IRANIAN JOURNAL OF BOTANY 31(1), 2025
DOI: https://doi.org/10.22092/ijb.2025.366644.1479

DIATOMS OF THE SUFI CHAI RIVER IN NORTHWEST IRAN

Saeed Charandabi[1] & Ehsan Atazadeh [1,2]*

[1]*Department of Plant, Cell and Molecular Biology, Faculty of Natural Sciences, University of Tabriz, Iran*
[2]*Faculty of Biology, University of Bremen, Germany*
**Corresponding author: Ehsan Atazadeh, atazadeh@tabrizu.ac.ir*

Abstract
Iran is the second-largest country in the Middle East with diverse eco-regions. East Azerbaijan, the northwestern province of Iran, has diverse ecosystems of lakes, rivers, springs, wetlands, and waterfalls. However, despite the numerous riverine ecosystems, few studies have been conducted on the diatom flora of the region. This study focuses on the Sufi Chai River diatom flora in East Azerbaijan, Iran. The river flows approximately 55 km and originates from the Sahand Mountain, substantially modified in several locations, and flows through the Qaraqishlaq Wetland before reaching Lake Urmia. In the present study, algal samples were taken from seven stations upstream and downstream of the Sufi Chai River during winter, spring, summer, and autumn in 2020. The sample preparation was performed using the hot hydrogen peroxide method, and finally, 90 diatom taxa were identified in this study. The findings showed that the highest species diversity *(*16 spp.) belongs to the genus *Nitzschia*. Furthermore, we identified 21 new records that have not been previously reported in the diatom flora of Iran.

Keywords: Azerbaijan; Diatom; diversity; ecology; Iran; Lake Urmia; Sufi Chai River

Citation: Charandabi, S. & Atazadeh, E. 2025: Diatoms of the Sufi Chai River in northwest Iran. Iran. J. Bot. 31(1): 128-154. https://doi.org/10.22092/ijb.2025.366644.1479

Article history
Received: 14 June 2024
Revised: 13 May 2025
Accepted: 20 May 2025
Published: 30 June 2025

دیاتومه‌های رودخانه صوفی‌چای در شمال‌غرب ایران

سعید چرندابی: دانش آموخته کارشناسی ارشد، گروه زیست شناسی گیاهی، دانشکده علوم طبیعی، دانشگاه تبریز، ایران

احسان عطازاده: دانشیار گروه زیست‌شناسی گیاهی، دانشکده علوم طبیعی، دانشگاه تبریز، ایران و دانشکده بیولوژی، دانشگاه برمن، آلمان

چکیده: ایران دومین کشور بزرگ در خاورمیانه با مناطق اکولوژیکی متنوع می‌باشد. آذربایجان شرقی، از استان‌های شمال غربی ایران، دارای اکوسیستم‌های متنوعی از دریاچه‌ها، رودخانه‌ها، چشمه‌ها، تالاب‌ها و آبشارها است. با این حال، با وجود اکوسیستم‌های رودخانه‌ای متعدد، مطالعات کمی بر روی فلور دیاتومه‌های این منطقه انجام شده است. مطالعه حاضر بر روی فلور دیاتومه رودخانه صوفی چای در آذربایجان شرقی، ایران تمرکز دارد. این رودخانه به طول تقریبی ۵۵ کیلومتر از کوه‌های سهند سرچشمه می‌گیرد و در طول جریان خود در مکان‌های مختلفی تغییرات اساسی یافته و در نهایت از طریق تالاب

قره قشلاق به دریاچه ارومیه می‌ریزد. در تحقیق حاضر نمونه جلبکی از هفت ایستگاه بالادست و پایین دست رودخانه صوفی چای در زمستان، بهار، تابستان و پاییز سال ۱۳۹۹ تهیه شد. تهیه نمونه با استفاده از روش پراکسید هیدروژن داغ انجام شد و در نهایت ۹۰ گونه دیاتومه در این مطالعه شناسایی شد. یافته ها نشان داد که بیشترین تنوع گونه‌ای (۱۶ گونه) متعلق به جنس *Nitzschia* است. همچنین ۲۱ رکورد جدید که قبلاً در فلور دیاتومه ایران گزارش نشده بود شناسایی کردیم.

INTRODUCTION

Algae are primary producers that power food webs and biogeochemical cycling in aquatic ecosystems (Stevenson 2014). Diatoms respond directly to physical, chemical, and biological changes in rivers and streams because they are sensitive to many changes in aquatic ecosystems (Hill & al., 2000). Indeed, diatoms often respond to changes in environmental conditions, due to their sensitivity, before effects on higher organisms are detected (Kelly & Whitton, 1995, Stevenson & al., 2010). Environmental variables (e.g. flow changes) can affect biological community structure and ecosystem functions (Atazadeh & al., 2020). Within the biofilm, diatom assemblages are highly responsive to shifts in water quality (Reid & al., 1995), so their identification can reveal ecological responses to flow-driven changes in stream water quality.

The taxonomic composition of benthic diatom communities has been widely used for monitoring water quality (Atazadeh & al., 2021). Therefore, floristics surveys are important for long-term ecological investigations and monitoring.

Some studies on diatoms of Iran were conducted including algae from the deserts of Iran (Compère 1981), Caspian Sea (Fallahi 1991), Zayandeh Rood (Afsharzadeh & al., 2003), Lake Neure (Nejadsattari 2005), Gharasou River (Atazadeh & al., 2007; Atazadeh & Sharifi, 2012), Streams in Ramsar (Soltanpour-Gargari & al., 2011), Karaj River (Kheiri & al., 2018), Balikhli River (Panahy-Mirzahasnlou & al., 2018), Taleghan River (Naseri & al., 2022), Western Rivers of Lake Urmia (Mehrjuyan & Atazadeh, 2022), Aras River (Parikhani & al., 2023), Ahar Chai River (Yadollahi & Atazadeh, 2024).

The Sufi Chai River originates from Sahand Mountain and flows through the Qaraqishlaq Wetland before reaching Lake Urmia. We chose the Sufi Chai River for study because this river has been substantially modified for an extended period, and is degraded due to catchment and water resource development and water supply for urban usage. The geographical significance of the Sufi Chai River is notable, as its catchment area spans 1,800 square kilometers. However, this river increasingly suffers from pollution due to rural and urban sources, particularly evident downstream (Haghshenas & al., 2016; Mobasheri & al., 2022). This research focused on the diatom flora of the Sufi Chari River, one of Lake Urmia Basin's main rivers.

MATERIALS AND METHODS

We established seven sampling stations along the Sufi Chai River to measure pollution levels and ecological status. Throughout the four seasons of 2020, we collected 49 algal samples from all the stations. Four stations are located upstream, and three are downstream of the Alavian Dam (Table 1).

Diatoms are sampled using different methods depending on their habitats, such as stone (epilithic), sand (epipsammic), mud or sediments (epipelic), and plants (epiphytic). In this project, we focused on sampling epilithic diatoms, which live on the surface of various rocks found in riverbeds and along banks. We employed standard sampling methods (Taylor & al. 2007). To increase sampling efficiency, we selected an area measuring 10 to 20 meters in length, with a width corresponding to that of the river. From this area, we chose approximately 8 to 10 stones with different characteristics and locations. After rubbing the stones with a brush, we obtained a solution containing the samples. We used half of this solution during the research process (Fig. 1).

