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Biodiversity of Algae from the Tajan River Basin (Mazandaran-Iran)

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ABSTRACT

The objective of this study is to investigate the biodiversity of phytoplankton and to identify the algal species as bio-indicators for water quality in Tajan River of Mazandaran Province (North of Iran).

A total of about 600 samples were collected from 9 stations; from Solayman Tange Dam to Caspian Sea during the period 2011- 2017. 305 species under 86 genera and 23 subspecies (totally 328 taxa) were identified under five algal divisions. The highest number of species was belonging to the Bacillariophyta including 71 species, and the lowest was for Streptophyta including 56 species. Also, the percentages of species in different algal divisions were about 21, 20, 22, 20, and 17% for Cyanoprokaryota, Euglenophyta, Bacillariophyta, Chlorophyta, and Streptophyta, respectively. Results showed that order Euglenales had the highest biodiversity (59 species). The Oscillatoriaceae was a dominant family with 3 genera and 35 species, while *Oscillatoria* was a dominant genus including 22 species. Referring to the stations, the highest number of Cyanoprokaryota was recorded at stations 1 & 2 (48 species), station 7 for Euglenophyta (44 species), station 5 for Bacillariophyta (41 species) and Chlorophyta (52 species), and finally station 2 for Streptophyta with 26 species. With respect to the importance of the Tajan River in north of Iran for drinking and agriculture activities, the results of this study is very important as one of the main criteria for assessing and monitoring of water quality and environment in this region with emphasis on algae interference.

INTRODUCTION

There is a large network of rivers throughout of Iran that most of them are filled only in a certain seasons (Kalantari and Ebadi, 2006a; Akbari *et al.*, 2015; Ebadi and Hisoriev, 2018). Tajan River is one of the main rivers in the north of Iran, which covers various ecosystems and undergoes wide changes in the rainfall seasons. Tajan River has an approximate length of 140 km, originates from the mountains of Ali Khani of Darab and the Sarkouh Mountains from Hazarjirib mountainous regionof the Alborz ranges (Kalantari and Ebadi, 2006b; Kalantari and Ebadi, 2006c; Yousefi Roushan, 2015). Different groups of Algae in freshwater environments such as streams, lakes and rivers and are useful indicators for measuring water quality due to their rapid responses to the environmental changes.

Algae also have great importance ecologically, especially in relation to human

interventions in natural resources especially in freshwater environments (Hisoriev, 2014; Anyinkeng *et al*., 2016; Ebadi and Hisoriev, 2017a). Phytoplankton is one of the major producers of aquatic ecosystems that consider as the basis of the entire of autotrophic diet network in the aquatic ecosystem.

The maximum production of phytoplankton is achieved when all physical and chemical parametersare at the desirable and normal levels.

Bacillariophyta (diatoms), Chlorophyta (green algae), Cyanoprokaryota, are three main groups of phytoplankton in the freshwater ecosystems (Erdal Sivaci *et al*., 2013; Ebadi and Hisoriev, 2014).

Due to the importance of the Tajan River in agricultural activityand also as supply for drinking water in some adjacent areas, the quality of water and sediments in this River become more important issue. Therefore, the objective of this study is to investigate the biodiversity of phytoplankton and to identify the algal speciesas indicators for water quality in Tajan River with emphasis on taxonomical perspectives.

MATERIALS AND METHODS

Sampling was conductedin 9 stations; from upper side of Soleyman Tange Dam to the Sea Caspian Sea (Farah Abad area); (36°12'48.91" N ; 53°16'59.34" E to 36°48'48.60" N; 53°07'18.72" E), during the period from 2011 to 2017. Totally, about 600 samples were collectedand all sampling and identification process of the species was carried out according to the standard methods and based on related taxonomic identification keys at the Institute of Botany, Physiology and Plant Genetics of the Academy of Sciences of Tajikistan (Hisoriev, 1993). The sampling was done in the same climate and the river conditions such as water speed or flood and also with respect to characteristics of algal groups such as Benthos, Periphyton, Plankton, Epilithon, Epiphyton, and Epipelon species (Fig. 1).

Fig. (1): Sampling stations along Tajan River Basin; S1: Origin (upper Side of Soleyman Tange Dam); S2: Soleyman Tange Dam; S3: Farim Region; S4: Takam Region; S5: Before wood Factory; S6: After wood factory; S7: Tajan Bridge (Sari City); S8: Farah Abad Region; S9: Caspian Sea (connecting the river Tajan to the sea).

RESULTS AND DISSCUSION

Table1 and Figure 2 revealed some concluding remarks. Based on the number of taxa, the main floristically points in the algal biodiversity are as follows:
1- A total of 328 taxa, belonging to 86 genera were recorded within 27 orders and 56 families. 2- The main elements of the flora are belonging to order Euglenales, followed by Desmidiales, Chlorococcales, Oscillatoriales, Naviculales, Chroococcales, Licmophoralers, Zygnematales, Cymbellales, and Chlorellales (Table 2). 3- Oscillatoriacea is considered as a dominanat family having the highest number of species during this study (Table 3); this result was in agreement with that found by Hamed (2005) that worked on distribution and diversity of blue-green algae (cyanobacteria) in Egypt. 4- *Oscillatoria* was the dominant genus, including 22 species (Tables 2-4).

Division Cyanoprokaryota

According to Table 1, all recognized species were related to the Class Cyanophyceae.Among the recognized orders, the Chroococcales with five and Pseudanabaenales with three families showed highest number of families, respectively. Among all five families of Chroococcales, 6 genera and 4 genera in Pseudanabaenales considered. The total number of identified families and genera in this group was 12 and 17, respectively. The highest number of species belonged to the Oscillatoriaceae family, which included 33 species and 2 sub-species among 3 identified genera (Ebadi and Hisoriev, 2014).

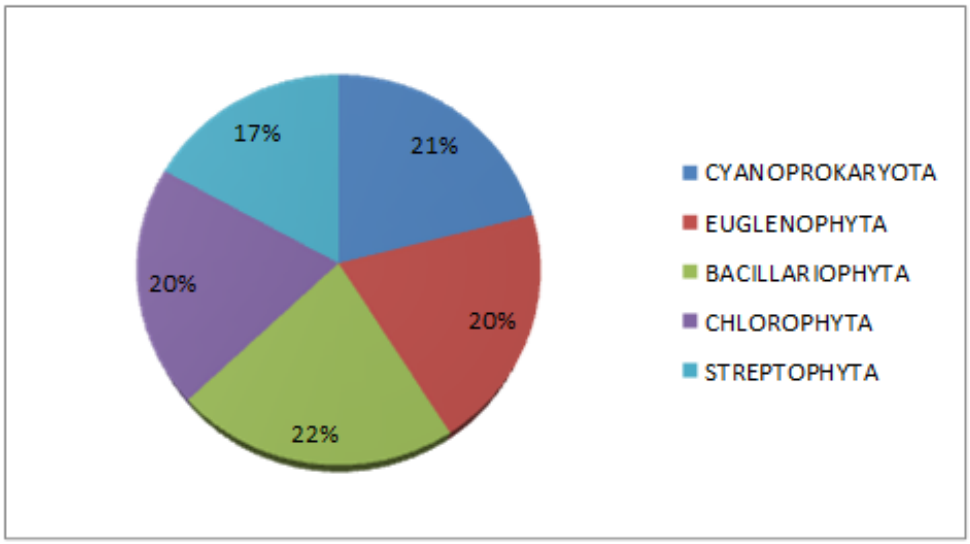

Fig. (2): Percentage of species numbers from different algae divisions of Tajan River basin, Mazandaran Province of Iran (2011-2017).

Table (1): Systematic structure of Algae found in Tajan River basin, Mazandaran Province of Iran (2011-2017).

