Hendrix have all had to fight for domain names after them.<sup>22</sup> It is important to note that many famous companies such as McDonald and Coke, which were slow in registering their domain names, were not aware that their name or trademark had already been registered as domain name.

### 'typosquatting'

'typosquatting' is registering a domain name which is minor variation or common typographical permutations of already registered domain names so as to divert internet users to their website by typing errors. Therefore, a typosquatter, is a person who seeks to get profit from controlling domain names and obtain common typographical permutations of already registered domain names. Examples: Registering www.radiff.com or www.rediff.com where www.rediff.com, is already registered and Registering www.pesi.com where www.pepsi.com already registered.

# Identical SLD in domain names registered by different registries in Different Countries

Yet another problem relation to domain name is that different registries all over the globe are registering the domain name and may provide identical SLD. For example: www.nokia.com may already be registered but still in India www.nokia.co.in may be registered which is not affiliated to www.nokia.com.<sup>23</sup> Thus misleading the internet user that www.nokia.co.in is a part of www.nokia.com.

#### Reverse Domain Name Hijacking

Significantly, another cause of domain name dispute is reverse domain name hijacking. It means depriving a domain name owner of his domain name. Generally, a powerful company tries to force a genuine domain name user (owner) to give up his domain name which was acquired by him in good faith. However, mostly such powerful companies use coercive measures like threat of legal preceding so as to instigate the domain name holder to relinquish his right in domain name and transfer it to such powerful companies (Registrant). However, it may be possible that domain name registrant may be in any way associated with a domain name i.e. based on the trademark of another; or domain name owner

#### Parties to domain name disputes:

Generally, in domain name disputes there are two parties e.g., domain name owner (defendant) and trademark owner (plaintiff). However, in some cases even registration authority could be made party (defendant) resulting in three persons to domain name dispute.

## DOMAIN NAME DISPUTES RESOLUTION

The domain name problems such as 'cybersquatting', 'typosquatting' 'Identical SLD by different registries' & 'Reverse Domain Name Hijacking' had raised an important question e.g., Is domain name an asset? If yes, to whom does such asset belong? Is it the asset of the first person that registers it (defendant) or is it the asset of the trademark owner that has invested time and money in developing goodwill and reputation associated with the mark (plaintiff)?

It is important to note that two domain name dispute resolutions are possible: Non-Judicial Dispute Resolution; and Judicial Dispute Resolution

# Non-Judicial Dispute Resolution:

Non-Judicial Dispute Resolution under Uniform Domain Name Dispute Resolution Policy (UDRP): ICANN was successor of NSI and like NSI, it formulated its own dispute resolution policy, called 'Uniform Domain Name Dispute Resolution Policy<sup>25</sup> in 1999. It is comprehensive policy that covers domain name dispute areas, like trademark or service mark infringements. It has created a basic global uniformity in the resolution of domain name disputes.

It is significant to note that ICANN has approved following dispute-resolution service providers for nonjudicial dispute resolution under UDRP: World Intellectual Property Organisation (WIPO);<sup>26</sup> National Arbitration Forum;<sup>27</sup> CPR Institute for Dispute Resolution;<sup>28</sup> and Asian Domain Name Dispute Resolution Centre (ADNDRC).<sup>29</sup>

It is important to note that main objective of UDRP was to settle the dispute between two persons other than the registrar over the registration and use of an internet domain name registered by any person. However, proceedings under paragraph 4 of this policy will be conducted according to the Rules for Uniform Domain Name Dispute Resolution Policy<sup>30</sup> and the selected administrative-dispute-resolution service provider's supplemental rules. <sup>31</sup> The UDRP and the UDRP Rules prescribe detailed procedures for appointing either a sole arbitrator or a three member panel to conduct the inquiry. The UDRP is an "online" procedure administered via the net. It is important to note that a panel may opt in exceptional cases to hold live or teleconference hearings.

However, under the rules service provider can cancel, transfer or otherwise make changes to domain name provided the complainant proves that the opposite party's domain name is identical or confusingly similar to a trademark or service mark in which the complainant has rights; and he has no rights or legitimate interests in respect of the domain name; and His domain name has been registered and is being used in bad faith. However, where the complainant fails to prove then the service provider does not cancel, transfer, activate, deactivate or otherwise change the status of any domain name registration under this policy and maintains the status quo.

It is important to note that all registrars in the .aero, .biz, .com, .coop, <.in>fo,.museum,.name,.net,.org and.mobi to-level domains follow the Uniform Domain Name Dispute Resolution Policy (UDRP) and its new additional avtars like .biz (STOP), .name (EDRP) etc. Further, many nations have come out with their own set of rules based on the UDRP to resolve country specific domain name disputes. For example, the Australian domain administrator, auDA, launched a UDRP based scheme, the auDRP, on August 1, 2002. It looks after.au domain names, <like.net.au>, <.org.au>, <.edu.au>, <.gov.au>, <.id.au>, <.in> <fo.au> and <.conf.au>. Similarly, in United Kingdom Nominet Articulates.Uk Domain Name Dispute Resolution Policy is formulated.

In India, the National Internet Exchange of India (NIXI) has evolved an Alternative Dispute Resolution mechanism namely < in> DRP (< in> Domain Name Dispute Resolution Policy) based on the Indian Arbitration and Conciliation Act, 1996 and the principles given under the Uniform Dispute Resolution Policy of ICANN. As on December 2006, 12 cases involving < in> domain names have been resolved under this policy. It is important to note that though, various service providers such as Asian Domain Name Dispute Resolution Centre (ADNDRC); CPR Institute for Dispute Resolution: National Arbitration Forum and WIPO had been approved in settlement of such disputes but WIPO had played commendable role in settlement of such disputes as it was the oldest approved service provider. Lets analyse few decided cases by these service providers.

In 2002 in a case Asian Paints (India) Ltd. v. Domain Admin.<sup>32</sup> domain names <asianpaint.com> of respondent was identical and confusingly similar to complainants mark and the domain name registered by its e.g., <asianpaints.com>. It observed that the respondent have no explanation for registering the disputed domain name and has no right or legitimate interests in it. Further, it was held that the omission of the letter "s" is a deliberate attempt to exploit users' typographical errors when seeking the complainant's website www.asianpaints.com. The absence or any legitimate interest in the disputed domain name and the lack of association with paint on the respondent website demonstrate registration and use in bad faith. Therefore, WIPO directed the respondent to transfer the domain name <asianpaint.com> to the complainant.

Again in 2002, two more cases before WIPO, where complainants succeeded as the Panel(s) concluded that the respondent(s) had no legitimate interest in the confusingly similar domain names and that they have been registered in bad faith are *ITC Ltd.* v. *Buy This Name*,<sup>33</sup> where the domain name involved was "itchreadneedle.com" and *Castrol Ltd.* v. *Shriniwas Ganediwal*,<sup>34</sup> where the domain name involved was"castrolindia.com".

In 2009, in a case of Mahindra & Mahindra Limited v. Zach Segal,<sup>35</sup> the disputed domain name, <mahindraforum.com> was registered by the respondent in 2008. The complainant, Mahindra & Mahindra Limited filed a Complaint with the WIPO Arbitration and Mediation Center (the "Center") in 2009 that the respondent's domain name. <mahindraforum.com> is confusingly similar to its MAHINDRA trade mark; and the Respondent has no rights or legitimate interests in respect of the Domain Name. Tony Willoughby, the sole panelist held that under paragraph 4(a)(i) of the Policy, the Domain Name

was confusingly similar to a trade mark in which the Complainant has rights and the Respondent has no rights or legitimate interests in respect of the Domain Name. The Panel also observed that Respondent by using the Domain Name, directly or indirectly have generated, some revenue. Therefore, the Panel orders that the domain name, mahindraforum.com>, be transferred to the Complainant.

It is important to note that though in most of the cases before WIPO, bad faith on the part of the respondent was proved and complainant succeeded but it is not always so. *NIIT Limited v. National Institute for Information Technology*<sup>36</sup> is one of the few cases where bad faith on the part of the respondent was not proved hence complaint was refused. Here, the Complainant was NIIT Limited, New Delhi, India, and the Respondent was National Institute for Information Technology, Ramallah, Palestinian National Authority Territories, in Jerusalem, Israel. The disputed domain name <ni-it.org> was registered on February 23, 2002 by the respondent. The Complainant has domain name registration for <niit.com> and for other domain names incorporating the word "niit".