To prevent changes to the diatom cell wall structure and maintain its natural shape, we utilized stabilizing agents like formaldehyde and Lugol’s solutions. However, some institutions and universities have opted to use Lugol instead of formaldehyde due to carcinogenic risk (Bosetti & al., 2008; Swenberg & al., 2013; Krammer 2000; Williams 2016). For our study, we chose to use Lugol. We also employed the hot H_2O_2 method for sample preparation, which is considered one of the best methods available (Battarbee, 1986; Barinova, 2017). After boiling the samples with HCl and H_2O_2, we placed the beakers in a place without shaking for 24 hours to allow the diatoms to settle. We then discard the supernatant and rinse it with distilled water.

Fig. 1. A, Location of Sufi Chai River and Alavian Dam (Google Maps); B, Someh- Ashan Road. C, Qishlaq village; D, Alavian Dam.

Table 1: Geographic coordinates and locations of the studied sites along the Sufi Chai River.

Site	No	Latitude	Longitude	Number of Species	Altitude (m)
Someh Ashan	S 1	37^{O} 32' 00"	46^{O} 19' 42"	43	1630
Someh Ashan Road	S 2	37^{O} 30' 55"	46^{O} 18' 56"	39	1588
Qishlaq village	S 3	37^{O} 27' 30"	46^{O} 16' 10"	36	1551
Alavian Dam	S 4	37^{O} 26' 52"	46^{O} 15' 39"	27	1463
Maragheh city center	S 5	37^{O} 24' 15"	46^{O} 13' 58"	31	1446
Dabbagh Khaneh	S 6	37^{O} 22' 09"	46^{O} 13' 10"	28	1400
Khoshe Mehr	S 7	37^{O} 18' 52"	46^{O} 08' 20"	15	1311

We continued washing every 24 hours for four days until the samples were completely washed from the acid. After this period, we poured 800 µL of the sample onto the slide, and after air drying, for slide preparation, we used Naphrax and examined the samples with Olympus and ZEISS optical microscopes equipped with 100x objectives. For identification, we used different key references (Krammer 1986, 1991a, 1991b; Van der Werff, 1955; Solak & al., 2019; Lange-Bertalot, 2001; Bahls. 2018). All LM images were taken using a camera mounted on the ZEISS and Olympus microscopes. SEM images were taken with the TESCAN VEGA3 field-emission scanning electron microscope, with a working voltage of 2/0kV and spot size 2. The voucher specimens are deposited in the ecology laboratory of the University of Tabriz.

We also measured 9 water chemistry and biological properties including phosphate, sulfate, nitrate, silica, chlorophyll-a, dry weight, pH, TDS, and EC in all 7 studied stations during 4 seasons. We measured pH, TDS, and EC by Hanna HI9811. To measure phosphate, sulfate, nitrate, and silica factors, we prepared samples with concentrations of 0-1-2-3-4-5 and 6 ppm from each station and measured their absorbance in a spectrophotometer. Then we drew a graph according to the amount of absorption and concentration. Using these standard charts, we calculated the main concentration of factors in the desired samples (APHA 2005). We poured 5 mL of each sample into the falcon to measure chlorophyll-*a*, and added 10 mL of 95% ethanol. We moved the falcons into the refrigerator for an overnight. The next day, we transferred the samples to room temperature and measured their absorbance in two steps including before adding acid and after adding two drops of 0.1N HCl acid at a wavelength of 665 nm by a spectrometer. Then we calculated the amount of chlorophyll-*a* by inserting the resulting information into the formula (Nusch, 1980b; Hilmer & Bate, 1990).

To determine the dry weight, we first measured the weight of the prepared filter papers in milligrams. Next, we passed a specific volume of the sampled solution (20 mL in this study) through the filter paper. We then placed the filter papers in an oven set to 60 degrees Celsius for 24 hours to completely evaporate the liquid from the samples. Once the filter papers were fully dry, we measured their weight again. The difference in weight was divided by the volume of the extracted solution, allowing us to calculate the dry weight in milligrams per liter. Additionally, to assess water quality and diatom biomass, we calculated the biomass using data from OMNIDIA software (Lecointe & al., 1993) (Table 2).

Table 2: Physico-chemical and biological factors measured in Sufi Chai River, in different stations. DW= Dry Weight; Chl-*a* = Chlorophyll-*a*; Biov=Biovolume.

	Unit	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**
EC	$\mu S\ cm^{-1}$	118.6±21	154±33	189±41	245±55	586±68	1980±75	2554±99
pH	-	6.96±1.4	7.07±0.8	7.12±0.9	7.2±0.5	7.35±0.7	7.39±0.7	7.47±0.4
NO_3	$mg\ l^{-1}$	0.23±0.2	0.5±0.3	0.6±0.3	0.7±0.5	1.2±0.7	1.8±0.9	1.9±0.9
SIO_2	$mg\ l^{-1}$	0.122±0.12	0.238±0.11	0.349±0.13	0.451±0.14	0.558±0.29	0.683±0.28	0.991±0.21
TDS	$mg\ l^{-1}$	2±1	3±1	4±1	5±2	6±2	6±3	8±3
SO_4	$mg\ l^{-1}$	0.128±0.11	0.288±0.11	0.379±0.12	0.466±0.11	0.578±0.29	0.693±0.28	0.771±0.23
PO_4	$mg\ l^{-1}$	0.041±0.01	0.076±0.03	0.067±0.02	0.093±0.03	0.111±0.04	0.281±0.06	0.355±0.9
DW	$\times 10^3 mg\ l^{-1}$	0.9±0.09	1.8±0.7	3.3±2.8	4.1 ± 0.6	13.1±2.6	29±5.5	20.4±4.2
Chl-*a*	$mg.m^2$	26±2	11±7	14±8	41±2	46±5	52±0.1	61 ±5
Biov	$\times 10^4\ \mu m^3\ cm^{-3}$	112±7	122±6	144±6	156±7	185±14	204±14	215±8

RESULTS

In this study, 90 species were identified, with the genus *Nitzschia* representing the largest number of species (Table 3). The composition of the diatom community varied among different stations and across various seasons. The genera *Cyclotella*, *Melosira*, and *Stephanodiscus* were categorized as centric diatoms. Most species observed in the upstream stations (S1-S4), in the mountainous region of the river, were large in terms of size. Conversely, most species found in the downstream stations (S5-S7) in non-mountainous areas were smaller. In the upstream stations (S1-S4), the most abundant species were *Diatoma vulgaris* and *Fragilaria vaucheriae*. Meanwhile, in the downstream stations (S5-S7), *Cocconeis placentula*, *Cocconeis pediculus*, and *Nitzschia dissipata* were more common. Among the studied genera, *Nitzschia*, with 16 species, and *Surirella*, with 7 species, were the most diverse in the river. Additionally, some genera included only a single species. A total of 17 species were present at all stations, while *Ctenophora pulchella* was observed three times at station 4. The LM and SEM Images of the identified species in the Sufi Chai River are presented in Figs. 2-16.