Taxon	Number of genus	Number of species (varieties and forms)	%
Division I. Cyanoprokaryota	**17**	**67 (69)**	**21.036**
Class Cyanophyceae	**17**	**67 (69)**	**21.036**
Order 1. Chroococcales	6	15 (15)	4.573
Families: 1. Chroococcaceae	1	2 (2)	0.609
2. Aphanothecaceae	1	3 (3)	0.914
3. Coelosphaeriaceae	1	2 (2)	0.609
4. Gomphosphaeriaceae	1	1 (1)	0.304
5. Microcystaceae	2	7 (7)	2.134
Order 2. Spirulinales	1	2 (2)	0.609
Family 1. Spirulinaceae	1	2 (2)	0.609
Order 3. Nostocales	3	8 (8)	2.438
Families: 1. Aphanizomenonaceae	1	1 (1)	0.304
2. Nostocaceae	2	7 (7)	2.133
Order 4. Oscillatoriales	3	33 (35)	10.670
Family 1. Oscillatoriaceae	3	33 (35)	10.670
Order 5. Pseudanabaenales	4	9 (9)	2.743
Families: 1. Pseudanabaenaceae	1	1 (1)	0.304
2. Merismopediaceae	2	7 (7)	2.133
3. Chamaesiphonaceae	1	1 (1)	0.304
Division II. Euglenophta	**11**	**62 (67)**	**20.426**
Class Euglenophyceae	**11**	**62 (67)**	**20.426**
Order 1. Euglenales	6	54 (59)	17.987
Families: 1. Euglenaceae	3	25 (26)	7.926
2. Peranemataceae	1	1 (1)	0.304
3. Phacaceae	2	28 (32)	9.755
Order 2. Eutreptiales	5	8 (8)	2.438
Families: 1. Astasiaceae	2	5 (5)	1.523
2. Eutreptiaceae	3	3 (3)	0.914
Division III. Bacillariophyta	**21**	**64 (71)**	**21.646**
Class 1. Bacillariophyceae	**17**	**53 (57)**	**17.377**
Order 1. Cocconeidales	1	2 (2)	0.609
Family 1. Cocconeidaceae	1	2 (2)	0.609
Order 2. Bacillariales	1	3 (3)	0.914
Family 1. Bacillariaceae	1	3 (3)	0.914
Order 3. Cymbellales	3	10 (11)	3.353
Families: 1. Anomoeoneidaceae	1	1 (1)	0.304
2. Cymbellaceae	1	7 (7)	2.133
3. Gomphonemataceae	1	2 (3)	0.914
Order 4. Eunotiales	1	2 (2)	0.609
Family 1. Eunotiaceae	1	2 (2)	0.609
Order 5. Mastogloiales	1	3 (3)	0.914
Family 1. Achnanthaceae	1	3 (3)	0.914
Order 6. Naviculales	6	26 (28)	8.536
Families: 1. Amphipleuraceae	1	1 (1)	0.304
2. Diploneidaceae	1	4 (4)	1.219
3. Naviculaceae	3	18 (20)	6.097
4. Pinnulariaceae	1	3 (3)	0.914
Order 7. Surirellales	2	4 (5)	1.524
Family 1. Surirellaceae	2	4 (5)	1.524
Order 8. Thalassiophysales	1	2 (2)	0.609
Family 1. Catenulaceae	1	2 (2)	0.609
Order 9. Thalassiosirales	1	1 (1)	0.304
Family 1. Stephanodiscaceae	1	1 (1)	0.304

Con. Table 1

Class 2. Fragilariophyceae	**4**	**11 (14)**	**4.268**
Order 10. Fragilariales	1	1 (1)	0.304
Family 1. Fragilariaceae	1	1 (1)	0.304
Order 11. Licmophorales	2	9 (12)	3.658
Family 1. Ulnariaceae	2	9 (12)	3.658
Order 12. Tabellariales	1	1 (1)	0.304
Family 1. Tabellariaceae	1	1 (1)	0.304
Division IV. Chlorophyta	**26**	**59 (65)**	**19.817**
Class 1. Chlorophyceae	**17**	**42 (48)**	**14.634**
Order 1. Chaetophorales	2	2 (2)	0.609
Families: 1. Chaetophoraceae	1	1 (1)	0.304
2. Uronemataceae	1	1 (1)	0.304
Order 2. Chlamydomonadales	3	6 (6)	1.829
Families: 1.Chlamydomonadaceae	1	4 (4)	1.219
2. Chlorococcaceae	1	1 (1)	0.304
3. Phacotaceae	1	1 (1)	0.304
Order 3. Chlorococcales	12	34 (40)	12.195
Families: 1. Characiaceae	2	2 (2)	0.609
2. Schroederiaceae	1	1 (1)	0.304
3. Hydrodictyaceae	2	9 (11)	3.353
4. Neochloridaceae	1	1 (1)	0.304
5. Coelastraceae	1	3 (3)	0.914
6. Scenedesmaceae	2	11 (15)	4.573
7. Selenastraceae	3	7 (7)	2.134
Class 2. Trebouxiophyceae	**7**	**10 (10)**	**3.048**
Order 4. Chlorellales	7	10 (10)	3.048
Families: 1. Chlorellaceae	3	3 (3)	0.914
2. Oocystaceae	3	6 (6)	1.828
3. Sphaerocystidaceae	1	1 (1)	0.304
Class 3. Ulvophyceae	**2**	**7 (7)**	**2.134**
Order 5. Ulotrichales	1	6 (6)	1.829
Family 1. Ulotrichaceae	1	6 (6)	1.829
Order 6. Cladophorales	1	1 (1)	0.304
Family 1. Cladophoraceae	1	1 (1)	0.304
Division V. Streptophyta	**11**	**53 (56)**	**17.073**
Class 1. Conjugatophyceae	**11**	**53 (56)**	**17.073**
Order 1. Desmidiales	7	42 (45)	13.719
Families: 1. Peniaceae	1	2 (2)	0.609
2. Closteriaceae	1	16 (17)	5.182
3. Desmidiaceae	5	24 (26)	7.926
Order 2. Zygnematales	4	11 (11)	3.353
Families: 1. Zygnemataceae	2	4 (4)	1.219
2. Spirogyraceae	2	7 (7)	2.133
Total	**86**	**305 (328)**	**100.00**

Table (2): Dominant Orders of Algae founded in water bodies of Tajan River basin, Mazandaran Province of Iran (2011-2017).

Algae Orders	Number of families	Number of genus	Number of species (varieties and forms)	%
1. Euglenales	3	6	54 (59)	22.188
2. Desmidiales	3	7	42 (45)	16.917
3. Chlorococcales	7	12	34 (40)	15.037
4. Oscillatoriales	1	3	33 (35)	13.157
5. Naviculales	4	6	26 (28)	10.526
6. Chroococcales	5	6	15 (15)	5.639
7. Licmophorales	1	2	9 (12)	4.511
8. Zygnematales	2	4	11 (11)	4.135
9. Cymbellales	3	3	10 (11)	4.135
10. Chlorellales	3	7	10 (10)	3.759
Total	**32**	**56**	**244 (266)**	**100.00**

Table (3): Dominant Families of Algae found in Tajan River basin, Mazandaran Province of Iran (2011-2017).

Algae Families	Number of genus	Number of species (varieties and forms)	%
1. Oscillatoriaceae	3	33 (35)	17.412
2. Phacaceae	2	28 (32)	15.920
3. Euglenaceae	3	25 (26)	12.935
4. Desmidiaceae	5	24 (26)	12.935
5. Naviculaceae	3	18 (20)	9.950
6. Closteriaceae	1	16 (17)	8.457
7. Scenedesmaceae	2	11 (15)	7.462
8. Ulnariaceae	2	9 (12)	5.970
9. Hydrodictyaceae	2	9 (11)	5.472
10. Cymbellaceae	1	7 (7)	3.482
Total	**24**	**180 (201)**	**100.00**

Table (4): Dominant Algae Genus found in water bodies of Tajan River basin, Mazandaran Province of Iran (2011-2017).

Genus	Number of species (varieties and forms)	%
1. *Oscillatoria*	22 (22)	12.290
2. *Phacus*	17 (20)	11.173
3. Closterium	16 (17)	9.497
4. *Navicula*	13 (15)	8.379
5. *Cosmarium*	13 (15)	8.379
6. *Scenedesmus*	10 (14)	7.821
7. *Trachelomonas*	13 (13)	7.262
8. *Euglena*	10 (11)	6.145
9. Lepocinclis	10 (11)	6.145
10. *Phormidium*	8 (8)	4.469
11. *Cymbella*	7 (7)	3.910
12. *Synedra*	5 (7)	3.910
13. *Pediastrum*	5 (7)	3.910
14. *Ulothrix*	6 (6)	3.351
15. *Spirogyra*	6 (6)	3.351
Total	**161 (179)**	**100.00**

Division Euglenophyta

Based on Table 1, the two orders of Euglenales and Eutreptiales were identified from the only one class of this division (Euglenophyceae), which had three and one family. Totally 3 families among Euglenales recognized which the Euglenaceae family with the three genera was the highest and Peranemataceae, with one genus was the lowest cases. The number of species and sub-species among all families of Euglenales showed that the Euglenophyceae with 25 species and one sub-species and Phacaceae with 28 species and 4 subspecies were highest amounts. Although the number of genera in Phacaceae family was lower than Euglenaceae, but included more species. Another order, Eutreptiales, showed five identified genera and eight species.

