

## Original Research Article

# Freshwater Algae (Excluding Diatoms and Red Algae) from Hasina Wetland, Sundar Haraicha, Morang, Nepal

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### Abstract:

This paper described 44 freshwater algae (except diatoms and red algae) belonging to classes' cyanophyceae, chlorophyceae, charophyceae and euglenophyceae from Hasina wetland and its surrounding area, Sundar-Haraicha, Morang, Nepal. Samples were collected from Budhi Khola, Khayer Khola and ponds and marshy land in Hasina wetland. In total, the largest family was chlorophyceae represented by 30 taxa and the largest genus was *Cosmarium* represented by 6 taxa. The study showed that this area is rich in algal diversity.

**Key words:** Budhi Khola, Cyanophyceae, Khayer Khola, *Spirulina*, *Trachelomonas*.

### Introduction

Algae are chlorophyllous thallophytes without true root, stem and leaves or leaf-like organs and commonly known as 'ponds scums', 'water mosses', 'frog spittle' or 'sea weeds'. They are unicellular to multicellular, without vascular tissue and have sex organ without jacket layer.

Algae are common in aquatic habitat but can also grow in many diverse habitats such as damp soil, moist wall, moist wood, tree trunk, and even under or inside porous rocks such as sand-stone and limestone. The occurrence of epiphytic, perforating algae of molluscs and calcareous rocks, snow, thermal water, epizoic condition and in symbiotic association had been reported. Specially, cyanophytes tolerate a wide range of temperatures and can be found growing on hot springs and snow bands or deep within polar-ice.

Algae vary greatly in size, ranging from 0.5  $\mu\text{m}$  unicellular to huge seaweeds (*Macrocystis pyrifera*) which may be of 100 feet or more. They are single celled, colonial, filamentous or frond like and bushy plant displaying endless degree of complexity. Algae also form mutually beneficial partnership with other organisms as with fungi to form lichens, with higher plants (*Azolla* leaf, coralloid root of *Cycas*), with coral reef (*Zooxanthellae*), etc. Algae provide oxygen and complex nutrients to their partner, and in return, they receive protection and simple

nutrients.

Algae constitute an economically important group of plants. Their economic importance is many folds, both positive and negative. *Spirulina* sp. are protein rich blue green algae and are considered as future health food for world and now being sold in the market at a high price as a protein capsule (Rai, 2011). Nitrogen fixing capacity of algae can be utilized in agriculture as bio-fertilizer. About 25% of the total blue-green algae recorded from Nepal are found in paddy fields. They increase nitrogen level in paddy field resulting in higher productivity of the soil. It has been estimated that blue-green algae can add about 40 kg bound nitrogen to the soil/hectare/year (Van Den Hoek et al, 2009). Algae have been used for centuries, especially in Asian countries, for their purported powers to cure or prevent illness such as cough, gout, gallstones, goiter, hypertension and diarrhoea. Recently, algae have been surveyed for anti-cancer compounds. Diatoms also have been used in forensic medicine as their presence in the lungs can indicate a person's death due to drowning. Algae can also serve as bio-indicators of environmental problem in aquatic ecosystems. Water quality of many streams and rivers of central and eastern Nepal have been studied on the basis of diatom (Juttner et al, 2003).

Harmful activities of algae are formation of algal blooms

which may deplete oxygen concentration in water as well as prevent light penetration for algae at lower depths preventing photosynthesis. Blue green algae grow in water tanks forming bottom gelatinous layers and hence creating problem in water supply.

Realizing various beneficial activities of algae, numerous taxonomic studies on algae have been carried out in the globe. In Nepal, the first major reports were published from Hirano (1963, 1969, and 1984) who reported 271 taxa (including 79 species of desmids) from Central and Eastern Nepal. Jha and Kargupta (2006) had described bluegreen algae from Sapta Koshi Basin but Hasina Wetland region has not been explored yet. Rai (2011a)

studied algal flora of Betana wetland, Morang and reported 23 taxa including 6 diatoms which were new for the country. Similarly, Shrestha et al. (2013) had studied algae of Itahari and its adjoining area and reported 52 taxa. Rai (2013, 2014) also studied the algal flora including desmids of Koshi Tappu Wildlife Reserve. Hasina Wetland is favourable locality for freshwater red algae. Recently, Necchi et al, (2016) studied the phylogeny and morphology of *Nemalionopsis shawii* collected from the Hasina wetland. But, the other groups of algae from this locality have not been studied so far. Thus, the present work is aimed to explore the algal flora (excluding diatoms and red algae) of Hasina Wetland, Morang.

## Materials and Methods

Algal samples (total 70) were collected by random sampling technique from five different localities, three from Hasina wetland and one each from Khayer Khola and Budhi Khola (Map 1) using plankton net (mesh size 0.5 mm) and by squeezing submerged leaves and roots of aquatic macrophytes during the period of April 2015 to March 2016 (Baishakh to Chaitra, 2072 BS). They were labeled properly with sample number, date of collection, method of collection, locality etc. The latitude, longitude and altitude were measured with the help of GPS Garmin etrex. Necessary photographs of the collection sites were taken with the help of Canon Powershoot Camera. Peripheral aquatic vegetation as well as land vegetation were also noted. Water temperature and pH of each locality were also measured with the help of Mercury thermometer and portable Henna pH meter, respectively. Field note was maintained properly. The materials were brought to the Phycology Research Lab, P.G. Campus, Biratnagar and examined as soon as possible in living condition. The materials were then preserved on FAA solution as well as 4% formaldehyde solution for further detail studies. The slides of each sample were mounted in the glycerin jelly (Sharma, 1992). The prepared slides were examined under compound microscope in 100X, 400X and 1000X magnification. Green and blue green algae were stained with 1% methylene blue and iodine solution, respectively. Microphotographs were taken with the help of Olympus Ch20i microscope and Canon Digital Power Shot Camera using flash-light off and macro-mode under long exposure period.