The Respondent was established in 2000 as a subsidiary of the Palestinian Economic Council for Development and Reconstruction (PECDAR) and was financed by the World Bank and it was set up as a specialized educational institute to deliver training in IT. The Respondent proved that it is not interested to attract Internet users from outside the Palestinian National Authority Territories, and it does not find any commercial gain by creating a likelihood of confusion with the Complainant's mark with regard to its domain name, hence, the Complaint was denied.

In 2010 (till May 8, 2010) approximately 800 domain name cases were registered before WIPO service provider out of which some are decided, some are terminated/cancelled and others are pending.<sup>37</sup>

## Judicial Dispute Resolution

It is important to note the some countries have enacted their own laws to resolve domain Name disputes whereas other countries follow the trademark Law to solve such disputes. Lets briefly analyse position in different countries.

Domain names dispute resolution in The United States

US congress has enacted two statutes for domain name judicial dispute resolution which are: Federal Trademark Dilution Act, 1994 (FTDA)38 and Anticybersquatting Consumer Prevention Act, 1999, (ACPA). The Federal Trademark Dilution Act, 1995 provides protection to famous trademarks. This defines dilution as the lessening of the capacity of a famous mark to identify and to distinguish goods or services. This Act did not provide an express solution to domain name issues, however, it was hoped that this Statute can help in stopping the use of deceptive Internet addresses taken by those who are choosing marks that are associated with the products and reputations of others. This Act provides injunction relief to the plaintiff when he proves that: he is an owner of a famous mark; that mark has been used by the defendant in commerce; his mark became famous prior to the defendant's use; and the defendant's use resulted in dilution of the distinctive quality of the mark.

Anticybersquatting Consumer Prevention Act, 1999 is applicable both against the cyberquatter but also applicable against the typosquatter. It is important to note that an important difference between two new statutes is that the FTDA requires a commercial use of the mark in commerce whereas the ACPA requires a "bad intent to profit".<sup>39</sup>

#### Domain names dispute resolution in the UK

In UK there is no separate law dealing with domain name dispute. There have been few cases on domain names that have reached court so far in the UK which have not contributed much to understand of confusion in trade mark law and domain names. Further, UK Trade Marks Act, 1994 has not yet been analysed in detail in connection with these disputes.<sup>40</sup>

## Domain Name Dispute Resolution in India

In India domain name dispute and resolution, there is no separate statute. However Indian judiciary in number of cases has applied the Indian Trademark Act, 1999 to resolve domain name disputes. In *Yahoo! Inc. v. Akash Arora*,<sup>41</sup> the defendant was restrained from using the domain name "yahoo**india**.com" which was identical to the plaintiff's "yahoo.com". It was observed by Dr. M.K. Sharma, J. of the Delhi High Court that "if an individual is a sophisticated user of the Internet he may be an unsophisticated consumer of information and such a person may find his/her way to the different internet site which provides almost similar type of information as that of the plaintiff and thereby confusion could be created in the mind of the said person who intends to visit the Internet site of the plaintiff, but in fact reaches the Internet site of the defendant".<sup>42</sup> Further, the Delhi High Court rejected the argument that the provisions of the Indian Trademark Act, 1999 would not be attracted to the use of the domain trade name or domain name on the internet.

Further, in Rediff Communication Ltd. v. Cyberbooth,<sup>43</sup> wherein the plaintiffs filed the suit for a permanent injunction restraining the defendants from using the mark/domain name "Radiff" or any other similar name so as to pass off or enable others to pass off their business or goods or services as for the business or goods or services of the plaintiffs. A.P. Shah, J. of Bombay High Court observed, "the Internet domain names are of importance and can be a valuable corporate asset. A domain name is more than an Internet address and is entitled to the equal protection as trademark. With the advancement and progress in the technology, the services rendered in the Internet site have also come to be recognized and accepted and are being given protection so as to protect such provider of service from passing off the services rendered by other as his services".44 Further, it was held that in registering domain name radiff.com by the defendant, intention to deceive was established therefore relief of injunction was granted.

In 2004, the Supreme Court for the first time decided a case relating to domain name dispute. In *Satyam Infoway Ltd.* v. *Sifynet Solutions (P) Ltd.*,<sup>45</sup> the question before the Court was whether the use of the same or similar domain name might lead to a diversion of users?

The appellant, claimed to have invented by using elements of its corporate name, Satyam Infoway. The appellant claimed a wide reputation and goodwill in the name "Sify". The respondent started carrying on business of internet marketing under the domain names, www.siffynet.net and www.siffynet.com from 2001.

The Supreme Court of India observed that there is visual as well as phonetic similarity between "Sify" & "Siffy". Adding word "net" to "siffy" does not remove this similarity. Further, Court found that putting extra "f" to "sify" has made the domain name of respondent deceptively similar to the domain name of appellant, therefore likely to cause confusion in the minds of internet user of average intelligence. Hence the appellant is entitled to relief.

Regarding the statute under which relief is to be granted, the Supreme Court held that the domain name is a valuable corporate asset and is entitled to equal protection as a trademark. The decisions in the aforesaid cases suggest that the basic principles of the trademark law apply to the disputes in respect to Internet domain names. The Supreme Court of India further held that "there is no legislation (in India) which explicitly refers to dispute resolution in connection with domain names. But although the operation of the Trade Marks Act, 1999 itself is not extraterritorial and may not allow for adequate protection of domain names, this does not mean that domain names are not to be legally protected to the extent possible under the laws relating to passing off".<sup>46</sup>

# **CONCLUSION AND SUGGESTIONS**

Internet has become essential part of our lives and for each electronic communication on internet, electronic address or domain name is required. Domain names are used for locating specific computers on the Internet. Domain name has compulsory as well as noncompulsory hierarchies. Compulsory hierarchies (FLD, SLD and host) give general information about the address i.e. FLD tells whether entity is a business entity or government body or nonprofit making organization and so on which is common all over the globe. However, SLD is essential part in every Domain Name which is to be chosen by the applicant at the time of registration. Host means the service provider. Non Compulsory hierarchies (Third Level, Fourth Level and so on) give specific information. It is important to note that when we move from extreme right to left we go from general to specific information.

ICANN is concerned with registration of Domain Name at global level. IANA is main body under ICANN dealing with registration, which is having Regional and National Registries for distribution in the countries. In India NIXI is a nonprofit making company mainly facilitating the exchange of internet traffic and has established <in> registry. We have various government and private registrars under this registry.

Sometimes, Domain Names conflict with existing trademarks and other traditional business identifiers.

Such conflicts lead to domain name disputes where existing trademark of any business entity or celebrity is registered as SLD.<sup>47</sup> Significantly, out of four types of domain Name disputes i.e. cybersquatting'; 'typosquatting'; Identical SLD in domain names registered by different registries in Different Countries and Reverse Domain Name Hijacking (R.D.N.H.), two are very common i.e., cybersquatting'; 'typo squatting'. All domain Names disputes are relating to SLD because SLD is allocated on first come first served basis without enquiry by the registrar that: whether it actually belongs to him; whether it is confusingly similar to the SLD of already existing Domain Name; and whether it is mark or name of other business entity or celebrity.

To resolve these dispute there are two types of resolutions; Non Judicial and Judicial. Regarding Non Judicial, ICANN has formulated UDRP and has approved four Dispute Resolution Service providers. It is important to note that WIPO is the first and main dispute resolution service provider which has played commendable role in soling such disputes. WIPO provides online service for settlement of dispute.48 For judicial disputes some countries like the United States have enacted separate laws whereas other counties are following their Trademark Law to solve such disputes. In India, The Apex Court in 2004 made it clear that the domain name is a valuable corporate asset and is entitled to equal protection as a trademark and the Trade Marks Act, 1999 protects domain name as there is no separate Act for domain Name.

With the increasing use of internet, domain names are increasing and accordingly disputes are also rising. Undoubtedly, we have a strong system of resolving such disputes but need of the hour is to nip the evil in the bud and reduce such disputes by becoming vigilant at the time of registration. For this important suggestions are:

- i. ICANN must be brought under United Nations.
- ii. ICANN should come out with a system of checking SLD at the time of registration.
- iii. Where SLD in the new domain name is confusingly similar to SLD of the existing Domain Name or likely to mislead the internet user, it should not be registered.