Division Bassillariophyta

No doubt, most species of algae in many similar studies (algae flora of the River water) are related to the Bacillariophyta or diatoms. Diatoms are considered as one of the main indicators of water quality, hence, the study and identification of them, can help to monitor and determine water and sediment status. In current study, two classes of Bacillariophyceae with 9 orders and Fragilariophyceae with 3 orders

were identified. Most families in this division were in connection to Naviculales order with 4 families and Cymbellales order with 3 families respectively. There are 14 families in all orders of this division. Among them, Naviculaceae family with 3 genera, 18 species, and 2 sub-species, showed highest number of species as well as the Cymbellaceae with one genus and 7 species. The total number of genera and species among all identified families in this class were 17 genera, 53 species and 4 sub-species.

In the case of Fragilariophyceae class, three orders identified that Fragilariales with one family, Licmophorales with one, and finally Tabellariales with one family that each of them showed one genus except Ulnariaceae with 2. The highest number of species and sub-species belonged to the Ulnariaceae family with 9 species and 3 sub-species.

Division Chlorophyta

The highest number of classes seen in division Chlorophyta (Chlorophyceae Trebouxiophyceae, and Ulvophyceae). Orders Sphaeropleales showed 7 families where Selenastraceae having 3 genera, Scenedesmaceae (2 genera) and Hydrodictyaceae (2 genera). The total numbers of identified families in Chlorophyceae were 12 families, that all of them included 17 genera. The highest number of species and sub-species was for family of Scenedesmaceae, with 2 genera, 11 species and 4 sub-species, however, family Hydrodictyaceae showed 9 species and 2 sub-species. The total number of genera, species, and sub-species in this classwere 17, 42, and 6, respectively. Class Trebouxiophyceae, showed only one order called Chlorellales with three identified families in this study. In all genra of this family, totally 7 genera and 10 species were identified. Class Ulvophyceae having two orders of Ulotrichales with one family (Ulotrichaceae), and the Cladophorales with one family (Cladophoraceae) that each of these families showed only one genus. The number of species in the family Ulotrichaceae was 6, whilein the family of Cladophorace a represented by *Cladophora glomerata* recognized in the Farah Abad station of the Caspian Sea (station No. 9). This alga has the great importance from for its potential in extraction of clean fuel (Biofuel) as well as environmental and toxicological bio-indicator (Fig. 3). In previous studies that conducted by the present authors, the purification of heavy metals (Phytoremediation) performed by *C. glomerata*as well as its potential of application in the field of clean energy (Ebadi and Hisoriev, 2017a ; Ebadi and Hisoriev, 2017c ; Ebadi *et al*., 2017; Ebadi and Hisoriev, 2018; Ebadi *et al.*, 2018).

Fig. (3): *Cladophora glomerata* L. obtained from Farahabad region of Caspian Sea – station 9 (2017).

Division Streptophyta

The members of this division were formerly studied in the Chlorophyta group, but now examined in the Streptophyta division with respect to some differences in morphological and taxonomic traits. In the present study, only one class called Conjugatophyceae identified. Two orders Desmidiales with three and Zygnematales with two families have been determined. Among families of oreder Desmidiales, family Desmidiaceae with with 5 genera, 24 species and 2 sub-species, showed highest number of species. The total number of genera in this order is seven, and the number of species and subtypes were 42 and 2, respectively. The order Zygnematales showedtwo families of Zygnemataceae (with two genera) and Spirogyraceae (with twogenera). The Spirogyraceae and Zygnemataceae showed 7 and 4 species, respectively.

According to Table 5, the most amounts of species of Cyanoprocaryota found in stations 1 & 2 and the lowest were for stations of 8 & 9. As we told earlier, in stations 1 and 2, the water is used mostly for drinking and agricultural purposes. In stations 8 and 9 are connected to Caspian Sea and it is salty and only one species found that can tolerate this salty condition. In Figure 4, it is clear that ecological conditions of stations 3-6 are nearly similar.

Table (5): List of Cyanoprocaryota species found in Tajan River basin, Mazandaran Province of Iran (2011-2017).

No.	Taxa	Stations								
		1	2	3	4	5	6	7	8	9
1	*Dactylococcopsis raphidioides* Hansg.	–	–	–	–	–	–	+	–	–
2	*D. rupestris*Hansg.	–	–	–	–	–	–	+	–	–
3	*Aphanothece castagnei* (Kütz.) Rabenh.	+	+	+	+	+	–	+	–	–
4	*A. microscopica* Näg.	+	+	+	+	+	–	–	–	–
5	*A. stagnina* (Spreng.) A. Br.	+	+	–	–	–	+	–	–	+
6	*Coelosphaerium kuetzingianum* Näg.	+	+	–	–	–	–	–	–	+
7	*C. dubium* Grun.	+	+	–	–	–	–	–	–	–
8	*Gomphos phaerialacustris* Chod.	+	+	–	–	–	–	–	+	+
9	*Gloeocapsa alpina* Brand.	+	+	+	+	+	–	–	–	–
10	*G. cohaerenc* (Bréb.)Hollerb.	+	+	+	+	+	–	–	–	–
11	*G. magma* Kütz.	+	+	–	–	–	–	–	–	–
12	*G. minuta* (Kütz.) Hollerb.	+	+	–	–	–	–	–	–	–
13	*Microcystis aeruginosa* Kütz. emend Elenk.	–	–	–	–	+	+	–	–	–
14	*M. pulverea* (Wood) Forti emend. Elenk.	–	–	–	–	–	+	+	+	+
15	*M. viridis* (A. Br.) Lemm.	–	–	–	–	–	–	+	–	–
16	*Spirulina jenneri* (Stizenb.) Geitl.	–	–	–	–	–	–	+	–	–
17	*S. subtilissima* Kütz. ex Gom.	–	–	–	–	–	–	+	–	–
18	*Aphanizomenon flos-aquae* Ralfs ex Born. et Flah.	–	–	–	–	–	+	+	–	–
19	*Anabaena ellipsoides* Bolochonz. em. Woronich.	–	–	–	–	–	–	+	–	–
20	*A. laxa* (Rabenh.) A.Br.	–	–	–	–	–	–	+	–	–
21	*A. oscillaroides* Bory	–	–	–	–	–	+	–	–	–
22	*A. spiroides* Kleb.	–	–	–	–	–	+	–	–	–
23	*Nostoc commune* Vauch. ex Born et Flah.	+	+	–	–	–	–	–	–	–
24	*N. gelatinosum* Schousboe ex Born. et Flah.	+	+	–	–	–	–	–	–	–
25	*N. paludosum* Kütz. ex Born et Flah.	+	+	–	–	–	–	–	–	–
26	*Lyngbya aerugineo-coerulea* (Kütz.) Gom.	+	+	–	–	+	–	–	–	–
27	*L. aestuarii* (Mert.) Liebm.	+	+	–	–	–	–	–	–	–
28	*L. attenuata* F.E. Fritsch	+	+	–	–	–	–	–	–	–
29	*L. cryptovaginata*Schkorb.	+	+	–	–	–	–	+	–	–
30	*L. hieronymusii* Lemm.	+	+	–	–	–	–	–	–	–
31	*Oscillatoria agardhii* Gom.	+	+	–	–	–	–	–	–	–
32	*O. amoena* Gom.	+	+	–	–	–	–	–	–	–