Algal taxa were identified consulting various literatures and monographs such as Prescott (1951), Tiffany and Britton (1952), Desikachary (1959), Scott and Prescott (1961), Philipose (1967), Croasdale and Flint (1986,

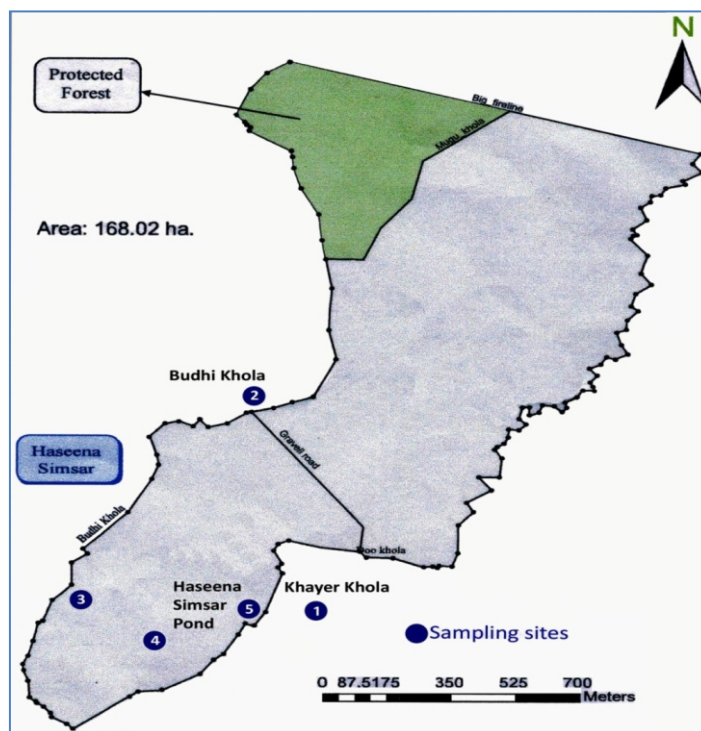
1988), Croasdale et al, (1994), Prasad and Misra (1992) etc. Identification and recent updates of nomenclature were also approved by consulting online algae databases like <http://algaebase.org>, <http://desmids.science4all>, <http://digicote.info> etc. All the collected materials have been deposited in the Phycology Research Lab, Department of Botany, P.G. Campus, Biratnagar.

## Study Area

Hasina wetland lies in the foothills of Churia range in the tropical zone about 4-5 km north from Bansbari Chowk (East-west highway) in Sundar Haraicha Municipality - 7, Morang. This wetland is situated between Budhi Khola and Khayer Khola, to the south of Charkhose Jhadi covering an area of about 48 ha including the forest (Map 1). It is a natural wetland consisting of swamp, marsh, pond and streams. Hasina Wetland is almost rectangular in shape with its wide width toward north and slightly narrow width towards the south side. The water body coverage area is 3.3 ha.. The wetland type is lacustrine (lake/pond), palustrine (marsh/swamp) and riverine. The water flowing through the wetland has been used by making two dams, one within the wetland area (locality 5) and the other outside the wetland towards the south. The wetland is being used for irrigation for about 3200 ha land.

The first locality was Khayer Khola, a small stream in Gurung Tole, which lies to the east side from Hasina Wetland (Table 1). The second was Budhi Khola (Lati Khola) situated to the northwest side from Hasina Wetland. The third to fifth localities were the ponds and marshy places inside the Hasina Wetland. The third one was an old pond situated in the western side of wetland.

The locality near the dinosaur statue was marked as locality no. 4 which consisted of flowing water with irrigation and also used for boating. But now this pond has shallow depth. The fifth locality was the largest pond situated in the eastern side which was the major source of irrigation and also used for boating. But now this pond has been destroyed by the heavy flood occurred in 2017.



Map 1. Hasina Wetland and surrounding area showing sampling sites.

Table 1. Algae sampling sites with geographical position and water parameters.

Locality No.	Name of locality	Habitat	Geographical position	Altitude (m)	Water temp. (°C)		Water pH	
					rainy	winter	rainy	winter
1	Khayera Khola	Stream	26°41'22.6"N, 87°19'22.2"E	126	26	21	7.0	7.0
2	Budhi Khola	River	26°42'05.4"N, 087°19'06.3"E	132	28	22	6.5	7.0
3	Hasina Wetland	Pond	26°41'33"N, 87°18'48.7"E	118	32	15	6.5	6.5
4	Hasina Wetland	Stream	26°41'34"N, 87°19'04.7"E	119	28	22	7.0	7.0
5	Hasina Wetland	Pond	26°41'35.8"N, 87°19'07.5"E	122	27	17	6.5	7.0

The climate of this area is tropical or subtropical monsoonal type and experiences three distinct seasons i.e., summer (February to May), rainy (June to September) and winter (October to January). The area has maximum temperature in May and minimum in January. Similarly, it experiences maximum rainfall in July and minimum in December.