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# "DIGITAL RIGHTS AND INTERNET FREEDOM: A LEGAL STUDY OF INTERNATIONAL AND NATIONAL SCENARIO OF LIABILITY OF INTERMEDIARY AND FREEDOM OF SPEECH AND EXPRESSION WITH SPECIAL REFERENCE TO INDIA"

# Jyoti Rattan

Department of Laws, Panjab University, Chandigarh

## Abstract

The right to privacy in the digital age report of July 2014 of the United Nations (UN) High Commissioner for Human Rights, Ms. Navi Pillay, crticised the practice followed by certain countries to store the indefinitely data they collected and intercepted, in the event it is needed in future.<sup>2</sup> In the era of computers, information and communication technologies and the internet, human rights in physical world also include human rights in cyber space. However, recently a controversy has arisen more ferociously all over the globe including India regarding freedom of speech and expression which could be exercised both offline and online. While exercising this freedom online, some unreasonable restrictions are imposed and intermediaries are given duty of blocking, censoring and removing the information transmitted by the internet user. Consequently, such intermediaries who fail to perform their duties are held criminally liable. Therefore, in such a scenario, moot questions that arise are; whether freedom of speech and expression as mentioned in various international instruments can be exercised online without any unreasonable restriction? Can intermediaries (private business entities) be given duties of blocking, censoring the information transmitted by the internet user while exercising their freedom of speech and expression as mentioned in various international instruments can be exercised online without any unreasonable restriction? Can intermediaries (private business entities) be given duties of blocking, censoring and removing the information transmitted by the internet user while exercising their freedom of speech and expression? Can they be held liable for not performing their duties? This paper is a humble attempt to examine these issues from a theoretical perspective.

#### METHODOLOGY

It is theoretical study based on international and national instruments, reports, article and the internet.

**Keywords:** Intermediaries, information and communication technologies, internet, freedom of speech and expression, censoring, unreasonable restriction

#### INTRODUCTION

On 16 July, 2014 the United Nations (UN) High Commissioner for Human Rights, Ms. Navi Pillay, in a report<sup>3</sup> titled, *The right to privacy in the digital age*<sup>4</sup> crticised the practice followed by certain countries to store the data indefinitely that they collected and intercepted, in the event it is needed in future.<sup>5</sup> It stated that: "Mandatory third-party data retention – a recurring feature of surveillance regimes in many States, where Governments require telephone companies and Internet service providers to store metadata about their customers' communications and location for subsequent law enforcement and intelligence agency access – appears neither necessary nor proportionate.<sup>76</sup>

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"Holding intermediaries liable for the content disseminated or created by their users severely undermines the enjoyment of the right to freedom of opinion and expression." "It leads to self-protective and over-board private censorship, often without transparency and the due process of law,"<sup>7</sup> Stated Special Rapporteur on the promotion and protection of the right to freedom of opinion and expression, Frank La Rue in the Annual Report in 2011. Undoubtedly, due to e-revolution technologies and internet communication these days, many new ways have also emerged in which human communication takes place, and has also given rise to new problem areas which were unheard of before.

In the era of computers, information and communication technologies and the internet, human rights in physical world also include human rights in cyber space. However, recently a controversy has arisen more ferociously all over the globe including India regarding freedom of speech and expression which could be

\*Corresponding Author: *jyotirattan@gmail.com* MS received: November 14, 2014, Accepted: November 23, 2015 exercised both offline and online. While exercising this freedom online, some unreasonable restrictions are imposed and intermediaries are given duty of blocking, censoring and removing the information transmitted by the internet user. Consequently, such intermediaries who fail to perform their duties are held criminally liable. Therefore, in such a scenario, moot questions that arise are; whether freedom of speech and expression as mentioned in various international instruments such as the Universal Declaration of Human Rights, 1948; relevant international human rights treaties, including the two international covenants on civil and political rights (ICCPR) and on economic, social and cultural rights (ICSECR), 1966 can be exercised in the cyber space without any unreasonable restriction? Can intermediaries i.e. private business entities, be given duties of blocking, censoring and removing the information transmitted by the internet user while exercising their freedom of speech and expression? Can they be held criminally liable for not performing their duties?

Significantly, unprecedented growth in the use of internet which came into existence in 1960, was root cause of these problems or had further aggravated the situation. In knowledge society of twenty first century, ICTs and internet have become an important aspect of the life and today surviving without this technology and internet appears to be impossible. Considering its growth, the number of users of the internet jumped from 700 million in 2001 to a mere 2 billions users in 2011. Active users of Facebook, an online social networking platform, grew from 150 million to 600 million between 2009 and 2011. The Millennium Development Goals Report 2013 launched in Geneva by the Secretary-General on 1 July 2013<sup>8</sup> claimed that by end of 2014, there will be almost 3 billion internet users.

Examining the issue of freedom of speech and expression online more deeply, the Human Rights Council (HRC) of the United Nations on 26<sup>th</sup> June 2014 adopted 10 resolutions including one on online free speech which provides "Concerning the promotion, protection and enjoyment of human rights on the Internet, the Council called upon all States to address security concerns on the Internet, ensure protection of freedom of expression and of association and other human rights online and stressed the importance of combating advocacy of hatred that constituted incitement to discrimination or violence on the Internet."9

Earlier, for the first time in July, 2012, the Human Rights Council (HRC) of the United Nations unanimously adopted a resolution<sup>10</sup> on Internet Free Speech to protect the free speech of individuals on the Internet which was the first such U.N. resolution of its kind. Approved by 47 members of the HRC where representatives of China and Cuba expressed reservations, this Resolution L13, titled The Promotion, Protection and Enjoyment of Human Rights on the Internet, evokes the Universal Declaration of Human Rights, 1948; relevant international human rights treaties, including the two international covenants on civil and political rights (ICCPR) and on economic, social and cultural rights(ICSECR), 1966; and "all relevant resolutions of the Commission on Human Rights and the Human Rights Council on the right to freedom of opinion and expression.<sup>11</sup> The Resolution affirmed that the same rights that people have offline must also be protected online, in particular freedom of expression, which is applicable regardless of frontiers and through any media of one's choice, in accordance with articles 19 of the UDHR, 1948 and ICCPR and ICSECR, 1966; and second it recognized the global and open nature of the Internet as a driving force in accelerating progress towards development in its various forms. Further, the Resolution indicated that the HRC will continue to consider human rights "on the Internet and in other technologies, as well as of how the Internet can be an important tool for development and for exercising human rights."12 Even U.S. ambassador to the HRC Eileen Donahoe stated, that human rights in the digital realm must be protected and promoted to the same extent and with the same commitment as human rights in the physical world.

Also, International Telecommunication Union (ITU) has affirmed the principle of the right to freedom of opinion and expression "as an essential foundation of the Information Society" since 2003.<sup>13</sup> In September 2011, the UN Human Rights Committee (HR Committee), a treaty monitoring body for the ICCPR, also admitted that: Article 19 of ICCPR protects all forms of expression and the means of their dissemination, including all forms of electronic and internet-based modes of expression.<sup>14</sup>

Further, the Special Rapporteur on the Promotion and

Protection of the Right to Freedom of Opinion and Expression believes that the Internet is one of the most powerful instruments of the 21st century for increasing transparency in the conduct of powerful access to information, and for facilitating active citizen participation in building democratic societies.<sup>15</sup> Significantly, internet cannot work without Intermediaries who play an important role in e- communication and allow netizens to use their computer resource to store e-record during transit. They enable netizens to enjoy their rights on the internet including freedom of expression and access to information. In general "Intermediary", with respect to a particular data message, means a person who, on behalf of another person, sends, receives or stores that data message or provides other services with respect to that data message.<sup>16</sup>

Therefore, whenever freedom of speech and expression is exercised by a netizen in cyber space, intermediaries play a commendable role in storing and transmitting that information or message to other netizens throughout the globe by providing the communication link and other services.