No.	Taxa	Stations								
		1	2	3	4	5	6	7	8	9
33	*O. amphibia* Ag.	+	+	–	–	–	–	–	–	–
34	*O. anguina* (Bory) Gom.	–	–	–	–	–	–	–	+	+
35	*O. boryana* (Ag.) Bory	–	–	–	–	–	–	–	+	+
36	*O. brevis* (Kütz.) Gom.	–	–	–	–	–	–	–	+	+
37	*O. chalybea* (Mert.) Gom.	–	–	–	–	–	–	–	+	+
38	*O. geminata* (Menegh.) Gom.	+	+	+	+	+	–	+	–	–
39	*O. granulata* Gardner	+	+	+	+	+	–	+	–	–
40	*O. formosa*Bory	+	+	+	+	+	–	+	–	–
41	*O. irrigua* (Kütz.) Gom.	+	+	+	+	+	–	+	–	–
42	*O. limnetica* Lemm.	+	+	+	+	+	–	+	–	–
43	*O. limosa* Ag.	+	+	+	+	+	–	+	–	–
44	*O. mougeotii* f. major (Elenk.) Elenk.	+	+	–	–	–	–	–	–	–
45	*O. ornata* (Kütz.) Gom.	+	+	–	–	–	–	–	–	–
46	*O. prolifica* (Grev.) Gom.	–	–	+	+	+	–	–	–	–
47	*O. putrida* Schmidle	+	+	+	+	+	+	–	–	–
48	*O. simplicissima* Gom.	+	+	+	+	+	+	–	–	–
49	*O. splendida* Grev.	+	+	+	+	+	+	–	–	–
50	*O. tenuis* Ag. ex Gom..	+	+	+	+	+	+	–	–	–
51	*O. tenuis* f. tergestina (Kütz.) Elenk.	+	+	+	+	+	+	–	–	–
52	*O. terebriformis* (Ag.) Elenk.	+	+	+	+	+	+	–	–	–
53	*Phormidium ambiguum* Gom.	+	+	–	–	–	–	+	–	–
54	*P. favosum* (Bory) Gom.	+	+	–	–	–	–	–	–	–
55	*P. foveolarum* (Mont.) Gom.	+	+	–	–	–	–	–	–	–
56	*P. ornatum* (Kütz.) Anagn. et Kom.	+	+	–	–	–	–	–	–	–
57	*P. retzii* (Ag.) Kutz. ex Gom.	+	+	–	–	–	–	–	–	–
58	*P. subfuscum* Kütz. ex Gom.	+	+	–	–	–	–	–	–	–
59	*P. terebriforme* (Ag.) Anagn. et Kom.	+	+	–	–	–	–	+	–	–
60	*P. tergestinum* (Rabehn.) Anagn. et Kom.	–	–	–	–	–	+	–	–	–
61	*Pseudanabaena limnetica* (Lemm.) Kom.	+	+	–	–	–	+	–	–	–
62	*Merismopedia elegans* A. Br.	+	+	+	+	+		+	–	–
63	*M. glauca* (Ehr.) Näg.	+	+	+	+	+	+	+	–	–
64	*M. major* (Smith) Geitl.	–	–	–	–	–	+	+	–	–
65	*M. punctata* Meyen	+	+	+	+	+	+	+	–	–
66	*M. tenuissima* Lemm.	+	+	+	+	+	+	+	–	–
67	*Synechocystis aquatilis* Sauv.	+	+	+	+	+	+	–	–	–
68	*S. elongatus* (Näg.) Näg.	–	–	–	–	–	+	–	+	+
69	*Chamaesiphon regularis* Geitler	–	–	–	–	–	+	–	+	–

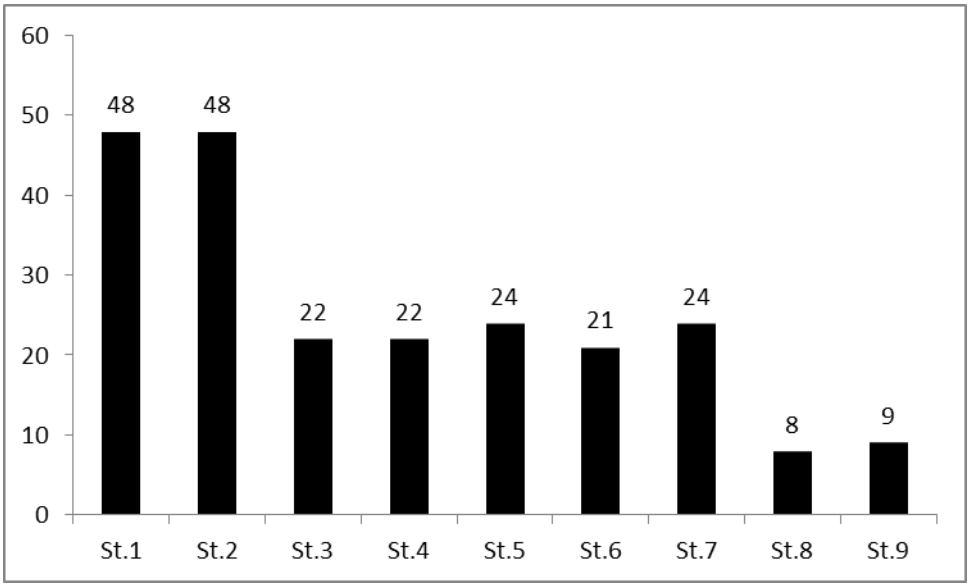

Fig. (4): Frequency of species of cyanoprocaryota from different sampling stations.

Table 5 shows that, there is no species that exist in all stations. The lowest frequency of species are found as, *Dactylococcopsis raphidioides*, *Dactylococcopsis rupestris*, *Microcystis viridis*, *Spirulina jenneri*, *Spirulina subtilissima*, and *Anabaena ellipsoides* (From Station 7) and *Anabaena oscillaroides*, *Anabaena spiroides,* and *Phormidium tergestinum* (from Station 6). It is also found that the Genus *Oscillatoria*including 22 species and *Phormidium* with 8 species were dominant.

According to Table 6, there is a mild slope about distribution of species of Euglenophyta in studied stations. In stations 8 & 9 for salty conditions, lower amount expected. Only about one species, T. volvocina, seen in all stations. This alga mostly finds in fresh water and its existence in stations 8 and 9 can for infusion of Tajan River to Caspian see. The most frequent of species can refer as, *Euglena gracilis* (Stations 1-7), *Phacus pleuronectes* & *Phacus pleuronectes* Duj. var. hyalinus Klebs (Stations 3-9), *Phacus anomalus* (Stations 3-9) and finally *Lepocinclis fusiformis* (Stations 3-9). The highest amount of species is for station 7.

Table (6): List of Euglenophyta species found in Tajan River basin, Mazandaran Province of Iran (2011-2017).

No.	Taxa	Stations								
		1	2	3	4	5	6	7	8	9
1	*Euglena acus* Ehr.	-	-	-	+	+	-	-	-	-
2	*Euglena acus* Ehr. var. hyalina Klebs	-	-	-	+	+	-	-	-	-
3	*E. caudata* Hübner	-	-	-	-	-	+	+	+	+
4	*E. clara* Skuja	-	-	-	-	-	+	-	-	+
5	*E. deses* Ehr.	+	+	+	+	+	+	-	-	-
6	*E. ehrenbergii* Klebs	+	+	+	+	+	-	-	+	-
7	*E. geniculata* Duj.	+	+	+	+	+	-	+	-	-
8	*E. gracilis* Klebs	+	+	+	+	+	+	+	-	-
9	*E. spirogyra*Ehr.	-	-	-	-	-	+	+	-	-
10	*E. texta* (Duj.) Hübn.	+	+	-	-	-	+	-	-	-
11	*E. viridis* (O.F. Müll.) Ehr.	-	-	+	+	+	+	-	-	-
12	*Strombomonas fluviatilis* (Lemm.) Defl.	-	-	-	-	-	-	+	-	-
13	*S. schauinslandii* (Lemm.) Defl.	-	-	-	-	-	-	+	-	-