This wetland provides habitat to different species of floating and submerged macro-flora. Common floating species are *Eichhornia crassipes*, *Pistia stratiotes*, *Monochoria* sp, *Lemna minor*, *Vallisneria natans*, etc. Emergent species in marshy area are *Schoenopletus*

*mucronata*, *Alternanthera philoxeroides*, etc. Invasive alien species such as *Banmara Chromolaena odorata*, *Agaratum conyzoides*, *Mikania mikrantha* and *Lantana camara* are growing dominantly along the marginal area of the wetland (Siwakoti et al, 2012). The major land vegetation is composed of tropical plants viz., *Shorea robusta*, *Syzygium cumini*, *Anthocephalus chinensis*, *Diospyros* species, *Cassia fistula*, *Schleichera oleosa*, *Dalbergia sissoo*, *Acacia catechu*, *Bombax ceiba*, *Aegle marmelos*, *Trewia nudiflora*, *Callicarpa arborea*, *Mallotus phillipensis*, etc. This wetland also provides a good habitat for many rare flora and fauna.

**Results and Discussion**

Algal flora (excluding diatoms) of Hasina Wetland and its periphery area have been studied. A total of 44 freshwater algae under 28 genera belonging to class cyanophyceae,

chlorophyceae, charophyceae and euglenophyceae were reported from 5 different localities (Table 2).

**Table 2. Classification (Guiry and Guiry, 2018) of algae reported from Hasina Wetland.**

Divisn	Class	Order	Family	Genera	Species	
Cyanophyta	Cyanophyceae	Nostocales	Chroococcales	Chroococcaceae	Chroococcus	1. C. turgidus
			Oscillatoriaceae	Spirulina	2. S. subsalsa	
				Oscillatoria	3. O. limosa	
					4. O. princeps	
					5. O. sancta	
					6. O. subbrevis	
				Phormidium	7. P. autumnale	
				Lyngbya	8. L. birgei	
				Nostoc	9. N. microscopicum	
				Rivulariaceae	Gloeotrichia	10. G. echinulata
				Stigonemataceae	Stigonema	11. S. ocellatum
Chlorophyta	Chlorophyceae	Volvocales	Volvocaceae	Eudorina	12. E. elegans	
				Pandorina	13. P. morum	
		Tetrasporales	Palmellaceae	Sphaerocystis	14. S. schroeteri	
				Oedogoniales	Oedogoniaceae	Oedogonium
		Chlorococcales	Hydrodictyaceae	Pediastrum	16. P. tetras v. tetraodon	
				Oocystaceae	Gloeotaenium	17. G. loitlesbergerianum
				Nephroclytium	18. N. agardhianum	
			Dictyosphaeriaceae	Westella	19. W. botryoides	
			Selenastraceae	Ankistrodesmus	20. A. spiralis	
					21. A. spiralis v. fasciculatus	
			Coelastraceae	Coelastrum	22. C. cambricum	
					23. C. cambricum v. intermedium	
			Scenedesmaceae	Crucigenia	24. C. tetrapedia	
				Scenedesmus	25. S. acutiformis	
				26. S. arcuatus		
				27. S. armatus v. boglariensis		
				28. S. bijugatus		
				29. S. bijugatus v. gravenitzii		
		Zygnematales	Desmidiaceae	Closterium	30. C. diana	
					31. C. ehrenbergii	
					32. C. praelongum v. brevius	
				Pleurotaenium	33. P. trabecula	
				Cosmarium	34. C. blyttii	
	35. C. impressulum					
	36. C. javanicum					
	37. C. lundellii v. circulare					
	38. C. lundellii v. ellipticum					
	39. C. sublateriundatum					
	Staurastrum	40. S. disputatum v. sinense				
	Hyalotheca	41. H. dissiliens				
Charophyceae	Charales	Characeae	Chara	42. C. sp.		
Euglenophyta	Euglenophyceae	Euglenales	Euglenaceae	Phacus	43. P. pseudoswirenkoi	
				Trachelomonas	44. T. armata v. longispina	



The largest class was chlorophyceae represented by 30 taxa, followed by cyanophyceae (11 taxa), eulgenophyceae (2 taxa) and charophyceae with single taxa. In chlorophyceae, the desmid (Family Desmidiaceae) algae were the dominant as usual. Among the genera, *Cosmarium* had the maximum number of taxa algae (6) followed by *Scenedesmus* (5), *Oscillatoria* (4), and *Closterium* (3). Genera *Oedogonium* and *Chara* could not be identified upto species level due to the lack of reproductive structures. Similarly, species of *Spirogyra* could not be confirmed due to the lack of literature. Taxonomic descriptions of all algae are as follow:

*Chroococcus turgidus* (Kuetz.) Nag. (Figs. 1-2) Desikachary 1959, P. 101, Pl. 26, Fig. 6.

Colony of 2-4 cells; cells 15-50 µm long with sheath, 8-32 µm in diameter without sheath.

Locality no: 2, Sample no: 4, Date of collection: 2072/04/12.

*Spirulina subsalsa* Oerst. ex Gom. (Fig. 3) Prescott 1951, P. 480, Pl. 108, Fig. 14.

Trichomes 1-2 µm in diameter, closely spiral; spiral 3-5 µm wide.

Locality no: 3, Sample no: 5, Date of collection: 2072/04/12.

*Oscillatoria limosa* (Roth) Agardh (Fig. 4) Desikachary 1959, P. 206, Pl. 42, Fig. 11.

Trichomes straight; cells 3.7-5 µm long, 12-18 µm in diameter, not constricted, apical cell rotund.

Locality no: 4, Sample no: 5, Date of collection: 2072/04/12.

*Oscillatoria princeps* Vaucher ex Gom. (Fig. 5) Tiffany and Britton 1952, P. 344, Pl. 93, Fig. 1080

Trichomes slightly taperig; cells 4-8.7 µm long, 32-55 µm in diameter, not constricted; apical cell not capitate.