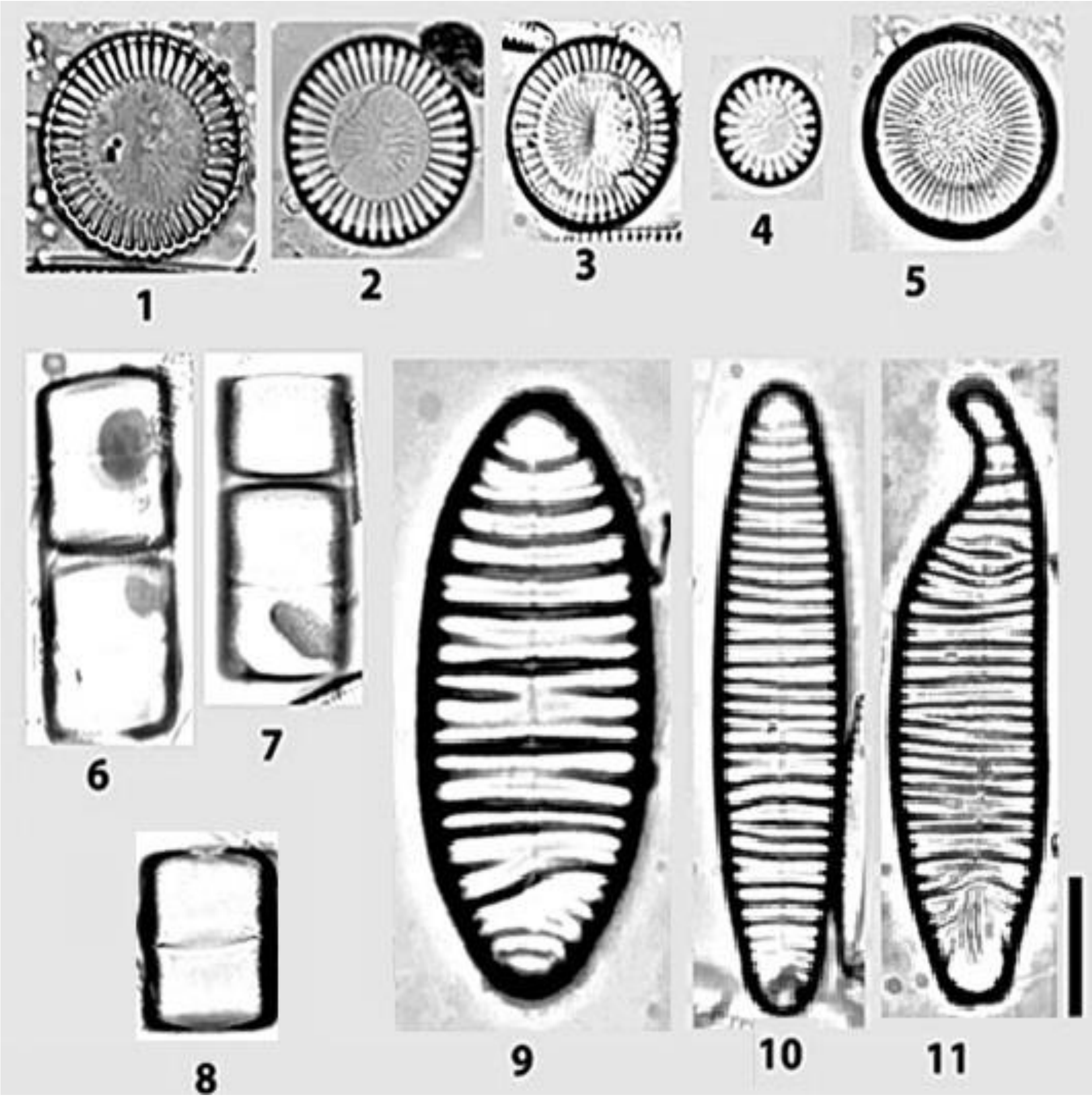

Fig. 2. LM images of studied species. 1-4, *Cyclotella meneghiniana*; 5, *Stephanodiscus medius*; 6-8, *Melosira varians*; 9-11, *Diatoma vulgaris*. Scale bar=10µm.