# LIABILITY OF INTERMEDIARY AND FREEDOM OF SPEECH AND EXPRESSION: INTERNATIONAL SCENARIO

Considering the liability of intermediaries, the provisions of Model Law on E-Signature (MLES), 2001 adopted by the United Nations Commission On International Trade Law (UNICTRAL) provide that as state governments do not have sufficient control over how and what is circulated on the Internet, therefore, states are permitted to confer power on intermediaries to exercise control over the netizens and to hold them legally liable for failing to prevent access to content deemed to be illegal. Significantly, United Nations Convention on the Use of Electronic Communications in International Contracts, 200517 did not lay much emphasis on the liability of intermediary regarding freedom of speech and expression. Cyber laws enacted by the states in tune with MLES, 2001 have imposed liability on the intermediaries to check e-communication and to unreasonably restrict freedom of speech and expression on the netizens.<sup>18</sup>

Basically, there are three distinct models of liability for intermediaries:<sup>19</sup>

- 1) The strict liability model: Under this Model, internet intermediaries are liable for third party content. Intermediaries are required to monitor content in order to comply with the law and where they fail to do so, they face a variety of sanctions, including the withdrawal of their business licence and/or criminal penalties. This model is used in some countries like Thailand and China.
- 2) The safe harbour model: This model grants intermediaries immunity, provided they comply with certain requirements. This model is at the heart of the so called 'notice and take down' and can be sub-divided into two approaches:
  - a) The vertical approach: The concept of liability applies only to certain types of content. The best example of this approach is the US Digital Copyright Millennium Act 1998 (DMCA) which lays down a specific 'notice and take down' procedure to deal with complaints about copyright infringement.<sup>20</sup> Other countries have adopted similar procedures.
  - b) The horizontal approach: Under this approach different levels of immunity are granted depending on the type of activity at issue. This model is based on the E-Commerce Directive (ECD) in the European Union<sup>21</sup> where almost complete immunity is provided to intermediaries who merely provide technical the internet such access to as telecommunications service providers or ISPs and to caches. However, hosts may lose their immunity if they fail to act "expeditiously" to remove or disable access to "illegal" information when they obtain actual knowledge of such content.<sup>22</sup> This provision effectively provides the basis for what is known as a 'notice and take down' procedure. This approach is followed in Western countries such as France, the United Kingdom, and the USA. Significantly, in India too, this approach of safe harbor Model is followed.
- 3) The broad immunity model: It grants internet intermediaries broad or conditional immunity from liability for third-party content and exempts them from any general requirement to monitor content. With this model, intermediaries are treated as

'messengers,' who are not responsible for the content they carry, rather than as 'publishers', who are responsible for the content that they disseminate although it is produced by others. It can be found, in the USA,<sup>23</sup> Singapore<sup>24</sup> or the EU.

Accordingly, various intermediaries ban certain types of content on internet and act as gatekeeper of internet, usually outside the scope of any internationallyrecognised legitimate restrictions on freedom of expression under UDHR, 1948, ICCPR, 19666 and ICESCR, 1966.<sup>25</sup>

Significantly, this role of censorship allotted to the intermediaries is in controversy and the jurists all over the globe criticize this liability of intermediaries. Even in 2011, Special Rapporteur on the promotion and protection of the right to freedom of opinion and expression, Frank La Rue in the Annual Report stated that Governments all over the globe are compelling ISPs and website operators to help in censorship efforts. He stated that censorship measures should never be delegated to private entities, and that intermediaries should not be held liable for refusing to take action that infringes individuals' human rights. Any requests submitted to intermediaries to prevent access to certain content, or to disclose private information for strictly limited purposes such as administration of criminal justice, should be done through an order issued by a court or a competent body which is independent of any political, commercial or other unwarranted influences.<sup>26</sup>

The Special Rapporteur further, opined that any request submitted to intermediaries to prevent access to certain content, or to disclose private information for strictly limited purposes such as administration of criminal justice, must be dealt with, by a court or a competent body which is independent of any political, commercial or other unwarranted influences. The Special Rapporteur also recommended intermediaries to: only implement restrictions to these rights after judicial intervention; be transparent to the user involved about measures taken, and, where applicable, to the wide public; to disclose details regarding content removal requests and accessibility of websites; provide, if possible, forewarning to users before the implementation of restrictive measures; and minimize the impact of restrictions strictly to the content involved.27

Considering the global picture of law relating to liability,

the United States provided very broad protection from liability to ISPs and other intermediaries. Section 230 of the Communications Decency Act, 1996 provides that no provider of an interactive computer service will be liable for any good faith action designed to restrict access to obscene content. Even the Digital Millennium Copyright Act (DMCA) protects intermediaries where users have infringed copyright of other person.28 However, Article 12 of the European E-Commerce Directive 2000/31 (ECD), provides that internet access providers and other providers of technical services can be made liable, as his activity is "mere conduit" i.e., "the transmission in a communication network of information provided by a recipient of the service, or the provision of access to a communication network." Like the DMCA, the ECD provisions requires that the ISP does not select or modify the content or the receiver of the transmission, and that no storage is made other than for the sole purpose of carrying out the transmission in the communication network, and for no longer than is reasonably necessary for the transmission. However, a EU study had identified certain loopholes with this article i.e., the lack of definition of "communication network" and the uncertainty over whether filters would be considered to select or modify the content.29

In Turkey, ISPs are required to assist in blocking several categories of content, including "insulting" the longdeceased founding father of the Turkish republic, Mustafa Kemal Ataturk. In Italy, Google executives faced criminal liability for hosting an insensitive YouTube video despite the fact that Google complied promptly with the takedown request.<sup>30</sup> In Japan, law provides that online service provider's function is to communicate third party information to other parties, and has established a unique safe harbor for secondary liability, based on the actual or constructive knowledge of illegal activity and the necessity of the measure in order to prevent infringements.<sup>31</sup> Similarly, in China liability of intermediary for transmission of illegal information by the internet user depends on the actual or constructive knowledge.32

It is important to note that Special Rapporteur on the promotion and protection of the right to freedom of opinion and expression, Frank La Rue in the Annual Report has appreciated US law, i.e., the Digital Millennium Copyright Act's notice-and-takedown system and also its counterpart in Europe. He praised them for shielding intermediaries from liability. *Special Rapporteur* La Rue also appreciated Chilean law, which only requires intermediaries to remove content in response to a court order.<sup>33</sup>

# LIABILITY OF INTERMEDIARY AND FREEDOM OF SPEECH AND EXPRESSION: INDIAN SCENARIO

India was signatory to Model Law on E-Commerce(MLEC), 1996 so it was obligatory for India to enact its cyber law in tune with said Model Law, hence. India enacted the Information Technology Act (ITA), 2000. This Act was further amended by the Information Technology (Amendment) Act 2008 so as to make it in tune with the MLES, 2001. Section 66A incorporated by the said Amendment Act provides punishment for online communication which is grossly offensive", or persistent sending of information known by the sender to be false, to cause "annovance, inconvenience, danger, obstruction, insult, injury, criminal intimidation, enmity, hatred or ill will" or sending e-mail causing annoyance or deceiving receiver about the sender. Therefore, some jurists believe that Section 66A of the IT Act, 2000 imposes unreasonable restrictions on online free speech which are not mentioned under in various international instruments (Article 19 of UDHR, 1948, Article 19 of ICCPR, 1966 etc.) and also in article 19(2) of the Indian Constitution.

In this regard an important question is, can intermediary be held liable for such illegal e-communication by the internet user? As mentioned earlier, India follows horizontal approach of safe harbor model of intermediary liability because of technical and economic impracticalities, intermediaries cannot be expected to monitor or regulate the vast amount of content which they host on their servers for their subscribers nor the phenomenal amount of material that is transmitted through the internet each day.<sup>34</sup>

Under section 79 of the Information Technology Act 2000, intermediary as such is not liable while publishing third party information provided he fulfills following conditions: the function of the intermediary is limited to providing access to a communication system over which information made available by third parties is transmitted or temporarily stored or hosted; or the intermediary does not initiate the transmission, select the receiver of the transmission; and select or modify the information contained in the transmission; and the intermediary observes due diligence while discharging his duties under this Act and also observes such other guidelines as the Central Government may prescribe in his behalf. However, due diligence to be observed by intermediary is mentioned under Rule 3 of the Information Technology (Intermediaries Guidelines) Rules, 2011.

Significantly these Rules were challenged in various writ petitions. Lets briefly analyse various cases:

# IMPORTANT WRIT PETITIONS IN INDIA RELATING TO LIABILITY OF INTERMEDIARIES AND ONLINE FREEDOM OF SPEECH AND EXPRESSION

In Shoran Jacob VS. Union of India & Others<sup>35</sup> a writ petition was filed in March 2012 before the Hon'ble High Court of Kerala where the petitioner challenged Rule 4 of the 'Information Technology (Intermediaries Guidelines) Rules, 2011 and Rules 8 and 16 of the Information Technology (Procedure and Safeguard for Blocking for access of information by public) Rules, 2009 as arbitrary, unreasonable, illegal and unconstitutional as they are violative of the fundamental right of the internet users of freedom of speech and expression guaranteed under art 19 1(a) of the Constitution of India.