Locality no: 5, Sample no: 4, Date of collection: 2072/04/12.

*Oscillatoria sancta* (Kutz.) Gom. (Fig. 6) Prescott 1951, P. 490, Pl. 110, Fig. 4

Trichomes straight; cells 4-5 µm long, 11-13 µm in

diameter, slightly constricted; apical cell somewhat capitate with a calyptra and with a much thickened outer membrane.

Locality no: 1, Sample no: 7, Date of collection: 2072/09/05

*Oscillatoria subbrevis* Schm. (Fig. 7) Desikachary 1959, P. 207, Pls. 37 and 40, Fig. 2

Trichome straight, not tapering; cells 1-2 µm long, 5-6 µm in diameter, short, with frequent necridia; apical cell rounded, not capitates and without a calyptras.

Locality no: 2, Sample no: 5, Date of collection: 2072/04/12.

*Phormidium autumnale* (Ag.) Gomont [*Microcoleus autumnalis* (Gom.) Strun. et al.] (Fig. 8) Prescott 1951, P. 493, Pl. 107, Fig. 19.

Filaments straight or curved, flexuous, slightly tapering; cell 2-5 µm long, 4-7 µm in diameter, not constricted, apex straight or curved, capitate, with a calyptras.

Locality no: 3, Sample no: 09, Date of collection: 2072/09/05

*Lyngbya birgei* Smith [*Limnoraphis birgei* (Smith) Kom. et al.] (Fig. 9) Tiffany and Britton 1952, P. 339, Pl. 92, Figs. 1066, 1067

Filaments straight, 24 µm in diameter; sheaths thick, firm, not lamellated, extending beyond apices; trichomes 20-24 µm in diameter, not constricted; cells 3-7 µm long, short, disciform.

Locality no: 5, Sample no: 07, Date of collection: 2072/09/05.

*Nostoc microscopicum* Carm. ex Born. & Flah. (Fig. 10) Prescott 1951, P. 523, Pl. 120, Fig. 3-5.

Colony minute, globose or ovoid; trichomes loose in colorless mucilage; cells globose, 5-8 µm in diameter, loosely arranged; heterocysts 7.3 µm in diameter, sub-spherical or ovate.

Locality no: 4, Sample no: 03, Date of collection: 2072/04/12

*Gloeotrichia echinulata* (Smith) Rich. (Fig. 11) Desikachary 1959, P. 556, Pl. 116, Figs. 9, 10.

Thallus spherical, 0.5-7 mm diam.; filaments loose, radial; sheath not lamellated, colourless; trichome 8-10  $\mu\text{m}$  broad at base, with a long hair; cells cylindrical with gas vacuoles.

Locality no: 3, Sample no: 08, Date of collection: 2072/09/05.

*Stigonema ocellatum* (Dillw.) Thuret ex Born. et Flah. (Fig. 12) Prescott 1951, P. 548, Pl. 130, Figs. 5, 6.

Filaments 35-45  $\mu\text{m}$  wide, brown tufts, with long curved branches; trichomes uniseriate; heterocyst lateral; cells 20-30  $\mu\text{m}$  broad, quadrate-globose to globose.

Locality no: 3, Sample no: 08, Date of collection: 2072/09/05.

*Eudorina elegans* Ehr. (Fig. 13) Tiffany and Britton 1952, P. 17, Pl. 2, Fig. 14

Colony spherical, up to 200  $\mu\text{m}$  diam., 16-32 celled; cells ovoid, 10-20  $\mu\text{m}$  broad, evenly disposed or arranged in transverse series, usually lying near the periphery of the envelope.

Locality no: 4, Sample no: 08, Date of collection: 2072/09/05.

*Pandorina morum* (Mull.) Bory (Fig. 14) Prescott 1951, P. 75, Pl. 1, Fig. 23

Colony motile, sub-spherical to ellipsoid, about 220  $\mu\text{m}$  diam., 16 celled; cells pyriform, 12-17  $\mu\text{m}$  long, 10-15  $\mu\text{m}$  broad, mutually compressed and enclosed in a gelatinous envelope.

Locality no: 5, Sample no: 05, Date of collection: 2072/04/12.

*Sphaerocystis schroeteri* Chodat (Fig. 15) Prescott 1951, P. 83, Pl. 3, Figs. 6, 7

Colony spherical, up to 500  $\mu\text{m}$  diam., 4-8 celled, arranged periphery in hyaline envelope; cells spherical, 6-20  $\mu\text{m}$  in diameter.

Locality no: 5, Sample no: 05, Date of collection: 2072/04/12.

*Oedogonium* sp. (Fig. 16) Prasad and Misra 1992, P. 66.

Filament unbranched, attached; cells cylindrical or enlarged toward the anterior end with one or more ring

like scars; chloroplast a parietal reticulum with many pyrenoids.

Locality no: 4, Sample no: 04, Date of collection: 2072/04/12.

*Pediastrum tetras* var. *tetraodon* (Corda) Hansg. (Fig. 17) Philipose 1967, P. 129, Fig. 45 d, e, g.

Colony circular, 4-8-16 celled, 8 celled colony 20-33  $\mu\text{m}$  in diam.; cells 5-15  $\mu\text{m}$  broad, no intercellular spaces; marginal cells 2 lobes, deep incision; inner cells 4-6 sided, 1 incision.

Locality no: 1, Sample no: 06, Date of collection: 2072/09/05

*Gloeotaenium loitlesbergerianum* Hansg. (Figs. 18-19) Komarek 1983, P. 116, Pl. 17, Fig 36.