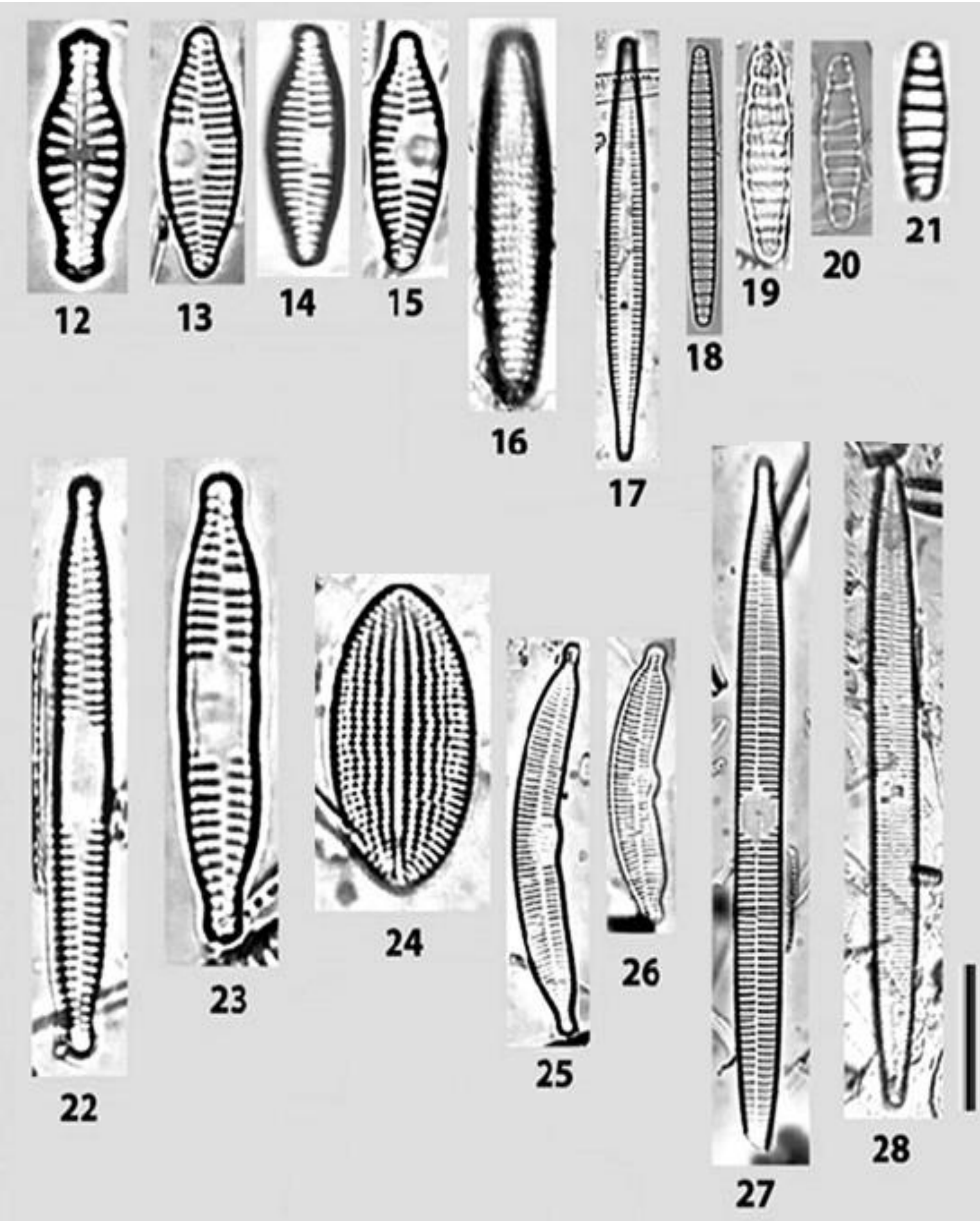

Fig. 3. LM images of studied species. 12, *Hippodonta capitata*; 13-15, *Fragilaria recapitellata*; 16, *Achnanthes* cf. *brevipes*; 17, *Tabularia fasciculata*; 18-21, *Diatoma moniliformis*; 22-23, *Fragilaria vaucheriae*; 24, *Cocconeis euglypta*; 25-26, *Hannaea arcus*, 27-28, *Ulnaria ulna*. Scale bar=10µm.

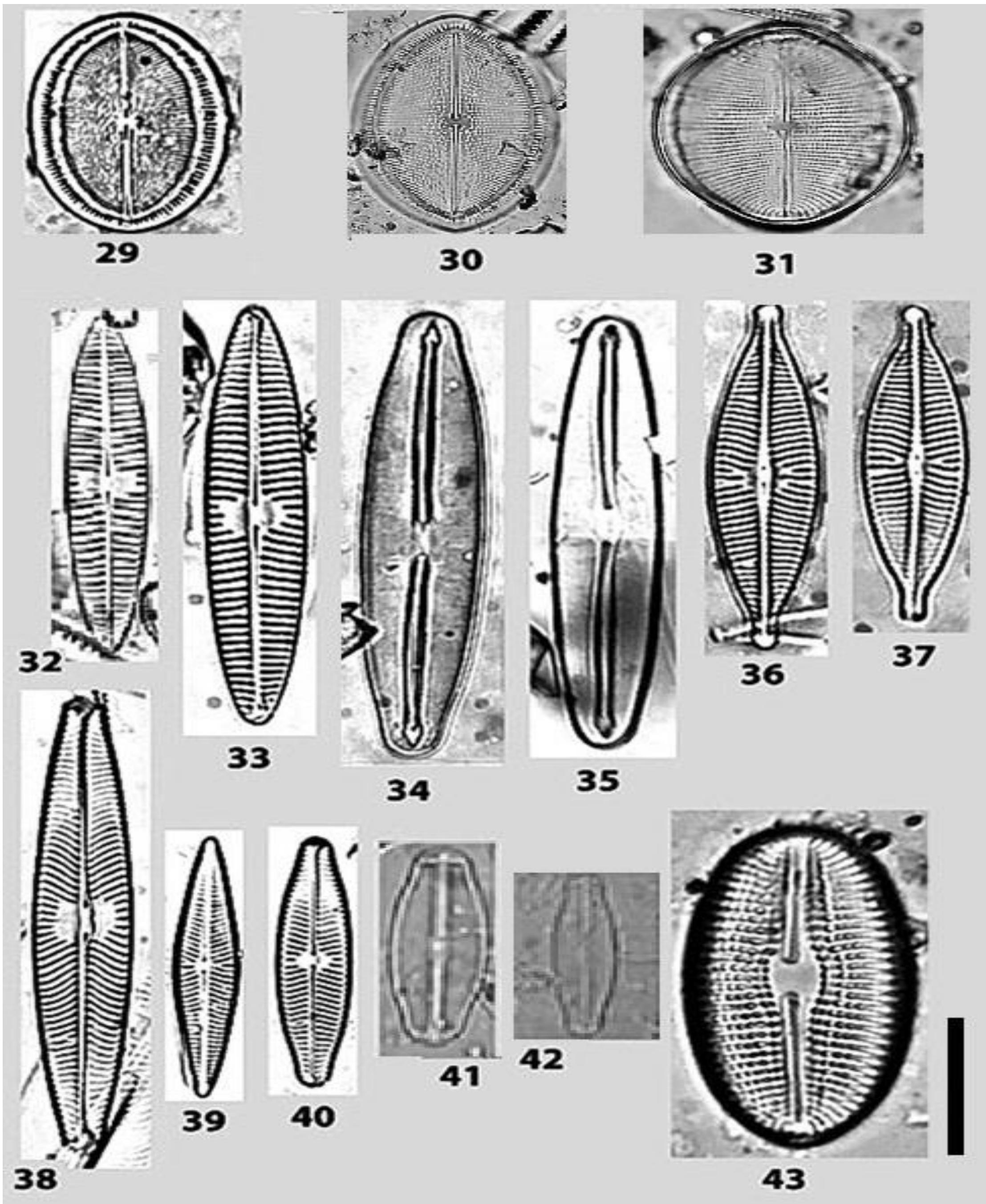

Fig. 4. LM images of studied species: 29, *Cocconeis placentula;* 30, *Cocconeis euglypta*; 31, *Cocconeis pediculus;* 32-33, *Navicula tripunctata;* 34-35, *Frustulia vulgaris;* 36-37, *Navicula capitatoradiata;* 38, *Navicula lanceolata*; 39, *Navicula cryptotenella*; 40, *Navicula splendicula;* 41-42, *Sellaphora pupula*; 43, *Diploneis parma.* Scale bar= 10µm.