No.	Taxa	Stations								
		1	2	3	4	5	6	7	8	9
14	*Trachelomonas acanthostoma* Stokes sensu Defl.	+	+	-	-	-	-	-	-	-
15	*T. allia* Drez.	-	-	-	-	-	+	+	-	-
16	*T. hispida* (Perty) Stein ex Delf.	+	+	+	+	+	-	+	-	-
17	*T. intermedia* Dang.	-	-	-	-	-	+	+	-	-
18	*T. lacustris* Drez. emend. Balech	+	+	+	+	+	-	+	-	-
19	*T. legatovii* (Skvort.) Defl.	+	+	+	+	+	-	+	-	-
20	*T. mirabilis* Swir.	+	+	+	+	+	-	+	-	-
21	*T. pavlovskoensis* (Poljansk.) Pop.	+	+	-	-	-	-	+	-	-
22	*T. perforata* Aver.	+	+	-	-	-	-	+	-	-
23	*T. scabra* Playf.	+	+	-	-	-	-	-	-	-
24	*T. superba* Swir. emend. Defl.	+	+	-	-	-	-	-	-	-
25	*T. volvocina* Ehr.	+	+	+	+	+	+	+	+	+
26	*T. volvocinopsis* Ehr.	+	+	-	-	-	-	-	-	-
27	*Anisonema acinus*Duj.	-	-	-	-	+	+	+	+	+
28	*Lepocinclis constricta* Matv.	-	+	+	+	-	-	-	-	-
29	*L. elongata* (Swir.) Conr.	-	+	+	+	-	-	-	-	-
30	*L. ovum* (Ehr.) Mink.	-	-	+	+	-	-	-	+	+
31	*L. ovum* (Ehr.) Mink. var. major Kufferath	+	+	-	-	-	-	-	-	-
32	*L. playfairiana* Defl.	-	-	-	-	-	+	-	-	-
33	*L. steinii* Lemm.	+	+	-	-	-	-	+	+	+
34	*L. teres* (Schmitz) Francé	-	-	+	+	+	-	-	-	-
35	*L. tschernovii* Popova	+	+	+	+	+	+	-	-	-
36	*L. fusiformis* (Carter) Lemm.	-	-	+	+	+	+	+	+	+
37	*L. spirogyra* Korschik.	-	-	-	-	-	+	+	-	-
38	*L. marssonii* Lemm.	-	-	+	+	+	+	+	-	-
39	*Ascoglena viridis* Popova	-	+	+	-	-	-	+	-	-
40	*Phacus acuminatus* Stokes	+	+	+	+	+	-	-	-	-
41	*Ph. acutus* Pochm.	+	+	-	-	-	-	+	-	-
42	*Ph. anomalus* Fritsch et Rich	-	-	+	+	+	+	+	+	+
43	*Ph. caudatus* Hübn.	-	-	+	+	+	+	+	-	-
44	*Ph. caudatus* Hübn. var. minor Drez.	-	-	+	+	+	+	+	-	-
45	*Ph. curvicauda* Swir.	-	-	+	+	+	-	-	-	-
46	*Ph. granum* Drez.	-	-	+	+	+	+	-	-	-
47	*Ph. hispidulus* (Eichw.) Pochm.	-	-	-	-	-	-	+	+	+
48	*Ph. inflexus* (Kisel.) Pochm.	-	-	-	-	-	+	+	+	+
49	*Ph. longicauda* (Ehr.) Duj.	-	-	+	+	+	+	+	-	-
50	*Ph. longicauda* (Ehr.) Duj. var. tortus Lemm.	-	-	+	+	+	+	+	-	-
51	*Ph. orbicularis* K.Hübner	-	+	+	+	+	-	+	-	-
52	*Ph. parvulus* Klebs	-	-	-	-	-	+	-	-	-
53	*Ph. pusillus* Lemm.	+	+	-	-	-	-	+	-	-
54	*Ph. pleuronectes* Duj.	-	-	+	+	+	+	+	+	+
55	*Ph. Pleuronectes* Duj. var. hyalinus Klebs	-	-	+	+	+	+	+	+	+
56	*Ph. pyrum* (Ehr.) Stein	-	-	-	-	-	+	+	+	+
57	*Ph. pseudonordstedtii* Pochm.	-	-	-	-	+	+	+	-	-
58	*Ph. spirogyra* Drez.	-	-	+	-	-	-	+	-	-
59	*Ph. tortuosus* Roll	-	-	-	-	-	-	+	-	-
60	*Distigma curvata* Prings.	-	-	-	+	+	+	+	-	-
61	*D. globifera* Skuja	-	+	-	-	-	-	-	-	-
62	*Astasia breviciliata* Matv.	-	-	-	-	-	+	+	-	-
63	*A. inflata* Duj.	-	-	-	-	-	+	+	+	+

No.	Taxa	Stations								
		1	2	3	4	5	6	7	8	9
64	*A. praecomplecta* Skuja	-	-	-	-	-	-	+	+	+
65	*Rhabdomonas incurve* Fres.	-	-	-	-	-	-	+	+	+
66	*Euglenopsis vorax* Klebs.	-	-	-	-	-	-	+	+	+
67	*Cyclidiopsis acus* Korsch.	-	-	-	-	-	+	+	-	-

There are not rapid ecological changes from stations 1 to 6. After that sudden increase and then sudden decrease seen. Condition of station 7 show that in Sari city, the purification of wastewater has better conditions and let to fresh species for growing (Fig. 5).

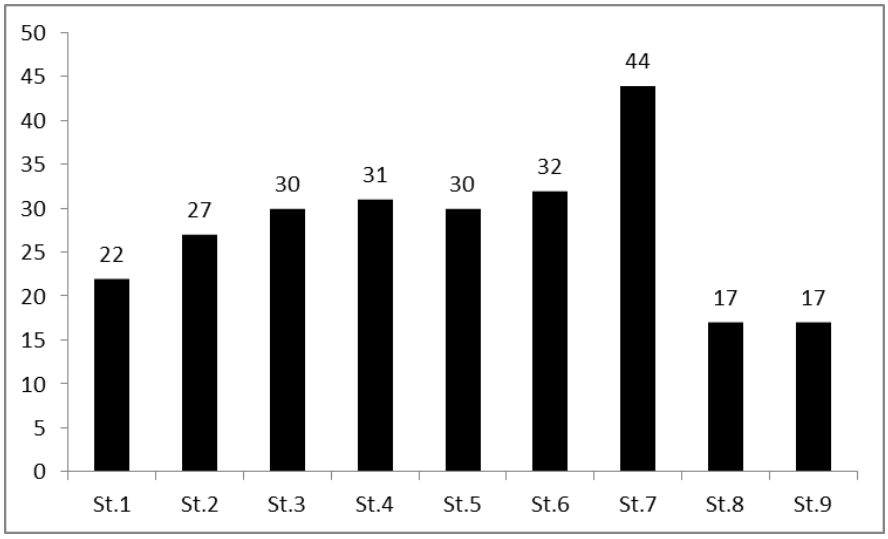

Fig. (5): Frequency of Euglenophyta species from different sampling stations.

Based on Table 7, the *Navicula*genus showed the highest species number and found in all stations. There are 15 species in this study that mostly live in freshwater bodies. Only 2 species found in salty waters of stations 8 & 9 (*Navicula dicephala* & *Navicula rhynchocephala*). This may be for selection of some samples from adjacent points that have freshwater source. The highest number of species was seen in station 5. There is an increase slope from stations 1 to 5 and decrease slope from 5-9. Decrease of species in stations 6 to 7 may be due to increasing of pollutant source such as physical damage of river for Non-standard exploitation and even some local little factories that enter waste water to the River in these points (Fig. 6). Table 7 also shows that there is no species that present in all stations but the most frequent species are *Cocconeis placentula* (all except station 6) and *Diploneis ovalis* (all except station 1). The lowest number were recorded for *Achnanthes cristata*, *Achnanthes hungarica*, *Achnanthes lanceolata*, *Diploneis oblongella*, *Navicula gracillis*, *Navicula grimmei*, *Navicula subrhombica*, *Navicula subtilissima*, *Amphora commutate*, *Amphora veneta* (only station 6), *Caloneis amphisbaena*, *Caloneis silicula*, *Navicula amphibola* (only station of 1), *Pinnularia borealis* (only station of 2), and *Cyclotella kuetzingiana* (only station 3).

Table (7): List of Bacillariophyta species found in Tajan River basin, Mazandaran Province of Iran (2011-2017).