Rule 4 of above mentioned Rules, under which the Government has transferred the power to censor, block or ban the websites and contents on the Internet to the intermediaries was challenged on the grounds that: the intermediaries are private companies who have their own business interest to protect and cannot be expected to be guardians of free speech; the owner of the content or the user

concerned has no opportunity for understanding the reasons for censoring his content; and no provision in the Rules to file an appeal hence. Rule 8 of abovementioned Rules is challenged because the Rule the government has empowered the 'Designated officer' of Computer Emergency Response Team (CERT-India) to block websites, blogs and content after giving notice but practically it is not complied with and the user concerned is not given a fair hearing; there is no mandate to issue notice to the ultimate affected user/ owner of the content; and there is also no provision in the Rules to file an appeal. Reason for challenging Rule 16 of the above mentioned Rules is that it enables

the designated officer not to serve a copy of the complaint or order so as to curtail the rights of the user concerned to resort to judicial remedies and is therefore arbitrary, unjust, illegal and unconstitutional. The Rule enables the designated officer to be secretly engaged in censoring the internet.

Consequently, the petitioner claimed that these rules must be declared as arbitrary, unreasonable, illegal and unconstitutional and set aside the same; and guidelines must be issued to respondent 1 to that effect; immediately after the blocking, banning or censoring the content a copy of the order stating reasons shall be communicated to the owner of the content/ user concerned so as to enable them to resort to judicial remedies; the Internet Service Providers (ISP) must be instructed to develop the technical competence to block only the specified webpages/websites which have been directed by the Courts/ orders of the government; and the deciding and censoring power must be taken from the intermediaries and must be conferred on a government appointed body like Computer Emergence Response Team (CERT-In) so as to ensure uniformity in the blockings.

Subsequently, in May 2012 *Amithab thakur vs. UOI*<sup>36</sup> Allahabad High Court orders all intermediaries like Google, Yahoo, Facebook, My Space etc like Google, Yahoo, Facebook, My Space etc to appoint public grievance officer in accordance with the IT(Intermediaries Guidelines) Rules. The bench of Justice Devi Prasad Singh and Justice Saeed Uz-zaman Siddiqui stated that if the Government of India has framed any Rules, then they must properly enforced.

In Rajeev Chandrashekar v. Union of India<sup>37</sup> writ petition has been filed in public interest under Article 32 of the Constitution of India, challenging Section 66A of the Information Technology Act, 2000 and Rules 3(2), 3(3), 3(4) and 3(7) of the Information Technology (Intermediaries Guidelines) Rules, 2011 as unconstitutional. However, the Department of Information Technology (DEITY) issued a clarification on the Information Technology (Intermediary Guidelines) Rules, 2011 stating that the intermediaries should respond within 36 hours and they should redress such complaints within one month.

Again in *PUCL v. Union of India* <sup>38</sup> the petitioner challenged the provisions of the Information Technology

Act, 2000 and Rules made thereunder that criminalise and otherwise restricts or restrains free speech which is permitted under article 19(1)(a) of Constitution of India. Accordingly, citizens are being arrested and criminalized for speaking truth and "annoying" those who are able to move police to act against them. Significantly, here petitioner challenged the Information Technology (Procedure and Safeguards for Blocking for Access of Information by Public) Rules, 2009 commonly known as the Website Blocking Rules, The Intermediary Rules are formally known as the Information Technology (Intermediaries Guidelines) Rules, 2011(Intermediary Rules) and section 66A of the IT Act 2000.

The Website Blocking Rules were challenged as they allow the DEITY of the central government to secretly censor speech on the internet, without providing reasons for censorship and without informing the person who has written or uploaded the content. However, the Intermediary Rules govern the relationship between users and intermediary such as Google, Yahoo, Facebook et al but also Airtel, MTNL, or the owner of a blog who hosts external content. Under the Rules intermediaries are required to block the prohibited content which is "grossly harmful", "blasphemous", "invasive of another's privacy", "ethnically objectionable", "disparaging" etc. Astonishingly, these terms are not defined anywhere, so intermediaries are required to use its discretion to decide whether internet content is covered under these terms and hence to block the contact, or face civil or criminal consequences.

Under section 66A any writing or speech that is "annoying" or "inconvenient" and is written or spoken on the internet (private emails included) or via SMS on a cell phone punishable with imprisonment for upto three years.

The petitioner submitted that number of citizens are facing criminal charges<sup>39</sup> and prayed that: the directions be issued for the suspension of Section 66A of the Act and for the formation of a Committee of experts in law and IT to review criminal complaints and ongoing cases registered under Section 66A of the Act; No FIR be registered or action taken by police authorities or cases be continued pursuant to Section 66A until approval by said committee; blocking the content by the government authority must record reasons. Further, the
petitioner submitted that till the disposal of the present petition, the respondent must notify intermediaries that the content taken down under the Intermediaries Guidelines Rules be required to pursue the following procedure: when the intermediary is brought to actual notice in writing of uploaded content in violation of law it must take steps: to inform the user who has uploaded the content; to initiate action on complaints within 36 hours; to redress such complaints promptly but in any case within one month from the date of receipt of complaint; and to allow take down of content if no reply is received from the user.

Finally, the Supreme Court of India decided to hear all petitions related to liability of intermediary and the regulation of free speech online together and fixed first week of January 2014 for a final hearing "on merits".40 Significantly, of the 5 respondents<sup>41</sup> only the Internet Service Providers Association of India (ISPAI) has filed a reply. ISPAI has stated in its reply that "ISPs neither create content of any sort, nor do they own, promote, modify or edit it; as ISPs are private bodies so they must not block without specific orders from the courts or government because otherwise it would amount to pre-censorship of contents without authority of law and could unfairly limit the fundamental rights of the customers and may expose them to liability under civil laws; ISP being a private body cannot decide whether information uploaded by the netizen is illegal because "one man's pornography is another man's high art", using AIDS awareness websites and photographs of Khajuraho as examples of how explicit material is not always pornography." 42 It is important to note that final decision is still awaited.

#### **CONCLUSION AND SUGGESTIONS**

Based on the above indepth observations and analysis, it is concluded that internet and ICTs are playing commendable role in the life of everyone and has provided a new method for exercising freedom of speech and expression. Freedom of speech and expression is an essential human right and is provided in various international instruments like UDHR, 1948, ICCPR, 1966 and ICESCR, 1966. Significantly this freedom now be exercised both offline and online as mentioned by the HRC. However, in India section 66A of ITA, 2000 has imposed unreasonable restrictions on this freedom while exercised online and has made netizen who has uploaded that information criminally liable. Consequently, various persons were arrested for violating this section and writ petitions are pending in the Apex Court of India.

Further, the role played by the intermediaries in enabling the netizen in exercising this freedom of speech and expression online is worth appreciating as they provide communication link or computer recourse for storing and transmitting e-record, data and information. But at the same time, UNICITRAL's Model Law on E-Signature, 2001 has required states to impose liability on checking, blocking and censoring such data or information. Basically there are three main models of liability of intermediaries; The strict liability model; The safe harbor liability model (The Vertical approach and The horizontal approach); and The broad immunity model. Different models are followed by the different countries. Consequently, under cyber law of almost every country, intermediaries are made liable where they fail to perform their duties i.e. the USA, France, china, Japan etc. Further, the Special Rapporteur on the promotion and protection of the right to freedom had also criticized the liability of the intermediaries in restricting the freedom of speech and expression of the netizens and had made various recommendations.

In India, the safe harbor liability model (horizontal approach) is followed and under Section 79 of the Information Technology Act 2000, intermediary is not liable for online communication of third party. However, he must follow certain conditions and debatable condition is observance of due diligence. Rule 3 Intermediaries Guidelines Rules, 2011 mentions, due diligence to be observed by the intermediary. However, some jurists believe that instead of clarifying what is meant by 'due diligence', the Rule create a notice and takedown system, forcing intermediaries to be excessively cautious such that they prefer removing content to challenging a takedown notice. Further, Rule 4 of the said rules is also criticised and main allegation is that the Government has transferred the power to censor, block or ban the websites and contents that appear in the Internet to the intermediaries. Main criticisms is : censoring is done by the Intermediaries (private entities) which must be done by government bodies after following proper procedure.