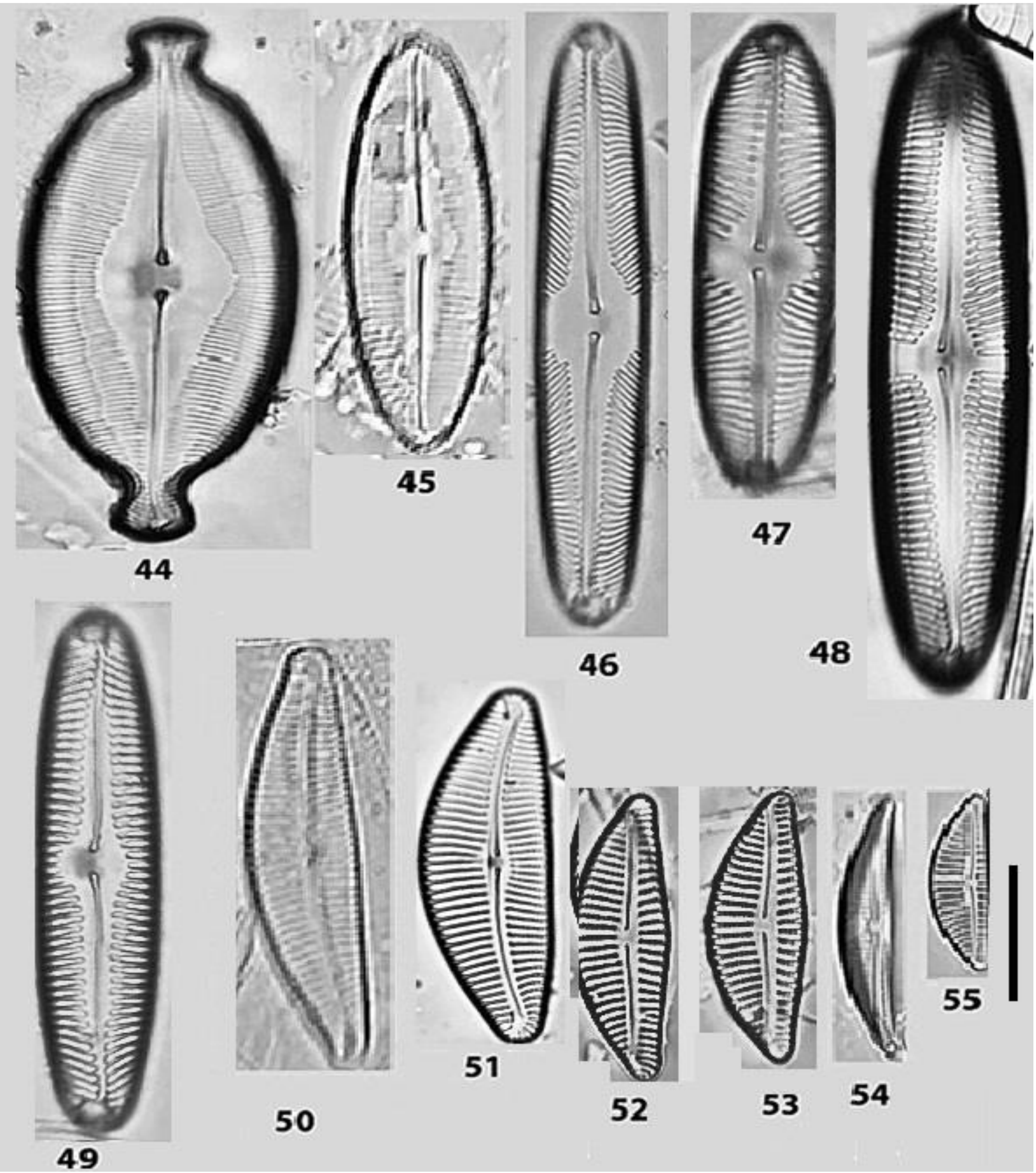

Fig. 5. LM images of studied species: 44, *Caloneis amphisbaena*; 45, *Caloneis* cf *silicula*; 46-47, *Pinnularia brebissonii;* 48, *Pinnularia microstauron;* 49, *Pinnularia viridiformis*; 50, *Cymbella* sp*;* 51, *Cymbella compacta;* 52-53, *Encyonema caespitosum;* 54, *Amphora paracopulata*; 55, *Encyonema silesiacum.* Scale bar= 10µm.

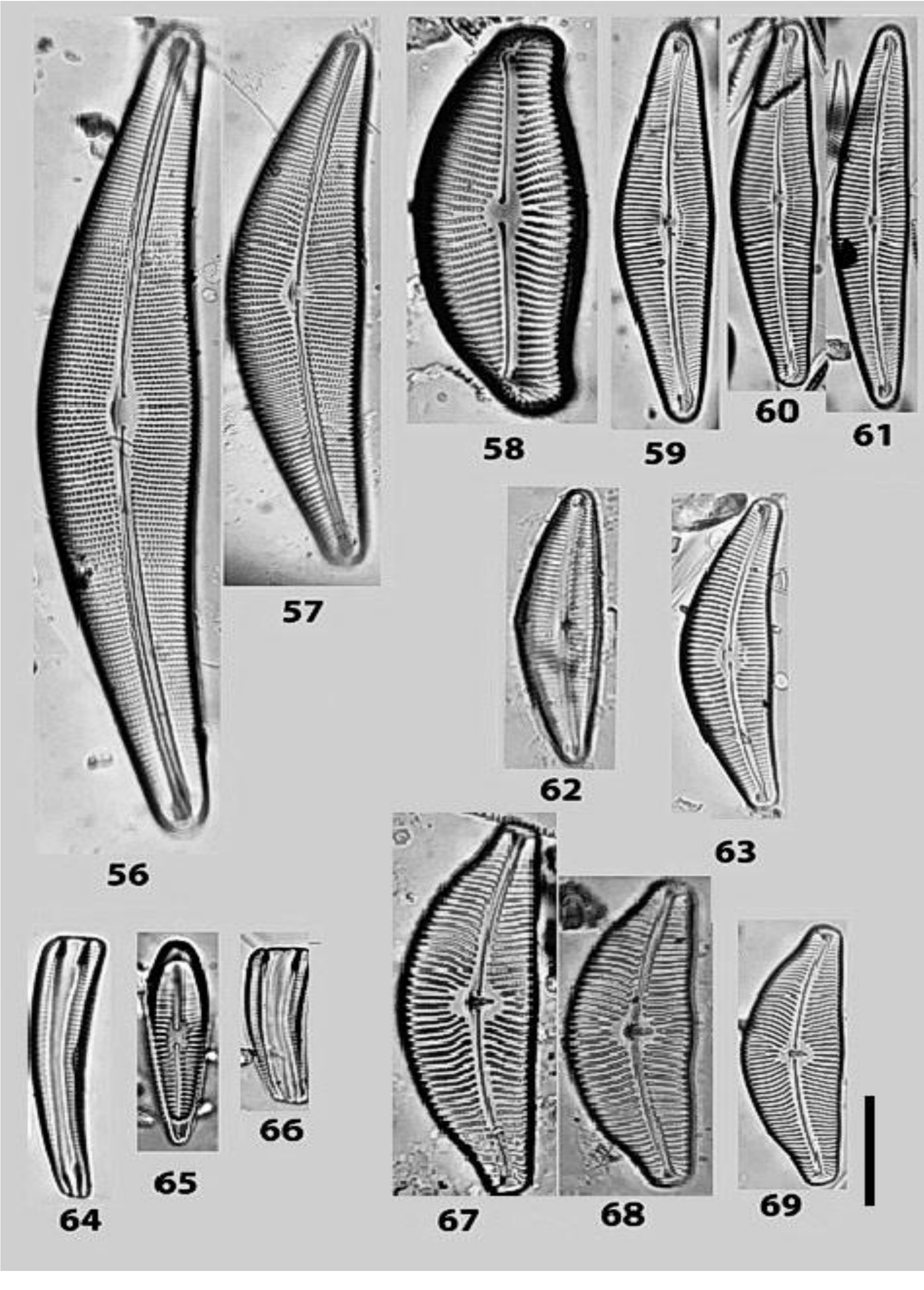

Fig. 6. LM images of studied species: 56-57, *Cymbella neolanceolata;* 58, *Encyonema leibleinii;* 59-61, *Cymbella helvetica;* 62, *Cymbella* sp*;* 63, *Cymbella neocistula*; 64-66, *Rhoicosphenia abbreviata*; 67-69, *Cymbella tumida.* Scale bar=10µm.