No.	Taxa	Stations								
		1	2	3	4	5	6	7	8	9
1	*Cocconeis pediculus* Ehr.	-	-	+	+	+	-	+	-	-
2	*C. placentula* Ehr.	+	+	+	+	+	-	+	+	+
3	*Nitzschia clausii* Hanzsch	+	+	+	+	+	-	-	-	-
4	*N. sigmoidea* (Nitzsch) G.W. Sm.	+	+	+	+	+	+	+	-	-
5	*N. vitrea* Norm.	+	+	+	+	+	+	+	-	-
6	*Anomoeoneis sphaerophora* (Ehr.) Pfitz.	+	+	-	-	-	-	-	-	-
7	*Cymbella affinis* Kütz.	+	+	+	+	+	-	-	-	-
8	*C. amphicephala*Näg.	+	+	+	+	+	-	-	-	-
9	*C. cymbiformis* Ag.	+	+	-	-	-	-	+	-	
10	*C. prostrata* (Berkeley) Cl.	-	-	-	-	-	+	+	-	-
11	*C. sinuata* Greg.	-	-	-	-	+	+	+	+	+
12	*C. tumida* (Breb.) Van Huerk	-	-	-	-	+	+	+	+	+
13	*C. ventricosa*Kütz.	-	+	+	+	+	-	+	-	-
14	*Gomphonema acuminatum* Ehr.	+	+	+	+	+	-	-	+	+
15	*G. acuminatum* Ehr. var. brebissonii (Kütz.) Schonfeldt	-	-	+	+	+	+	-	-	-
16	*G. constrictum* Ehr.	-	-	+	+	+	+	+	-	-
17	*Eunotia arcus* Ehr.	+	+	+	-	-	-	-	-	-
18	*E. exigua* (Bréb. ex Kütz.) Rabenh.	+	+	+	+	-	-	-	-	-
19	*Achnanthes cristata* Rabenh.	-	-	-	-	-	+	-	-	-
20	*A. hungarica* Grun.	-	-	-	-	-	+	-	-	-
21	*A. lanceolata* (Bréb) Grun.	-	-	-	-	-	+	-	-	-
22	*Amphipleura pellucida* (Kütz.) Kütz.	+	+	-	-	-	-	+	-	-
23	*Diploneis interrupta* (Kütz.) Cl.	+	+	+	+	+	-	-	-	-
24	*D. oblongella* (Näg. ex Kütz.) Cl.-Euler	-	-	-	-	-	+	-	-	-
25	*D. oculata* (Bréb.) Cl.	+	+	+	+	+	-	-	-	-
26	*D. ovalis* (Hilse) Cl.	-	+	+	+	+	+	+	+	+
27	*Caloneis alpestris* Cl.	-	+	+	+	+	-	-	-	-
28	*C. amphisbaena* (Bory) Cl.	+	-	-	-	-	-	-	-	-
29	*C. silicula* (Ehr.) Cl.	+	-	-	-	-	-	-	-	-
30	*Gyrosigma scalproides* (Rabenh.) Cl.	+	+	+	+	+	-	-	-	-
31	*G. spenceri* (W. Sm.) Cl.	+	+	+	+	+	-	-	-	-
32	*Navicula amphibola* Cl.	+	-	-	-	-	-	-	-	-
33	*N. cryptocephala* Kütz.	+	+	-	-	-	-	-	-	-
34	*N. cryptocephala* Kütz. var. lata Poretz. et Anissimova	+	+	-	-	-	-	-	-	-
35	*N. cryptocephala* Kütz. var. veneta (Kütz.) Rabenh.	+	+	-	-	-	-	-	-	-
36	*N. dicephala* Ehr.	-	-	+	+	+	+	+	+	+
37	*N. exigua* (Greg.) O.Müll.	+	+	+	+	+	-	-	-	-
38	*N. gracillis* Ehr.	-	-	-	-	-	+	-	-	-
39	*N. grimmei* Krasske	-	-	-	-	-	+	-	-	-
40	*N. pupula* Kütz.	-	+	+	+	+	-	-	-	-
41	*N. rhynchocephala* Kütz.	-	-	+	+	+	+	+	+	+
42	*N. subrhombica* Hust.	-	-	-	-	-	+	-	-	-

No.	Taxa	Stations								
		1	2	3	4	5	6	7	8	9
43	*N. subtilissima* Cl.	-	-	-	-	-	+	-	-	-
44	*N. tripunctata* (O. Müll.) Bory	-	-	+	+	+	-	-	-	-
45	*N. tuscula* (Ehr.) Grun.	-	-	+	+	+	-	-	-	-
46	*N. viridula* (Kütz.) Ehr.	+	+	+	-	-	-	-	-	-
47	*Pinnularia borealis* Ehr.	-	+	-	-	-	-	-	-	-
48	*P. gibba* Ehr.	+	+	+	+	+	+	+	-	-
49	*P. mesolepta* (Ehr.) G.W. Sm.	+	+	+	+	+	-	+	-	-
50	*Cymatopleura solea* (Bréb.) G.W. Sm.	+	+	+	+	+	-	-	-	-
51	*Cymatopleura solea* (Bréb.) G.W. Sm. var. subconstricta O. Müll.	+	+	+	+	+	-	-	-	-
52	*Surirella biseriata* Bréb.	-	+	+	+	+	-	-	-	-
53	*S. gracilis* (W. Sm.) Grun.	-	-	+	+	+	-	-	-	-
54	*S. linearis* W. Sm.	-	+	+	+	+	-	-	-	-
55	*Amphora commutata* Grun.	-	-	-	-	-	-	+	-	-
56	*A.veneta*Kütz.	-	-	-	-	-	-	+	-	-
57	*Cyclotella kuetzingiana* Thw.	-	-	+	-	-	-	-	-	-
58	*Fragilaria crotonensis* Kitt.	-	-	-	-	+	+	+	+	+
59	*Synedra acus* Kütz.	-	-	+	+	+	+	+	+	+
60	*S. pulchella* (Ralfs) Kütz. var. pulchella	-	-	+	+	+	+	+	+	+
61	*S. pulchella* (Ralfs) Kütz. var. pulchellavar. lanceolata O. Meara	-	-	-	-	+	+	+	-	-
62	*S. rumpens* Kütz.	-	-	-	-	+	-	+	+	+
63	*S. ulna* (Nitzsch) Ehr.	-	-	-	-	+	+	+	+	+
64	*S. ulna* (Nitzsch) Ehr.var. impressa Hust.	-	-	-	-	+	+	-	+	-
65	*S. vaucheriae* Kütz.	-	-	-	-	-	+	+	+	+
66	*Ulnaria amphirhinchus* (EhrCompere	-	-	-	-	+	+	-	+	+
67	*U. biceps* (Kütz.) Compare	-	+	+	+	-	-	-	-	-
68	*U. oxyrhynchus* (Kütz.) Aboal	-	-	-	-	+	-	+	+	+
69	*U. ulna* (Kütz.) Hust.	-	-	-	-	-	+	+	-	+
70	*U. ulna* (Kütz.) Hust. var .aequalis (Kütz.) Hust.	-	-	-	-	-	+	+	-	+
71	*Diatoma vulgare* Bory	-	-	-	+	-	+	+	+	+

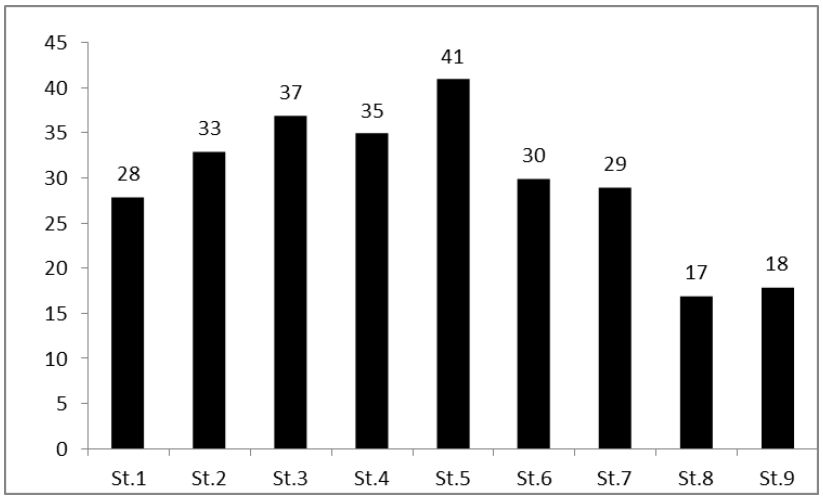

Fig. (6): Frequency of Bacillariophyta species from different sampling stations.

Table 8 shows that, no species was found in all stations. The highest number of species is belonging to *Ulothrix oscillarina*, *Ulothrix subtilissima* and *Ulothrix tenerrima* that exist in all stations except station 9. All three species are belonging to freshwater origin and lace of them in station 9 is normal condition. The lowest number of species found is *Characium ornithochephalum* (Station 5), *Coelastrum astroideum* (Station 3) and *Ulothrix implexa* (station 9) with one species. The highest amount of species found in station of 5 and lowest was station 9. There is normal distribution of species in this division. Moderate climatic conditions are necessary for grow and reproductions. In stations 1 and 2 for cold temperature, the amount was lower than expectation (Fig. 7).

Table (8): List of Chlorophyta species found in Tajan River basin, Mazandaran Province of Iran (2011-2017).