Colony spherical or quadrangular ovate, 2-8 celled, 8 celled colony 80  $\mu\text{m}$  long, 70  $\mu\text{m}$  in diam.; cells globose or ellipsoid, 18-25  $\mu\text{m}$  in diam., compactly and cruciately arranged.

Locality no: 3, Sample no: 03, Date of collection: 2072/04/12.

*Nephrocytium agardhianum* Nag. (Fig. 20) Philipose 1967, P. 189, Fig. 104

Colony ovate, 2-8 celled; cells 8-18  $\mu\text{m}$  long, 2-7  $\mu\text{m}$  in diam., cylindrical or reniform, twisting so as to give a spiral arrangement in an old mother cell wall.

Locality no: 4, Sample no: 04, Date of collection: 2072/09/05.

*Westella botryoides* (West) de Wild. (Fig. 21) Prescott 1951, P. 237, Pl. 53, Fig. 14.

Colony 40-80 celled; cells spherical, 3-9  $\mu\text{m}$  in diam., quadrately arranged in groups of 4, the groups loosely connected by persistent remains of old mother cell walls.

Locality no: 1, Sample no: 06, Date of collection: 2072/09/05.

*Ankistrodesmus spiralis* (Trun.) Lemm. (Fig. 22) Philipose 1967, P. 210, Fig. 119 a.

Cells 25-35  $\mu\text{m}$  long, 2-3  $\mu\text{m}$  broad, spindle, spirally twisted into bundles of 4-16 cells.

Locality no: 1, Sample no: 06, Date of collection: 2072/09/05.

*Ankistrodesmus spiralis* (Turn.) Lemm. var. fasciculatus Smith (Figs. 23-24) Prasad and Misra 1992, P. 27, Pl. 4, Fig. 8.

Colony 75-180 µm in diam., cells 55-110 µm long, 3-4.5 µm broad, curved or sigmoid, middle part twisted around each other in colonies of 34-50 cells, apical portion of cell free.

Locality no: 2, Sample no: 07, Date of collection: 2072/09/05.

*Coelastrum cambricum* Arch. (Fig. 25) Prescott 1951, P. 229, Pl. 53, Fig. 2.

Colony spherical, 8-128 celled; each cells 10-20 µm in diam., joined to other cells by 6 projections of sheath, triangular intercellular space; outer free wall with truncate projection.

Locality no: 4, Sample no: 04, Date of collection: 2072/04/12.

*Coelastrum cambricum* var. intermedium (Boh.) West (Fig. 26) Prasad and Misra 1992, P. 30, Pl. 4, Fig. 5.

Colony spherical, 60-66 µm in diam., 32 celled; cells 14-21 µm in diam., spherical in middle, subspherical at periphery with slightly thick, blunt and rounded projections.

Locality no: 5, Sample no: 10, Date of collection: 2072/09/05.

*Crucigenia tetrapedia* (Kirch.) West (Fig. 27) Philipose 1967, P. 240, Fig. 151.

Colony flat, 4 triangular cells cruciately arranged leaving a central space, frequently form plate of 16 cells; cells 4.5-9 µm in diam., outer walls straight, and angles acutely rounded.

Locality no: 4, Sample no: 08, Date of collection: 2072/09/05.

*Scenedesmus acutiformis* Schroed. [*Acutodesmus acutiformis* (Schroed.) Tsarenko et John] (Fig. 28) Tiffany and Britton 1952, P. 123, Pl. 35, Fig. 356

Colony flat; cells fusiform-elliptic, cylindrical, 17-22.5 µm long, 6-8 µm broad, arranged in a single series of 2-8,

poles sharply pointed.

Locality no: 4, Sample no: 04, Date of collection: 2072/04/12.

*Scenedesmus arcuatus* (Lemm.) Lemm. (Fig. 29) Prescott 1951, P. 275, Pl. 62, Fig. 8.

Cells oblong ovate, 10-15 µm long, 4-8 µm broad, arranged forming a curve of 4-16 cells, lateral walls contact along 1/3 to 1/2 of length; poles broadly rounded.

Locality no: 2, Sample no: 04, Date of collection: 2072/04/12.

*Scenedesmus armatus* var. boglariensis Horto. (Fig. 30) Philipose 1967, P. 264, Figs. 171 g, j.

Colony flat, slightly curved, 2-4 celled in a linear series; cells 8-14 µm long, 2.4-4.2 µm broad with longitudinal rib; terminal cells with a spine, one straight, other slightly curved.

Locality no: 3, Sample no: 08, Date of collection: 2072/09/05.

*Scenedesmus bijugatus* (Turp.) Kutz. (Fig. 31) Prasad and Misra 1992, P.35, Pl.5, Fig. 1

Colony flat, slightly curved, 2-4-8 celled, in a linear series; cells oblong-ellipsoid to ovoid, cells 7-23 µm long, 3.5-7 µm broad, ends broadly rounded.

Locality no: 4, Sample no: 04, Date of collection: 2072/04/12.

*Scenedesmus bijugatus* var. gravenitzii (Barn.) Chodat (Fig. 32) Philipose 1967, P. 254, Figs. 164 a, b.

Colony 4-8 celled, in alternate series, adjacent cells contact along a short portion of their length; cells fusiform, ellipsoid, ovoid, 10-16.7 µm long, 4.5-7.9 µm broad, obtuse poles.

Locality no: 5, Sample no: 05, Date of collection: 2072/04/12.

*Closterium diana* Ehr. ex Ralfs (Fig. 33) Tiffany and Britton 1952, P. 169, Pl. 52, Fig. 548

Cells 105-303 µm long, 16-35 µm broad, outer margins with 112-125° arced, inner slightly tumid, gradually attenuated towards obtusely rounded apex.