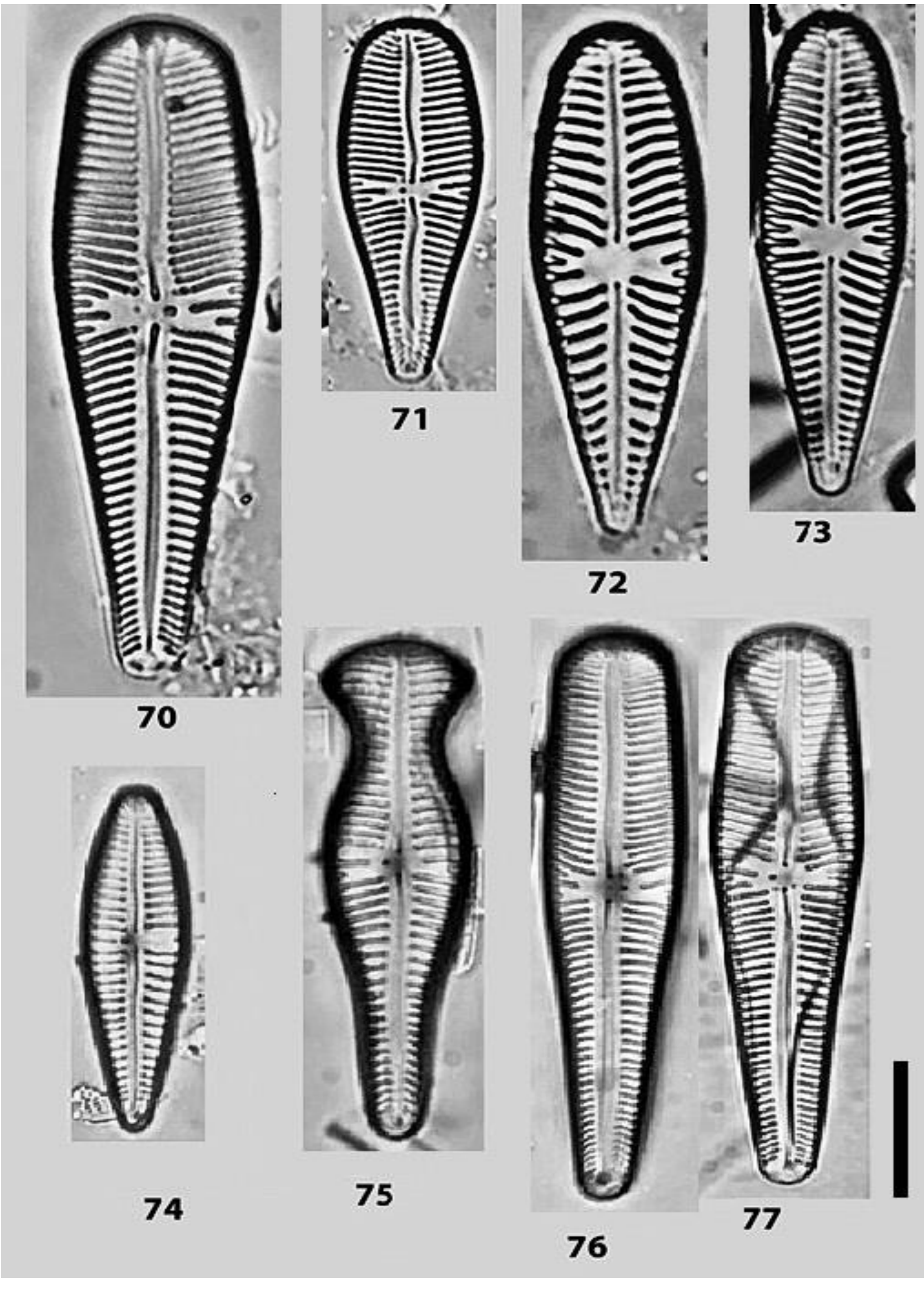

Fig. 7. LM images of studied species. 70-71, *Gomphonema italicum;* 72-73, *Gomphonema olivaceum;* 74, *Gomphonema parvulum;* 75, *Gomphonema capitatum;* 76-77, *Gomphonema laticollum.* Scale bar=10µm.