Rule 8 of Blocking Rules, 2009 is also alleged to be

unreasonable, illegal and unconstitutional as under the said Rule the government has empowered the 'Designated officer' of Computer Emergency Response Team (CERT-India) to block websites, blogs and content after giving notice to the accused but it is not complied with and the user concerned is not given a fair hearing in some cases. Therefore, a number of writ petitions were filed before the apex court of India. The Court decided to hear all the petitions together and final decision is still awaited. However, in Shreya singal v. UOI43 Section 66A of the Information technology Act 2000 has been declared as unconstitutional on the ground that it takes within its sweep protected speech and speech that is innocent in nature and is liable therefore to be used in such a way as to have a chilling effect on free speech. The Court observed that Section 66A purports to authorize the imposition of restrictions on the fundamental right contained in Article 19(1)(a) in language wide enough to cover restrictions both within and without the limits of constitutionally permissible legislative action. However, Section 69A and the Information Technology (Procedure & Safeguards for Blocking for Access of Information by Public) Rules 2009 are constitutionally valid.

Similarly the Apex Court upheld the validity of Section 79 subject to Section 79(3)(b) being read down to mean that an intermediary upon receiving actual knowledge from a court order or on being notified by the appropriate government or its agency that unlawful acts relatable to Article 19(2) are going to be committed then he must expeditiously remove or disable access to such material. Similarly, the Information Technology "Intermediary Guidelines" Rules, 2011 are valid subject to Rule 3 subrule (4) being read down in the same manner as indicated in the judgment.

Need of the hour is to implement various recommendations by the Special Rapporteur on the promotion and protection of the right to freedom and for this important suggestions are:

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- Freedom of speech and expression as mentioned in various international instruments such as UDHR, 1948 and ICCPR, 1966 must be permitted online in the same way as offline as suggested by the HRC. Hence, only reasonable restrictions as mentioned under these Rules must be imposed.
- 2) The MLES, 2001 and the United Nations Convention on the Use of Electronic Communications in International Contracts, 2005 must be amended or new international instrument i.e., the United Nations Convention on liability of Intermediaries in Electronic Communications must be adopted to abolish liability of the intermediaries in checking, blocking and censoring the information of the netizens and they must be given this freedom as they exercise offline. Under new instrument:
  - Wherever intermediary have to implement any restriction on online free speech, it must be done by the intervention of the court as suggested by the Apex Court;
  - The intermediary must be transparent to netizens while taking action and proper notice must be served;
  - c. Whenever it receives any complaint regarding uploading an illegal content it must verify the complaint properly.
- Various countries must modify and amend their cyber law in tune with the new international instrument till then judiciary must take action in declaring law (making intermediaries liable) void.
- Information Technology "Intermediary Guidelines" Rules, 2011 must be applied in the strict manner as directed by the Apex court of India in Shreya Sengal Case (while abolishing Section 66A of the Information Technology Act 2000).

www.ictpulse.com/2014/07/privacy-digital-age

<sup>2</sup> NSA whistle-blower, Edward Snowden, in June 2013, was that the US Government was storing the data it collected and intercepted indefinitely, in

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the event it is needed in the future.

3. The Report was requested by the UN General Assembly, following the Resolution 68/167 Passed in December 2013, which reaffirmed and extended the right to privacy persons have offline, online. Though the General Assembly noted the concern about the need for public/ national security measures, it emphasised that unlawful, arbitrary or mass scale surveillance, or interception of communications, were highly intrusive and violated "the rights to privacy and to freedom of expression and may contradict the tenets of a democratic society". In addition to calling for countries to respect and protect the right to privacy both offline and online, the Resolution asked them to:

> ...take measures to put an end to violations of those rights and to create the conditions to prevent such violations...

> ...review their procedures, practices and legislation regarding the surveillance of communications, their interception and the collection of personal data, including mass surveillance, interception and collection, with a view to upholding the right to privacy...

> ...establish or maintain existing independent, effective domestic oversight mechanisms capable of ensuring transparency, as appropriate..."

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## STATE-OF-ART IN COMPONENTS OF AUTOMATIC VEHICLE PLATE RECOGNITION

#### Anuj Kumar\*, Anuj Sharma and R. K. Singla

Department of Computer Science, Panjab University, Chandigarh, India

#### Abstract

Automatic Vehicle Plate Recognition (AVPR) is an image processing and pattern recognition technique which is used to identify vehicles using their vehicle plate numbers. AVPR can be applied in parking areas, highways, bridges and tunnels to help a human operator to improve overall quality of a service. The process of AVPR is divided into six stages. Firstly, Data consisting of videos of moving vehicles and images of vehicles is acquired using a camera. The noise is removed from the image of the vehicle in preprocessing stage. In Plate Detection stage, vehicle plate is extracted from the preprocessed image of the vehicle. The characters on the vehicle plate are isolated in the plate segmentation stage. The ûnal stage is to recognize the alphanumeric characters present on the vehicle plate. This paper highlights the techniques used in Automatic Vehicle Plate Recognition System including the future challenges.

Index Terms: Automatic Vehicle Plate Recognition, feature extraction, Segmentation, Optical Character Recognition, Plate Localization, Character Recognition.

#### INTRODUCTION

Vehicles are the important part of transportation and its increase has been observed in recent past based on unmatched advantages. This leads to an interesting problem in computer vision and pattern recognition as vehicle monitoring and recognition through machines. Vehicles have an external component as number plate used for its identification in social life. Therefore, recognition of this number plate through machine and identification of its overall shape save cost, manual efforts and time. There is a need for automation of process of vehicle plate recognition. Automatic vehicle plate recognition comes in image processing and pattern recognition problem. Automatic recognition of car license plates plays an important role in trafûc surveillance systems. Such system which is applied in parking areas, highways, bridges and tunnels, can help a human operator and improve overall quality of the service <sup>1</sup>. Automatic number plate recognition is a mass

surveillance method that uses optical character recognition on images to read vehicle registration plates. It is a technique which is used to identify vehicles using their license plate numbers. It is the process of extraction of vehicle plate number from an image of a vehicle or video of a moving vehicle. The main use of AVPR is security. This technique is very helpful in toll collection, parking management, access control, radar based speed control, boarder control. and road patrolling. Figure 1 shows the working of AVPR process.

First of all the video of a moving vehicle is taken using a camera. That video is converted into frames. Key frame is to be selected from the frames of video. Then vehicle plate is to be extracted from the image of the vehicle. Software for character recognition is to be run to recognize the Vehicle plate number.





As stated in <sup>2</sup>, there are seven primary algorithms that the system requires for identifying a license plate:

- Plate Localization In this algorithm potential license plate is localized from the image of the Vehicle. This algorithm is responsible for finding and isolating the plate on the image of the Vehicle.
- Plate Orientation and Sizing In this algorithm dimensions of the Vehicle Plate is adjusts to the required size and skew of the plate is compensated. The size of the plate is converted to the normal size.
- Normalization As videos are taken in real environment in uncontrolled illumination, the noise is removed and the brightness and contrast of the images are adjusted using this algorithm.
- Character Segmentation After localizing the plate, the plate is segmented to extract the characters for recognition. This algorithm is used to isolate the characters from the image component..
- Optical Character Recognition This algorithm is used to recognize the alphanumeric characters present on the Vehicle Plate. The output of Optical Character Recognition is the Vehicle plate license number.
- Syntactical/Geometrical analysis As different countries have different rules for license plate numbers, this algorithm check characters and positions against country-specific rules.
- The averaging The averaging of the recognized value over multiple images to produce a more reliable or conûdent result. Especially since any single image may contain a reflected light ûare, be partially obscured or other temporary effect.

The basic requirement for any Number Plate Recognition system, for practical implementation, is realtime performance with high recognition accuracy. The algorithm for Automatic vehicle plate recognition should have high recognition speed, accuracy and consistency <sup>3</sup>.

There are many challenges in recognizing the vehicle number plate. Text on plates may be written in different languages and fonts. Size of vehicle plates is not same. Plate may exists in different location of image of vehicle There may be dirt on the plates. Plates may have different types of illumination due to environment. Plates may have unnecessary text. Vehicle Plates have screws. Vehicles plate may be tilted. There may be poor lighting due to shadows and reflections.