No.	Taxa	Stations								
		1	2	3	4	5	6	7	8	9
1	*Stigeoclonium tenue* (Ag.) Kütz.	-	-	–	-	-	+	+	+	+
2	*Uronema confervicolum* Lagerh.	-	-	–	-	+	+	+	–	–
3	*Chlamydomonas atactogama* Korschik.	-	-	-	-	+	+	+	–	–
4	*Ch. conferta* Korschik.	-	-	-	+	-	-	–	–	–
5	*Ch. ehrenbergii* Gorosch.	-	-	+	+	+	+	+	–	–
6	*Ch. monadina* Stein	-	+	+	+	+	+	–	–	–
7	*Chlorococcum infusionum* (Schrank) Menegh.	–	+	–	-	-	-	+	-	–
8	*Phacotus lenticularis* (Ehr.) Stein	–	-	–	-	+	+	-	–	–
9	*Korschikoviella limnetica* (Lemm.) Silva	–	-	–	+	+	+	-	–	–
10	*Characium ornithochephalum* A. Braun	-	-	-	-	+	-	-	-	-
11	*Schroederia setigera* (Schröd.) Lemm.	–	-	+	+	+	+	-	–	–
12	*Pediastrum angulosum* Ehr. et Menegh.	–	-	–	+	+	+	+	-	–
13	*P. boryanum* (Turp.) Menegh. var. boryanum	–	-	–	-	+	+	+	-	–
14	*P. boryanum* (Turp.) Menegh. var.cornutum (Racib.) Sulek	–	-	–	-	+	+	+	-	–
15	*P. duplex* Meyen var. duplex	-	-	+	+	+	+	-	–	–
16	*P. duplex* Meyen. var. rugulosum Racib.	-	-	+	+	+	+	-	–	–
17	*P. simplex* Meyen	+	+	+	+	+	+	-	–	–
18	*P. tetras* (Ehrenb.) Ralfs	+	+	+	+	+	+	-	–	–
19	*Tetraedron caudatum* (Corda) Hansg.	-	+	+	+	+	+	-	–	–
20	*T. incus* (Teil.) G.M. Smith	-	+	+	+	+	+	+	-	–
21	*T. minimum* (A. Br.) Hansg.	-	+	+	+	+	+	+	-	–
22	*T. triangulare* Korsch.	–	-	–	-	+	+	+	-	–
23	*Golenkinia radiata* Chodat	-	-	+	+	+	+	+	-	–
24	*Coelastrum astroideum* De-Notaris	-	-	+	-	-	-	-	-	-
25	*C. indicum*Turner	–	-	–	-	-	+	-	–	–
26	*C. microporum* Nägeli	+	+	+	+	+	+	+	-	–
27	*Scenedesmus acuminatus* (Lag.) Chod.	-	-	+	+	+	-	-	-	-
28	*S. acutiformis* Schröder	-	-	+	+	+	-	-	-	-
29	*S. apiculatus* (W. et G.S.West) Chod. var. apiculatus	-	-	+	+	+	-	-	-	-
30	*S. apiculatus* (W. et G.S.West) Chod. var. apiculatus. var. indicus (Hortob.) Tzar.	-	-	+	+	+	-	-	-	-
31	*S. brasiliensis* Bohlin	+	+	+	+	+	-	–	–	–
32	*S. denticulatus* Lagerh.	+	+	+	-	-	-	+	-	–

No.	Taxa	Stations								
		1	2	3	4	5	6	7	8	9
33	*S. denticulatus*. var. linearis Hansg.	+	+	+	-	-	-	+	-	–
34	*S. granulatus* W. et G.S.West	+	+	+	-	-	-	+	-	–
35	*S. incrassatulus* Bohlin	+	+	+	+	-	-	+	-	–
36	*S. obliquus* (Turp.) Kütz.	–	-	+	+	+	+	-	–	–
37	*S. quadricauda* (Turp.) Bohlin	–	-	+	+	+	+	+	+	+
38	*S. quadricauda* (Turp.) Bohlin. var. eualternans Proshkina-Lavrenko	–	-	+	+	+	-	–	–	–
39	*S. quadricauda* (Turp.) Bohlin. var. setosus Kirchner	–	-	–	+	+	+	–	–	–
40	*S. serratus* (Corda) Kütz.	–	-	+	+	+	+	-	–	–
41	*Westella botryoides* (W.West) De-Wild.	–	-	–	-	+	+	+	-	–
42	*Ankistrodesmus falcatus* (Corda) Ralfs	–	-	+	+	+	+	+	-	–
43	*A. fusiformis* Corda ex Korschik.	–	-	+	+	+	+	+	-	–
44	*A. spiralis* (Turn.) Lemm.	–	-	+	+	+	+	+	-	–
45	*Monoraphidium arcuatum* (Korsch.) Hind.	+	+	+	+	+	-	-	-	–
46	*M. contortum* (Thur.) Kom.-Legn.	–	-	+	+	+	+	+	-	–
47	*M. griffithii* (Berk.) Kom.-Legn.	+	+	+	+	+	+	+	-	–
48	*Quadrigula korschikoffii* Komàrek	-	+	+	+	+	+	-	-	–
49	*Chlorella vulgaris* Beijer.	-	-	+	+	+	+	+	-	–
50	*Micractinium quadrisetum* (Lemm.) G. M. Smith	–	-	+	+	+	+	+	+	–
51	*Tetraedron caudatum* (Corda) Hansg.	–	-	+	+	+	+	+	-	–
52	*Dictiosphaerium anomalum* Korschik.	-	+	+	+	+	+	+	-	-
53	*Lagerheimia longiseta* (Lemm.) Wille	–	-	–	+	+	+	+	-	–
54	*L. marssonii* Lemm.	–	-	–	+	+	+	+	-	–
55	*Oocystis borgei* Snow	-	+	+	+	+	+	+	-	–
56	*O. lacustris* Chod.	-	+	+	+	+	+	-	–	-
57	*O. solitaria* Wittrik	-	+	+	+	+	+	-	–	-
58	*Sphaerocystis planctonica* (Korsch.) Bourr.	-	+	+	+	+	+	+	-	-
59	*Ulothrix implexa* Kütz.	-	-	-	-	-	-	-	-	+
60	*U. oscillarina* Kütz.	+	+	+	+	+	+	+	+	–
61	*U. subtilissima* Rabenh.	+	+	+	+	+	+	+	+	–
62	*U. tenerrima* (Kütz.) Kütz.	+	+	+	+	+	+	+	+	–
63	*U. tenuissima* Kütz.	+	+	–	-	-	-	–	–	–
64	*U. zonata* (Web. et Mohr.) Kütz.	+	+	–	-	-	-	–	–	–
65	*Cladophora glomerata* (L.) Kütz.	-	-	-	-	-	-	-	+	+

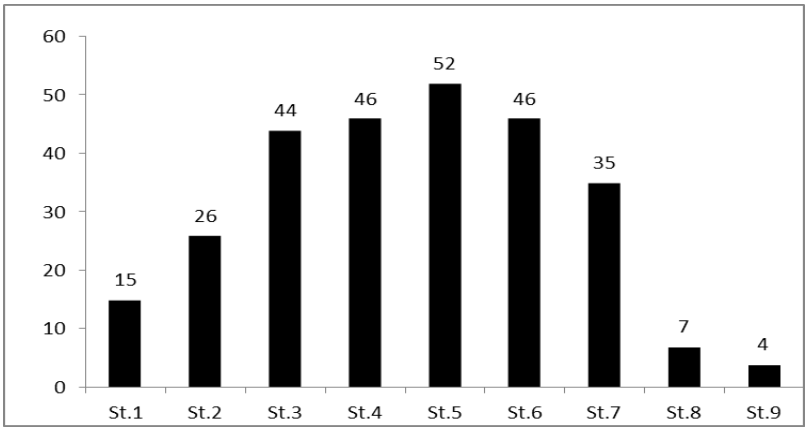

Fig. (7): Frequency of Chlorophyta species from different sampling stations.

Based on Table 9, it is obvious that there is no Streptophyta species in all studied stations. Max. Number of species in each station is 6 that seen in *Closterium acerosum* & *Closterium acerosum* (Schrank) Ehr. var. f. elongatum (Bréb.) Kossinsk. (Stations of 4-9); *Closterium leibleinii* (stations of 3-4, 6-9); *Cosmarium laeve* Rabenh. var. leave & *Cosmarium laeve* Rabenh. var. septentrionale Wille (stations of 3-8); *Cosmarium margaritatum*, *Cosmarium perforatum*, *Cosmarium phaseolus* Bréb. var. phaseolus, and *Cosmarium phaseolus* Bréb. var. elevatum Nordst (stations of 1-6). The lowest number was one species that seen as, *Closterium eboracense*, *Closterium gracile*, *Cosmarium subreniforme*, and *Staurastrum laeve* (only station of 1); *Closterium jenneri Ralfs*, *Cosmarium punctulatum* , *Cosmarium subprotumidum*, *Spirogyra lutetiana* (only station 2); *Zygnema rhynchonema*, *Spirogyra rivularis* (only station of 3); *Actinotaenium inconspicuum* (only station 4); *Euastrum binale* & *Actinotaenium globosum* (only station 5); *Spirogyra palena* & *Closterium peracerosum* (only station 6); and finally, *Closterium parvulum*, *Cosmarium twaitesii*, *Cosmarium undulatum*, *Euastrum ansatum* and *Zygnemopsis decussate* (only station 7). The highest amount of species seen in Station of 2 but there is mild slope from stations 2-5. The lowest amount based expectations were for stations of 8 & 9. Decrease of number of species from stations 2 to 7 related to increase of pollutants in this stations that are mostly for household wastes and also infuse of organic materials by some local factories (Fig. 8).