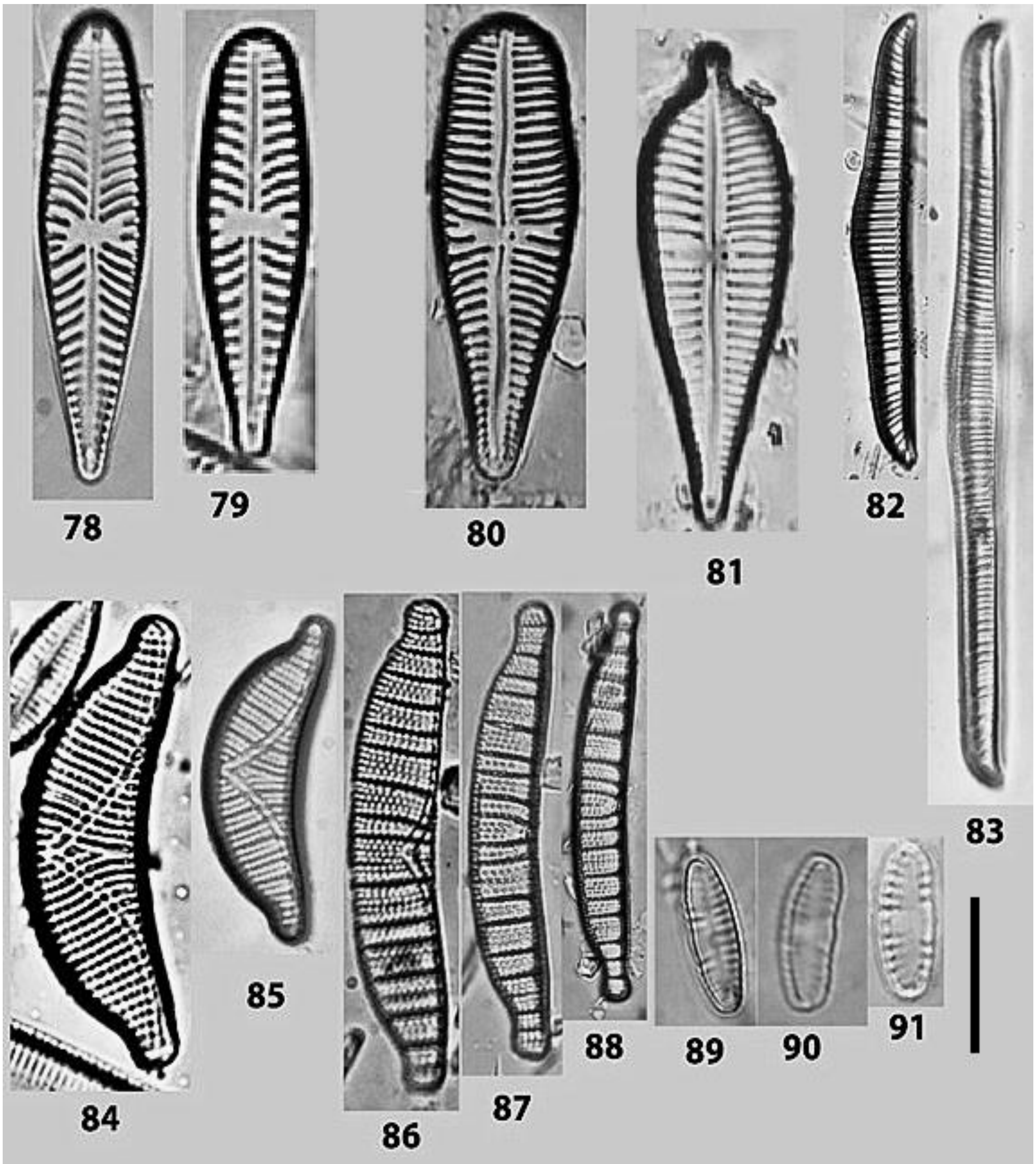

Fig. 8. LM images of studied species: 78-79, *Gomphonema olivaceum;* 80, *Gomphonema italicum;* 81, *Gomphonema augur;* 82, *Rhopalodia gibba;* 83, *Rhopalodia parallela*; 84-85, *Epithemia sorex;* 86, *Epithemia adnata*; 87-88, *Epithemia selengensis;* 89-91, *Reimeria sinuate*. Scale bar=10µm.

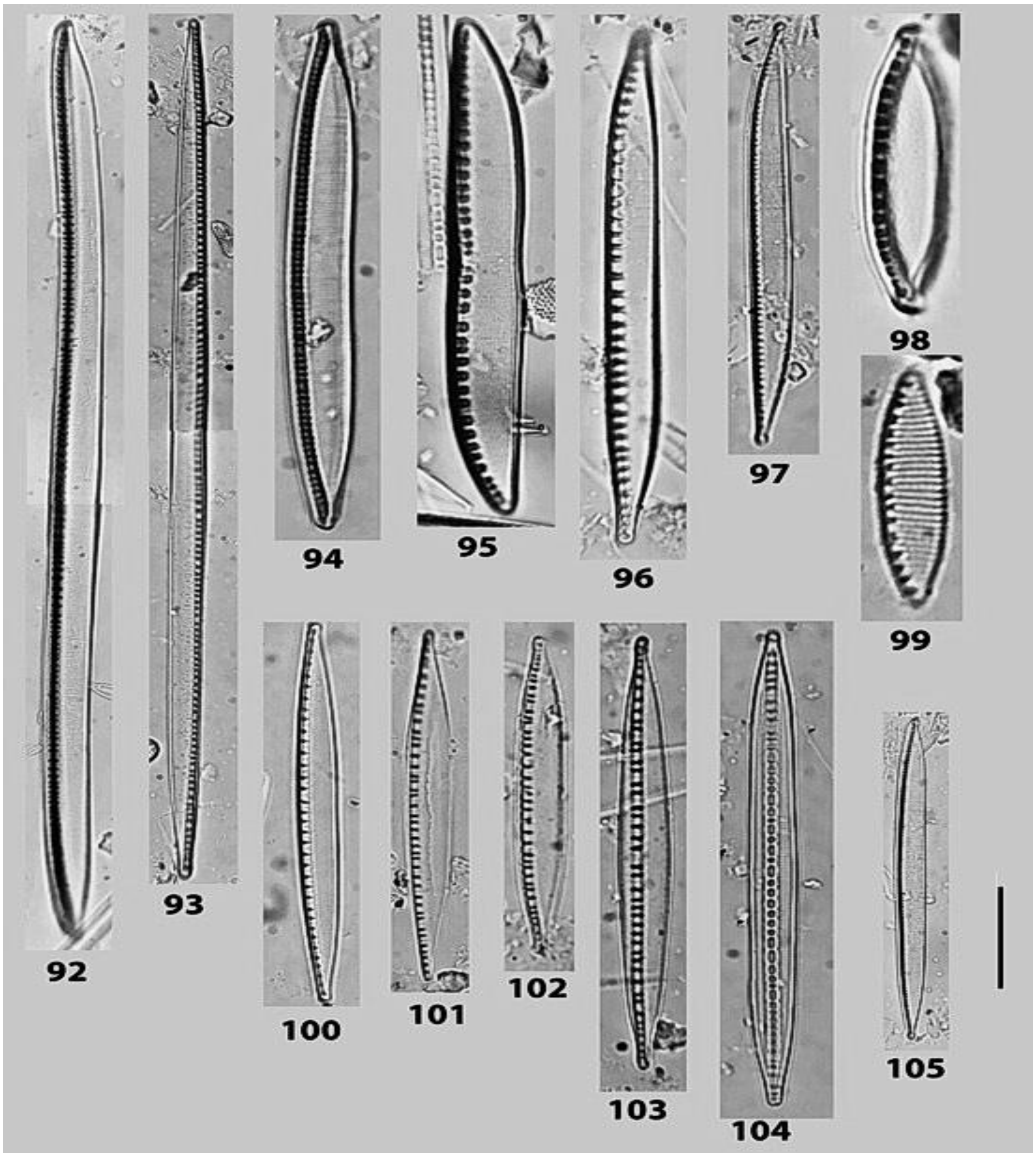

Fig. 9. LM images of studied species. 92, *Nitzschia sigmoidea;* 93, *Nitzschia wuellerstorffii;* 94, *Nitzschia sp;* 95, *Nitzschia brevissima;* 96, *Nitzschia fasciculata;* 97, *Nitzschia sigma;* 98, *Nitzschia vitrea;* 99, *Nitzschia amphibia;* 100, *Nitzschia recta;* 101-103, *Nitzschia dissipata* var *media;* 104, *Bacillaria paxillifera;* 105, *Nitzschia* sp. Scale bar=10µm.