Locality no: 1, Sample no: 01, Date of collection: 2072/04/12.

*Closterium ehrenbergii* Menegh. ex Ralfs (Fig. 34) Scott and Prescott 1961, P. 11, Pl. 2, Fig. 2.

Cells large, stout, 450-530  $\mu\text{m}$  long, 65-80  $\mu\text{m}$  broad, moderately curved, outer margins 92-110° arced, inner margin inflated in middle, attenuate towards obtusely rounded apex.

Locality no: 1, Sample no: 01, Date of collection: 2072/04/12.

*Closterium praelongum* var. *brevius* (Nordst.) Krieg. (Fig. 35) Croasdale and Flint 1986, P. 67, Pl. 9, Figs. 4-7.

Cells long, 250-360  $\mu\text{m}$  long, 17-23  $\mu\text{m}$  broad, slightly curved, straight at middle, gradually attenuated to recurved apical region, apices rounded-truncate; isthmus 3-3.5  $\mu\text{m}$  wide.

Locality no: 1, Sample no: 01, Date of collection: 2072/04/12.

*Pleurotaenium trabecula* (Ehr.) Nag. (Figs. 36-37) Kouwets 1987, P. 208, Pl. 6, Fig. 7.

Cells straight, 430-510  $\mu\text{m}$  long, 28-40  $\mu\text{m}$  broad; semicells with slight basal inflation, gradually attenuated to rotundo-truncate apices, cell apices without tubercles.

Locality no: 5, Sample no: 10, Date of collection: 2072/09/05.

*Cosmarium blyttii* Wille (Fig. 38) Prasad and Misra 1992, P. 155, Pl. 24, Figs. 2-3.

Cell small, 14-17.5  $\mu\text{m}$  long, 13-14.5  $\mu\text{m}$  broad, deeply constricted; semicell trapiziform-semicircular, basal angles subrectangular, sides with 4 crenates; apex truncate, 4 crenates.

Locality no: 5, Sample no: 10, Date of collection: 2072/09/05.

*Cosmarium impressulum* Elfv. (Fig. 39) Croasdale and Flint 1988, P. 71, Pl. 40, Figs. 16-19.

Cells small, 20.5  $\mu\text{m}$  long, 15  $\mu\text{m}$  broad, deeply constricted; sinus narrow, linear; semicells vsubquadrate, tri-undulate margin, undulation sub-acute; apex retuse with rounded angles.

Locality no: 5, Sample no: 10, Date of collection: 2072/09/05.

*Cosmarium javanicum* Nordst. (Fig. 40) Nurul Islam and Yusuf Haroon 1980, P. 576, Pl. 11, Figs. 156-157; Pl. 13, Fig. 179.

Cells large, 90-188  $\mu\text{m}$  long, 45-89  $\mu\text{m}$  broad, oblong-elliptic, sides convex; sinus shallow, closed; semicells in side and end views elliptic; isthmus 35-52  $\mu\text{m}$  wide.

Locality no: 4, Sample no: 04, Date of collection: 2072/04/12.

*Cosmarium lundellii* var. *circularis* (Reins.) Krieg. (Fig. 41) Bharati and Hegde 1982, P. 744, Pl. 1, Fig. 2

Cells 46  $\mu\text{m}$  long, 37.8  $\mu\text{m}$  broad, circular in front view and elliptic in top view; cell-wall minutely punctate; isthmus 13.5  $\mu\text{m}$  wide.

Locality no: 4, Sample no: 04, Date of collection: 2072/04/12.

*Cosmarium lundellii* var. *ellipticum* West et West (Figs. 42-43) Scott and Prescott 1961, P. 61, Pl. 25, Fig. 8

Cells 57-73  $\mu\text{m}$  long, 40-58  $\mu\text{m}$  broad, more or less broadly ellipsoid in front view, elliptical in top view; cell apex is somewhat flat; isthmus 15-23  $\mu\text{m}$  wide.

Locality no: 2, Sample no: 02, Date of collection: 2072/04/12.

*Cosmarium sublateriundatum* West et West (Fig. 44) Bando et al. 1989, P. 21, Fig. 7 e.