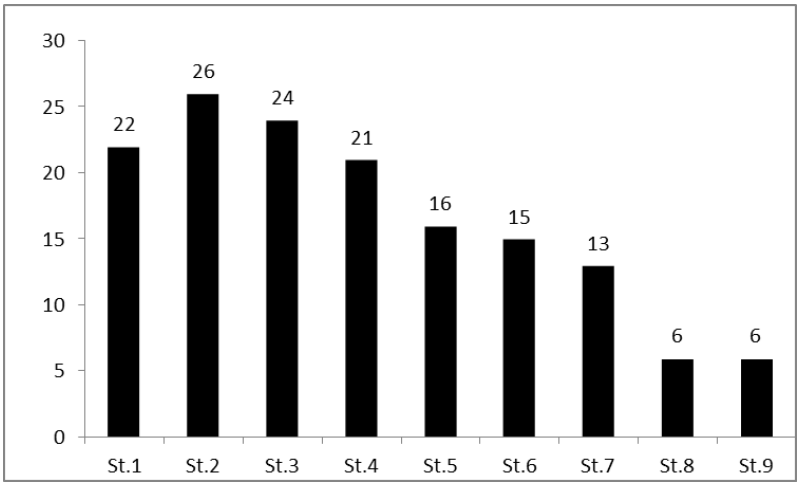

Fig. (8): Frequency of Species of Streptophyta division from different sampling stations.

Table (9): List of Streptophyta species found in Tajan River basin, Mazandaran Province of Iran (2011-2017).

No.	Taxa	Stations								
		1	2	3	4	5	6	7	8	9
1	*Penium didymocarpum* Lund.	+	+	+	-	-	-	-	-	-
2	*P. margaritaceum* Bréb.	+	+	-	-	-	-	-	-	-
3	*Closterium abruptum* W. West	+	+	-	-	-	-	-	-	-
4	*Cl. acerosum* (Schrank) Ehr. f. acerosum	-	-	-	+	+	+	+	+	+
5	*Cl. acerosum* (Schrank) Ehr. var. f. elongatum (Bréb.) Kossinsk.	-	-	-	+	+	+	+	+	+
6	*Cl. acutum* (Lyngb.) Bréb.	+	+	-	-	+	-	-	-	-
7	*Cl. angustatum* Kütz.	+	+	+	-	-	-	-	-	-
8	*Cl. cynthia* De-Not	-	+	-	-	-	-	-	-	-
9	*Cl. dianae* Ehr.	+	+	-	-	-	-	-	-	-
10	*Cl. didymotocum* Ralfs	-	+	-	+	-	-	-	-	-

No.	Taxa	Stations								
		1	2	3	4	5	6	7	8	9
11	*Cl. eboracense* Turner	+	-	-	-	-	-	-	-	-
12	*Cl. jenneri* Ralfs	-	+	-	-	-	-	-	-	-
13	*Cl. gracile* Bréb.	+	-	-	-	-	-	-	-	-
14	*Cl. leibleinii* Kütz.	-	-	+	+	-	+	+	+	+
15	*Cl. libellula* Focke	-	-	+	-	+	+	+	-	-
16	*Cl. lineatum* Ehr.	+	+	+	-	-	+	+	-	-
17	*Cl. moniliferum* Ehr.	+	-	-	+	-	-	+	-	+
18	*Cl. parvulum* Näg.	-	-	-	-	-	-	+	-	-
19	*Cl. peracerosum* Gay	-	-	-	-	-	+	-	-	-
20	*Cosmarium contractum* Kirchn.	+	+	-	-	-	-	-	-	-
21	*C. formosulum* Hoffm.	-	-	+	+	+	+	-	-	+
22	*C. impressulum* Elfv.	-	+	+	+	-	-	-	+	+
23	*C. laeve* Rabenh. var. laeve	-	-	+	+	+	+	+	+	-
24	*C. laeve* Rabenh. var. septentrionale Wille	-	-	+	+	+	+	+	+	-
25	*C. lundellii* Delp	-	-	+	+	+	-	-	-	-
26	*C. margaritatum* (Lund.) Roy et Biss.	+	+	+	+	+	+	-	-	-
27	*C. perforatum* Lund.	+	+	+	+	+	+	-	-	-
28	*C. phaseolus* Bréb. var. phaseolus	+	+	+	+	+	+	-	-	-
29	*C. phaseolus* Bréb. var. elevatum Nordst.	+	+	+	+	+	+	-	-	-
30	*C. punctulatum* Bréb.	-	+	-	-	-	-	-	-	-
31	*C. subprotumidum* Nordst.	-	+	-	-	-	-	-	-	-
32	*C. subreniforme* Nordst.	+	-	-	-	-	-	-	-	-
33	*C. twaitesii* Ralfs	-	-	-	-	-	-	+	-	-
34	*C. undulatum* Corda	-	-	-	-	-	-	+	-	-
35	*Euastrum ansatum* (Ehr.) Ralfs	-	-	-	-	-	-	+	-	-
36	*E. binale* (Turp.) Ralfs	-	-	-	-	+	-	-	-	-
37	*Actinotaenium inconspicuum* (W. et G.S. West) Teil.	-	-	-	+	-	-	-	-	-
38	*A. globosum* (Delp.) Pal.-Mordv.	-	-	-	-	+	-	-	-	-
39	*Staurastrum gracile* Ralfs	+	+	-	-	-	-	-	-	-
40	*S. laeve* Ralfs	+	-	-	-	-	-	-	-	-
41	*S. margaritaceum* Ehr. ex Ralfs	-	+	+	-	-	-	-	-	-
42	*S. muticum* Bréb.	-	+	+	+	-	-	-	-	-
43	*S. polymorphum* Bréb.	+	+	-	-	+	-	-	-	-
44	*Staurodesmus dejectus* (Bréb.) Teil.	-	-	+	+	-	-	-	-	-
45	*St. incus* (Bréb.) Teil.	-	-	+	+	-	-	-	-	-
46	*Zygnema insigne* (Hass.) Kütz.	-	-	+	+	-	-	-	-	-
47	*Z. pectinatum* (Vauch.) Ag.	-	-	-	+	+	-	-	-	-
48	*Z. rhynchonema* Hansg.	-	-	+	-	-	-	-	-	-
49	*Zygnemopsis decussata* Transeau	-	-	-	-	-	-	+	-	-
50	*Mougeotia recurva* (Hass) De Toni	+	+	-	-	-	-	-	-	-
51	*Spirogyra inflata* (Vauch.) Kütz.	+	+	+	-	-	-	-	-	-
52	*S. longata* (Vauch.) Kütz.	-	-	+	-	-	+	-	-	-
53	*S. lutetiana* Petit	-	+	-	-	-	-	-	-	-
54	*S. rivularis* (Hass.) Rabenh.	-	-	+	-	-	-	-	-	-
55	*S. palena* (W.West et G.S.West) Czurda	-	-	-	-	-	+	-	-	-
56	*S. varians* (Hass.) Kütz.	+	+	+	+	-	-	-	-	-

CONCLUSION

The current work, studied all algal groups in the Tajan River basin from Soleyman Tange Dam to the Caspian Sea, for the first time. Based on results, 328

species belonging to 86 genera identified from about 600 samples of water bodies in Tajan River basin during 2011-2017. The highest number of algae was belonging toBacillariophyta and the lowest was for Streptophyta. The number of species in the five identified groups is not different and all groups showed identical diversity in this River.

Due to the importance of the Tajan River in irrigation and agriculture, as well as the supply of drinking water to some parts of the village adjacent to it, and with respect to a population of nearly 50,000 individuals that live in this area, the studying of the densities of algal groups and relevant species survey can be a very precise indicators for assessing the water quality of this river. Of course, the desired ecological analysis will be considered in the future plans of the present researchers.

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