## SYSTEM DESIGN

Firstly, Data consisting of videos of moving vehicles and images of vehicles is acquired using a camera. Features of camera such as resolution, shutter speed and orientation have to be considered into account while making the video of a moving vehicle and images of vehicles. Video is to be converted into the frames and the key frame is to be selected. As the videos and images are taken in real environment under uncontrolled illumination, there may be noise and low contrast. The noise is removed from the image of the vehicle in second stage. Contrast adjustment is also performed on the image. The image is enhanced and preprocessed so that it is easy to recognize the number. In next stage, the vehicle plate is to be extracted from that image. The input of this stage is a vehicle image and output is the portion of the image carrying the vehicle plate. The candidates regions are extracted according to the features of the license plates such as rectangular shape of plates, presence of characters on the plates and specific color of the plate. The characters on the vehicle plate are isolated in next stage. The features like size, color and position of the characters are considered into account while extracting the characters. The vehicle plate is segmented to extract the characters for recognition. The input to this stage is license plate of vehicle and output is the characters. The final stage is to recognize the alphanumeric numbers present on the vehicle plate using features of the characters like shape and size. The output of this stage is the number of the license plate of vehicle. The success of the AVPR system depends on the successful completion of each stage of the system. The figure 2 represents the stage wise description of the Automatic Vehicle Plate Recognition System.



Fig. 2. Steps for AVPR

## AVPR COMPONENTS

#### A. Preprocessing

The Data acquisition is the first stage in the AVPR system where the videos and images of vehicles is acquired using the camera. As the videos and images are taken in real environment under uncontrolled illumination, there may be noise and low contrast. The image may contain impurities such as holes and dirt particles. The noise is removed from the image of the vehicle in preprocessing stage. Contrast adjustment is also performed on the image in this stage. The image is enhanced and preprocessed so that it is easy to recognize the number. In 4,5 and 6 Gaussian filter is used to remove the noise from input image. A Gaussian filter smoothes an image by calculating weighted averages. Blur of the image is controlled by Gaussian filter. Authors in <sup>1</sup> used Histogram Equalization for contrast enhancement. Authors 7, 8 and 9 used Median Filtering to remove noise from the foreground of the image. Median filtering is a technique that removes noise form the image while preserving the edge information. It works by moving through the image pixel by pixel, replacing each value with the median value of neighboring pixels. A Mexican Hat Filtering is used to remove noise and distortion on the images in <sup>10</sup>. This method is used to enhance spots in noisy images. Reference <sup>11</sup> and <sup>12</sup> used Morphological operators to further refine the image. Image corrosion technology is used to remove the effect of the image edge burr in <sup>11</sup>. In <sup>12</sup>, brightness variation is corrected by gamma intensity correction, difference of Gaussian, local histogram matching and local normal distribution. The erosion method is used in <sup>13</sup> for noise removal. It computes for each pixel in image a local minimum in the area covered by a 3\*3 pixel kernel. ULEA (Unwanted Lines

Elimination Algorithm) is used in <sup>14</sup> to remove noise and enhance image. Various methods like Gaussian, Median, Kalman can be used to remove the noise and reduces sharp edges in the image. All these methods to remove the sharp edges and discontinuities creates a water color image of the real image. Gaussian ûlter has a better performance as compared to median ûlter in high noise image processing <sup>15</sup>.

#### **B. Plate Detection**

Vehicle Plate Detection is the extraction of Vehicle plate from the preprocessed image of the vehicle. The input of this stage is a vehicle image and output is the portion of the image carrying the vehicle plate. The main objective is to identify location of vehicle plate in the image. The candidates regions are extracted according to the features of the license plates such as rectangular shape of plates, presence of characters on the plates and specific color of the plate. The localization of the plate is very important phase of AVPR system. The success of AVPR system depends upon the accuracy of plate detection step. In 4, Radial Basis Function Neural Network(RBFNN) is used to detect the vehicle plate. Otsu's thresholding method is used to detect the plate region in <sup>6</sup>. This method can recognize the plates under different illumination conditions. Potential plate regions are found on the basis of features, such as aspect ratios and the number of pixels. Reference<sup>8</sup>, <sup>17</sup> and <sup>18</sup> proposed connected component analysis to localize and extract the plate from the image of the vehicle. Authors in <sup>19</sup>, used edges as a feature to detect plates. They proposed edge clustering using Expectation-Maximization algorithm for detection. This method is very effective for the purpose. Reference <sup>7</sup> detected the vehicle plate by finding the contours of connected components in the frame. These components are further processed based

on template matching to und Region of Interest(ROI). Region of Interest is judged on the basis of size and aspect ratio of the plate. Cropping method in MATLAB is employed to extract the vehicle plate from the image of car in <sup>10</sup>. Sobel edge detectors is used in <sup>11</sup> to locate the four corners of the vehicle plate. Sobel edge detector uses a 3\*3 mask on image to give edged image. In [5], Authors use canny edge detection method to find the edges. Hough transformation is used to detect the plate in <sup>9</sup>. Reference <sup>21</sup> used adaboost algorithm with convolutional feature and cascade classiûer to localize the license plates. In 22, Sobel edge detector, morphological algorithm and dilation is used to ûnd rectangles in the vehicle image. All the rectangles are compared with plate dimension to extract the vehicle plate. In <sup>23</sup>, Authors found connected components to detect the number plate. In <sup>24</sup>, Authors used connected component property, area, aspect ratio and white/black pixels ratio of license plate to detect the plate. Tophat transformation method is used in 25 for plate localization from the image. Top-hat transformation technique is used to correcting the effects of non uniform illumination. Then Area and aspect ratio is used to detect the plate. In <sup>26</sup>, Authors presented a simple, fast and efficient technique using SIFT (Scale Invariant Feature Transform) features. In this technique, SIFT based template matching is used to locate special marks in the license plate. Based on these marks, the plate is segmented out from the image of vehicle. In <sup>11</sup>, Authors used mathematical morphology and color positioning for plate recognition. Mathematical morphology method uses the elements with a certain shape to measure and extract the corresponding shape from the image. In <sup>12</sup>, license plate is located by Optimal Adaptive Correlation (OAC) technique. OAC algorithm gives a high overall pace to the process of license plate localization. In <sup>27</sup>, Plate localization is performed by adaptive thresholding and edge detection. Thresholding is a technique where pixels are separated depending on the value of threshold. Accuracy of result depend on appropriate selection of threshold value. In 6, Wavelength transform and RBFNN are used for license plate recognition. Decomposition of image in different layers is done by Wavelength transform and license plate is recognized by RBFNN. The algorithm in <sup>28</sup> localized the plate through the detection of white regular rectangular area to the right of a red, green or blue rectangular area. The colors are detected by converting the image into the LAB color space and using level set methods to extract the contour. Authors in <sup>29</sup> used Principal component analysis and artificial neural networks to detect the car plate. In <sup>13</sup>, the algorithm for plate detection ûrstly searches the image for plate digits as in character features method and then groups them and analysis them to determine a license plate. This method can identify the plate location even when plate contains drawings in background. Binary jump and image differencing techniques are used in <sup>15</sup> to determine the location of vehicle plate in the image. Binary jump method is used to detect top/down boundaries of license plate and left/right boundaries are detected by image differencing technique. In <sup>30</sup>, Authors ûrstly applied level set based LPL process to find candidate plate regions and then a graph grammar is applied to each candidate location to recognize the license plate. Algorithm in <sup>31</sup> used canny edge detection operator to get transition between white and black colors of the plate. VEDA (Vertical Edge Detection algorithm) is used in <sup>14</sup> to localize the plate region. VEDA algorithm can work on blurry images and is based on the contrast between gray scale values. This algorithm is better than Sobel operator for extracting vertical edges. In 32, Morphological operator is used for plate extraction. It is a method of image processing based on shapes. First derivative of Gaussian smoothing filter is the base of canny edge detection operator. In 33, Authors presented an two stage approach based on characteristics of characters connection and projection. The candidate region is roughly located based on characters connection feature in ûrst stage. The median ûlter and projection is used to ûnd the exact position of the license plate. In <sup>34</sup>, morphological operations and color information of the plate is used to locate the plate. Morphology is a technique which is used for shape analysis. Fuzzy logic is introduced in <sup>35</sup> for color recognition of the plate. HSV color space is used for color feature extraction. Reference <sup>36</sup> proposed OCS (Operator Context scanning) algorithm for License plate detection. OCS algorithm is applied on the sliding concentric windows pixel operator to improve the performance of the system. A region based license plate detection method is presented in <sup>37</sup>. Candidate regions are extracted using mean shift firstly. Then candidate regions are analyzed and classified to detect the plate. Reference <sup>38</sup> used vertical edge detection and morphology to extract the region of interest from the image of the car.