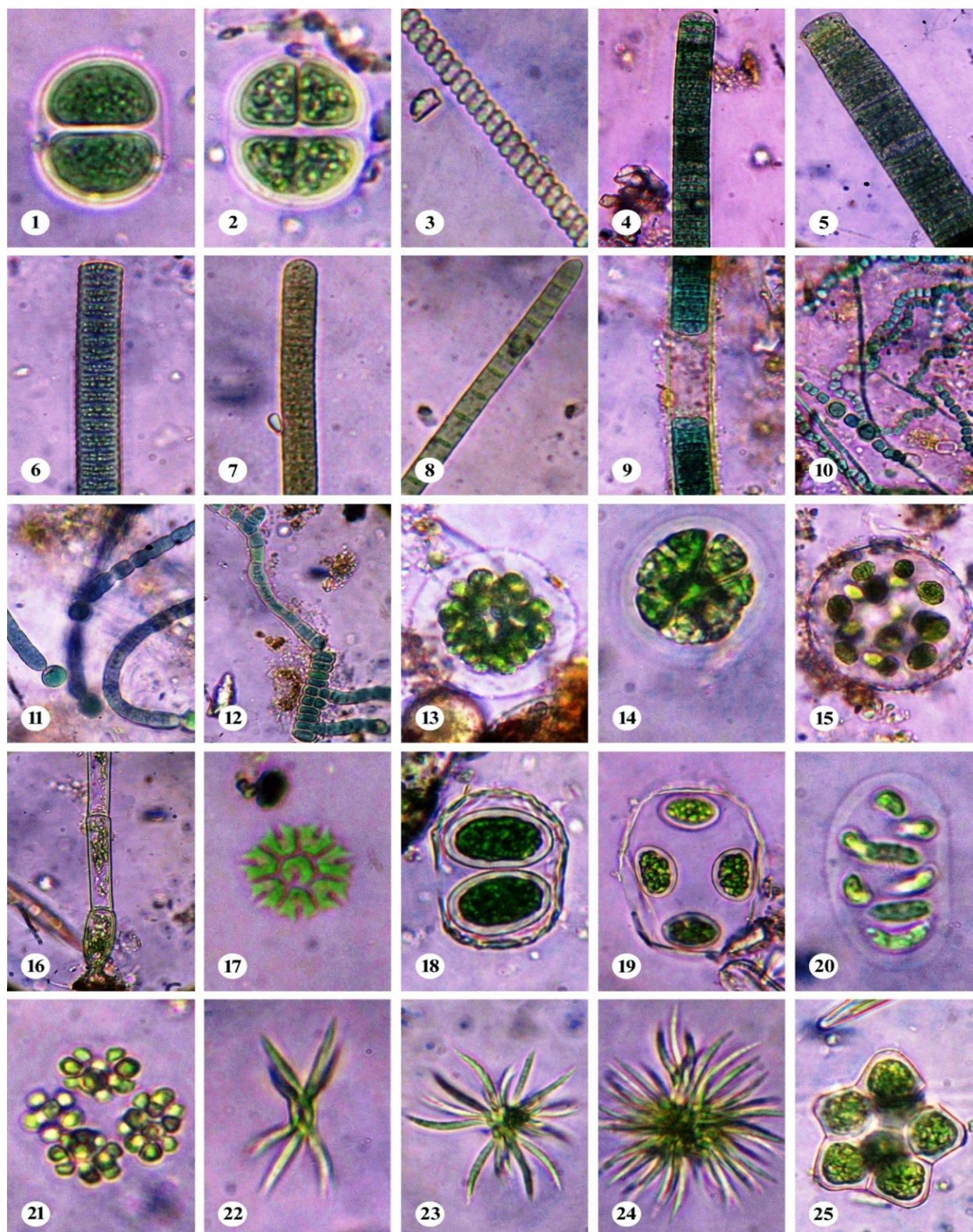
Cells 41-46  $\mu\text{m}$  long, 36-40  $\mu\text{m}$  broad, deeply constricted; semicells subtrapeziform; lateral margins 6-7 undulations; apex truncate, 2 undulations; isthmus 12.5-13.5  $\mu\text{m}$  wide.

Locality no: 4, Sample no: 08, Date of collection: 2072/09/05

*Staurastrum disputatum* var. *sinense* (Lutk.) West et West (Figs. 45-46) Croasdale et al. 1994, P. 95, Pl. 81, Figs. 10-14.

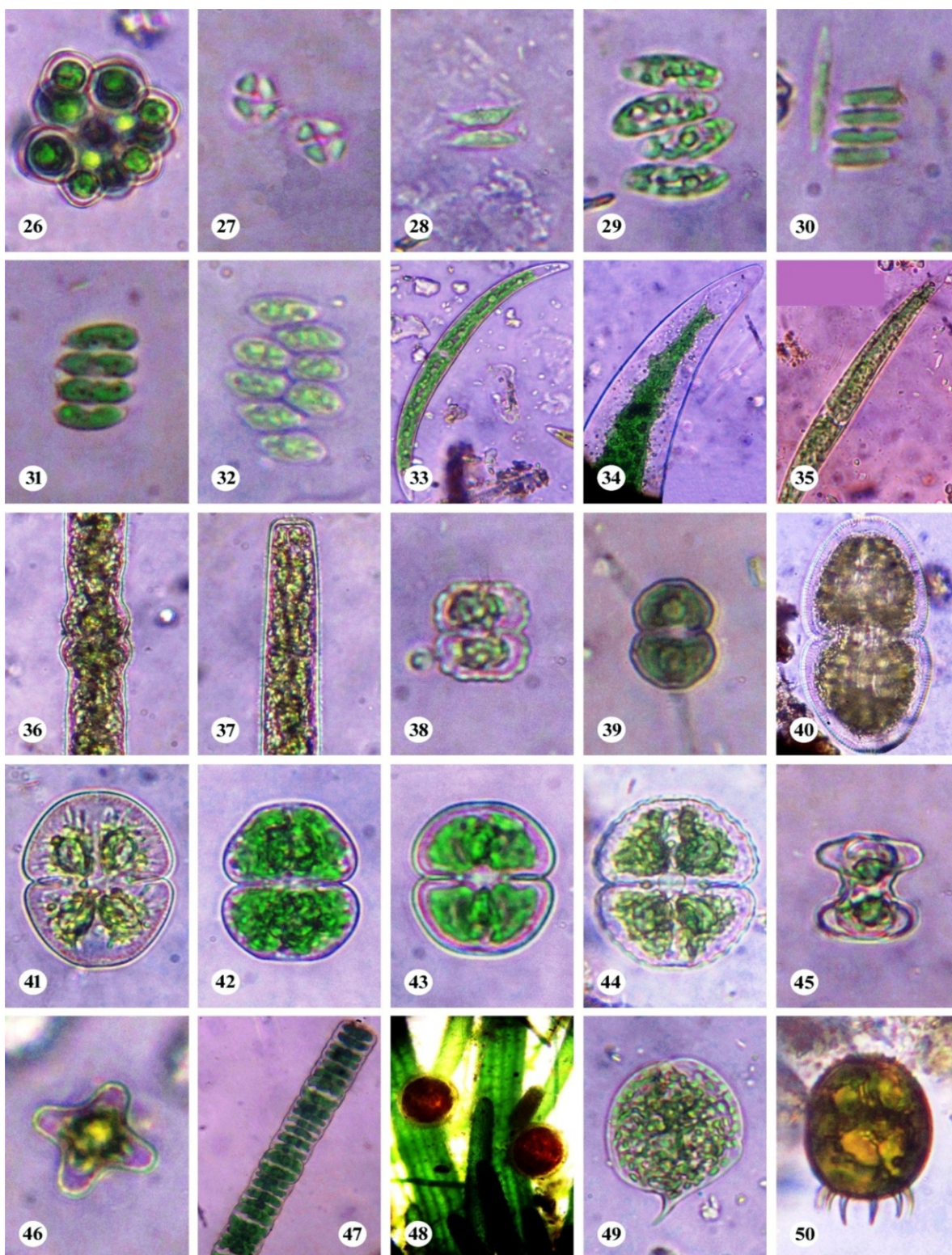
Cells small, 17-24  $\mu\text{m}$  long, 19-25  $\mu\text{m}$  broad; sinus widely open, minutely notched interior; semicells cuneiform; upper part horizontal, bluntly cylindrical; isthmus 5.5-9  $\mu\text{m}$  wide.