#### C. Plate Segmentation

The characters on the vehicle plate are isolated in this stage. The vehicle plate is segmented to extract the characters for recognition. The features like size, color and position of the characters are considered into account while extracting the characters. The input to this stage is license plate of vehicle and output is the alpha numeric characters present on the vehicle plate. In <sup>16</sup>, CSV Column Sum Vector Charts are used for extraction of characters. Authors proposed MSER based character segmentation in <sup>19</sup>. MSER detector can recognize characters effectively. Bounding Box technique is used to to detect characters in the image by the authors in <sup>10</sup>. In bounding box method, each segment in the plate is counted and represented one by one. Authors <sup>20</sup> used horizontal projection to find starting and end points of characters. Horizontal Projection is used to extract the characters form the image in 9. Authors used local Otsu's method to segment the characters. Reference <sup>21</sup> and <sup>39</sup> used horizontal and vertical projection to segment the plate. In <sup>40</sup>, Authors presented an algorithm based on pixel projection and morphological operations. They introduced two optional morphological operations in proposed algorithm to minimize the effect of noise. In this algorithm horizontal projection step is replaced by NP height optimization step. In <sup>11</sup>, Horizontal projection is performed to calibrate the license plate. The position of each character is found by calculating the projection. In <sup>12</sup>, characters are segmented by edge detection methodology. Reference <sup>41</sup> proposed two stage segmentation method for segment characters from the plate. A template matching algorithm using a harrowshaped filter (HSF) bank is used in first stage. It detects the locations of segmenting points between characters. Avariant of A\* path-finding algorithm is used for accurate segmentations between connected characters at second stage. In <sup>31</sup>, BLOB (Binary Large Object) coloring technique isused to find the boundaries of the characters. This techniques makes use of a L shaped template to scan the image from left to right and from up to down to ûnd the characters. Dilation operator is used in <sup>32</sup> to separate the characters from each other. Then, Authors proposed partition scanning to extract the characters from the plate. Th is approach is conducted by checking the mean of each partition. Reference <sup>42</sup> proposed grey-level quantization and

morphology analysis algorithm to obtain characters from the plate. Local binarization method is combined with this algorithm to improve performance of segmentation. Authors of reference <sup>18</sup> used shift ûltering technique for extracting the characters from the vehicle plate and segmentation.

#### **D. Character Recognition**

The final stage is to recognize the alphanumeric characters present on the vehicle plate using features of the characters like shape and size. The output of this stage is the number of the license plate of vehicle. Probabilistic Neural Network is used to recognize the characters in <sup>16</sup>. Authors <sup>17</sup> introduced Digital Board method for computing feature vector for each character uniquely. They used Genetic Algorithm for recognizing the characters at second level. In 7, Authors preprocessed the localized plate for noise removal and edge enhancement. After preprocessing, characters are separated by using Minimum Boundary Rectangle. Then characters are classified using a nearest neighbor classifier. Template matching is used in <sup>10</sup>, <sup>24</sup>, <sup>26</sup>, <sup>11</sup>, <sup>27</sup> and <sup>32</sup> for recognizing the characters. In template matching, segmented characters are matched with the database templates. The best match is be the recognized character. This method is called OCR which is a mechanical and electronic conversion of images of text to machine encoded text. In <sup>20</sup>, a dilation operation is used to enhance the image and MLP is used for character recognition. Reference <sup>43</sup> proposed OCR based multi-layer neural network to recognize the characters present on the vehicle plate. Normalized Cross Correlation template matching is used in <sup>8</sup> to recognize the characters. Normalized cross Correlation is a template matching technique which is used to ûnd the degree of similarity between characters and templates. In <sup>18</sup> and <sup>42</sup>, Artificial Neural network is used and trained for feature extraction and character recognition. Statistical correlation method was used in matching the character in <sup>22</sup>. Then, Artificial Neural Networks were designed and trained for features extraction. OCR approach based on convolutional neural network for feature extraction and linear support vector machines for classification is used in <sup>44</sup>. Good results were achieved by training linear support vector machines on the resulting convolutional neural network features. In <sup>12</sup>, cross correlation based approach is used for

classification. This method computes the similarity between the character and its matching template. The D-isomap based method is used for final character recognition which yields higher recognition rate. In 28, detected plates are pre-processed and then feeded their extracted features to a trained neural network for recognition. Author in <sup>45</sup> used MUNL shape descriptor for extracting outer contour of characters and Partial Point Matching Algorithm (PPMA)to match the characters to the templates. The maximal similarity measure indicated the recognized character. This algorithm was used to recognize Polish car license plates. Feed-forward neural network based OCR algorithm is proposed in <sup>46</sup> to translate scanned character images into machine encoded text. In this algorithm, Authors used noise added training process on neural network for better performance. Binary Large Objects (BLOB) analysis in <sup>13</sup> is used for character recognition. In this method, characteristics of characters like location, aspect ratio and dimension are used to identify the characters. In <sup>31</sup> MLP (Multi Layered Perceptron) ANN model was used for classification of the characters. Two sperate ANN were used by authors to increase the success rate of the character recognition. In 47, Authors trained data sets for MLP with three hidden layers with sigmoid functions. The performance of MLP neural network model is higher for character recognition.

## DISCUSSION

This section described the study of AVPR components on our own collection of Data. We have collected data in form of video and images from three gates of the Panjab University, Chandigarh. Then, we wrote a code in MATLAB to convert video into frames and then key frame is to be selected. Now, we have removed the noise using >> m = medfilt2(image) command in MATLAB. Then, Vehicle Plate will be extracted from the preprocessed image of the vehicle. The location of Plate will be identified. The characters on the vehicle plate will isolated in next stage. The vehicle plate will be segmented to extract the characters for recognition. The features like size, color and position of the characters can be considered while extracting the characters. The final stage is to recognize the alphanumeric characters present on the vehicle plate using features of the characters like shape and size. The stepwise description is shown in fig 3:

#### SUMMARY

This paper gave a comprehensive survey of Automatic License Plate Recognition techniques available in literature. The process of AVPR is divided into six stages. Videos and images of vehicles is acquired using the camera in the first stage. After converting video into frames, key frame is selected for further reference. The image may contain impurities such as holes and dirt particles. The noise is removed from the image of the vehicle in preprocessing stage. Authors commonly used Median Filter, Gaussian filter, Mexican Hat Filter for removing the noise from the plate. According to reference <sup>15</sup>, Gaussian ûlter has a better performance as compared to median ulter in high noise image processing. In Plate Detection stage Vehicle plate is extracted from the preprocessed image of the vehicle. The features of vehicle plate like presence of characters, aspect ratio, color, size and rectangular shape are used to localize the plate. A number of techniques, such as connected component analysis, neural networks, genetic algorithms, morphology, were implemented for vehicle license plate detection in literature. Two or more techniques can be combined to give more efficient and accurate results. The success of AVPR system depends upon the accuracy of plate detection stage. The characters on the vehicle plate are isolated in the plate segmentation stage. Horizontal and vertical projection, Bounding Box Technique, Blob Analysis and otsu's method are used by the authors in literature to extract the characters from the vehicle plate. In order to efuciently segment the license plate, two or more features are combined in literature to extract the characters. According to reference 48 dirt, shadows and physical damage may degrade the performance of segmentation phase. The final stage is to recognize the alphanumeric characters present on the vehicle plate. The features of the characters like shape, size and contours of characters can be used for character recognition. Template Matching, OCR, ANN, BLOB (Binary Large Objects) Analysis are widely used methods to recognize the characters on the vehicle plate in literature. Reference 49 discussed the ambiguity problem in character recognition. The characters like (0,0), (I,1), (B,8), (C,G) are similar and may confuse character recognizer. This ambiguity problem should attract more attention than regular OCR in future research. We have observed from state-of-art literature in this research field that AVPR needs to overcome challenges in extraction of text area and its segmentation with more accuracy to implement in real life situation under different environment.



Fig. 3. Stepwise Description

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