Figures: 1-2. *Chroococcus turgidus* 3. *Spirulina subsalsa* 4. *Oscillatoria limosa* 5. *O. princeps* 6. *O. sancta* 7. *O. subbrevis* 8. *Phormidium autumnale* 9. *Lyngbya birgei* 10. *Nostoc microscopicum* 11. *Gloeotrichia echinulata* 12. *Stigonema ocellatum* 13. *Eudorina elegans* 14. *Pandorina morum* 15. *Sphaerocystis schroeteri* 16. *Oedogonium* sp. 17. *Pediastrum tetras* v. *tetraodon* 18-19. *Gloeotaenium loitlesbergerianum* 20. *Nephrocystium agardhianum* 21. *Westella botryoides* 22. *Ankistrodesmus spiralis* 223-24. *A. spiralis* v. *fasciculatus* 25. *Coelastrum cambricum*





Figures: 26. *Coelastrum cambricum* v. *intermedium* 27. *Crucigenia tetrapedia* 28. *Scenedesmus acutiformis* 29. *S. arcuatus* 30. *S. armatus* v. *boglariensis* 31. *S. bijugatus* 32. *S. bijugatus* v. *gravenitzii* 33. *Closterium diana* 34. *C. ehrenbergii* 35. *C. praelongum* v. *brevius* 36-37. *Pleurotaenium trabecula* 38. *Cosmarium blyttii* 39. *C. impressulum* 40. *C. javanicum* 41. *C. lundellii* v. *circular* 42-43. *C. lundellii* v. *ellipticum* 44. *C. sublateriundatum* 45-46. *Staurastrum disputatum* v. *sinense* 47. *Hyalotheca dissiliens* 48. *Chara* sp. 49. *Phacus pseudoswirenkoi* 50. *Trachelomonas armata* v. *longispina*.

Locality no: 5, Sample no: 10, Date of collection: 2072/09/05.

*Hyalotheca dissiliens* (Smith) ex Bréb. in Ralfs (Fig. 47) Tiffany and Britton 1952, P. 204, Pl. 56, fig. 631

Filaments straight, cylindrical with wide sheath; cells cylindric-discoidal, 10-39  $\mu\text{m}$  long, 10-33  $\mu\text{m}$  broad, faintly constricted, lateral margins slightly convex.

Locality no: 4, Sample no: 08, Date of collection: 2072/09/05.

*Chara* sp. (Fig. 48) Prescott 1951, P. 336.

Stem and branchlets corticated; branchlets 4 segmented; bract cells 4 or more at a node; antheridium below the oogonium, both from periphery of branchlet nodes.

Locality no: 4, Sample no: 08, Date of collection: 2072/09/05.

*Phacus pseudowirenkoi* Prescott (Fig. 49) Prescott 1951, P. 402, Pl. 85, Fig. 26; Pl. 87, Fig. 2; Pl. 88, Fig. 14.

Cells orbicular, 41  $\mu\text{m}$  long, 30  $\mu\text{m}$  broad; anterior broadly rounded, posterior caudus short, sharp and curved; periplast longitudinally striated; paramylon single, large circular disc.

Locality no: 4, Sample no: 08, Date of collection: 2072/09/05.

*Trachelomonas armata* var. *longispina* (Playf.) Def. (Fig. 50) Prescott 1951, P. 411, Pl. 83, Fig. 27.

Test broadly ovate, 40-43  $\mu\text{m}$  long, 30  $\mu\text{m}$  broad; without collar but with a circle of erect spines at margin; anterior spines short but posterior spines stout and both short and long.

Locality no: 5, Sample no: 05, Date of collection: 2072/04/12.

## Conclusions

The study showed that the algal flora of Hasina wetland area was rich. Out of 44 algae reported from this wetland, desmids were dominant with five genera. As usual, genus *Cosmarium* was dominant with six species. The rare but interesting algae reported here were *Spirulina subsalsa*,

*Nostoc microscopicum*, *Stigonema ocellatum*, *Crucigenia tetrapedia* and *Staurastrum disputatum*. Further extensive exploration is essential to identify more important algae of this area that may help for further documentation and conservation.

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