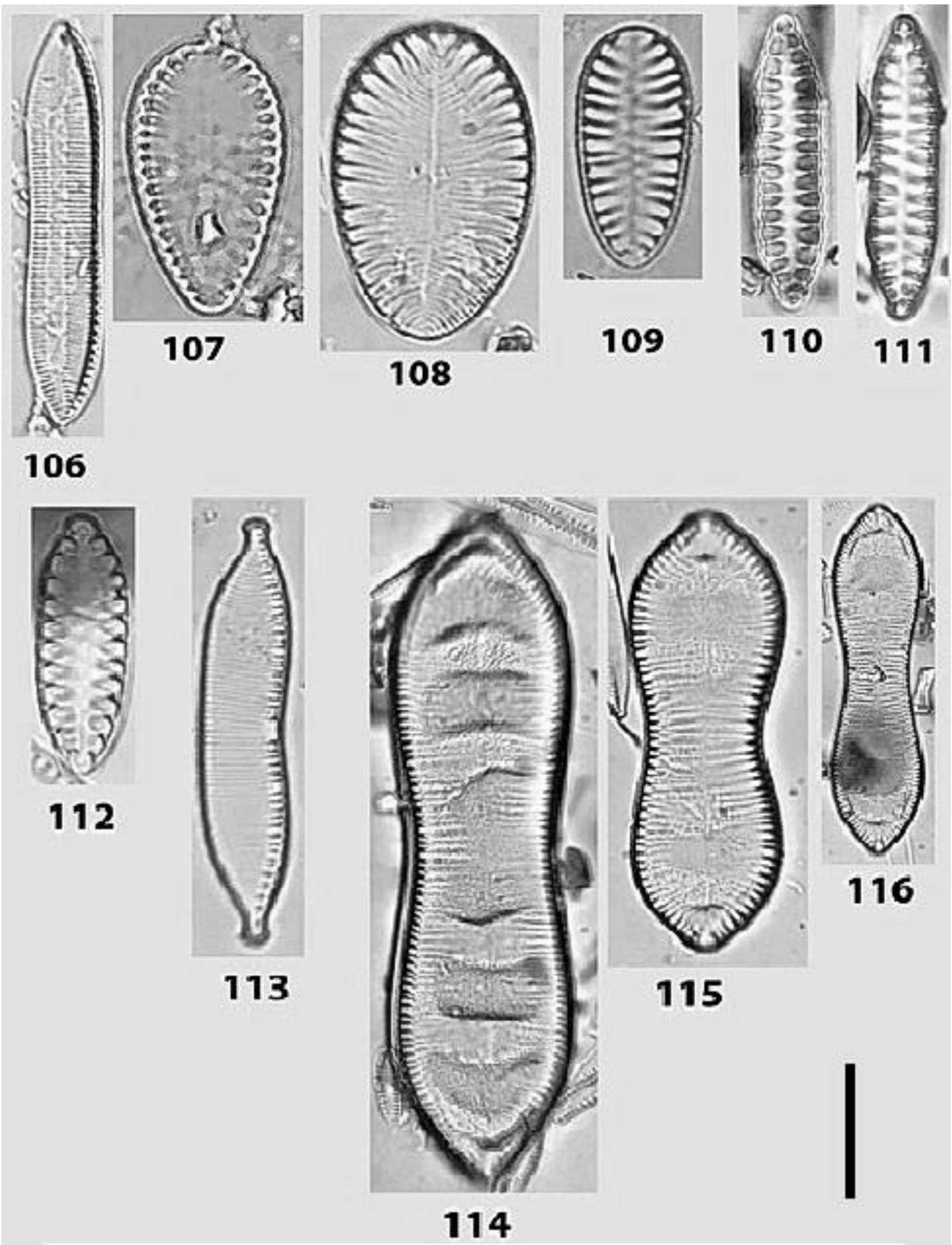

Fig. 10. LM images of studied species. 106, *Tryblionella hungarica;* 107, *Surirella ovalis;* 108, *Surirella brebissonii;* 109, Surirella *minuta*; 110-112, *Staurosirella angusta;* 113, *Hantzschia amphioxys;* 114-116, *Cymatopleura solea*. Scale bar=10µm.

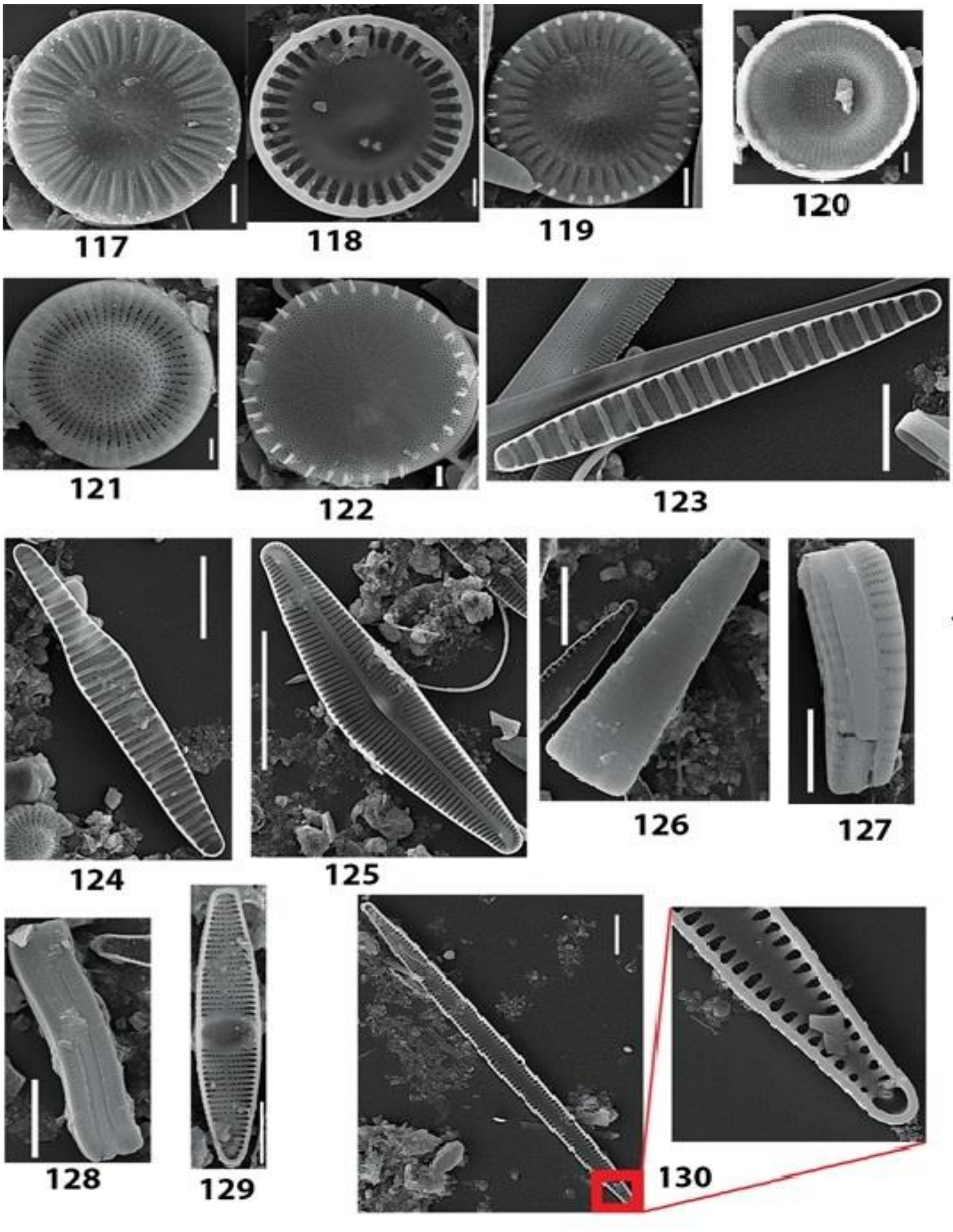

Fig. 11. SEM images of studied species. 117, *Cyclotella meneghiniana* (external view); 118, *Cyclotella meneghiniana* (internal view); 119, *Cyclotella meneghiniana* (with spine); 120, *Stephanodiscus medius* (internal view); 121, *Stephanodiscus medius* (external view); 122, *Stephanodiscus neoastraea*; 123, *Diatoma moniliformis*; 124, *Diatoma vulgaris* (deform); 125, *Cymbella helvetica*; 126-127, *Rhoicosphenia abbreviate* (girdle view); 128, *Achnanthes brevipes*; 129, *Ctenophora pulchella*; 130, *Tabularia fasciculata*. 117-122, Scale bar=5µm; 118-130, Scale bar=10µm.

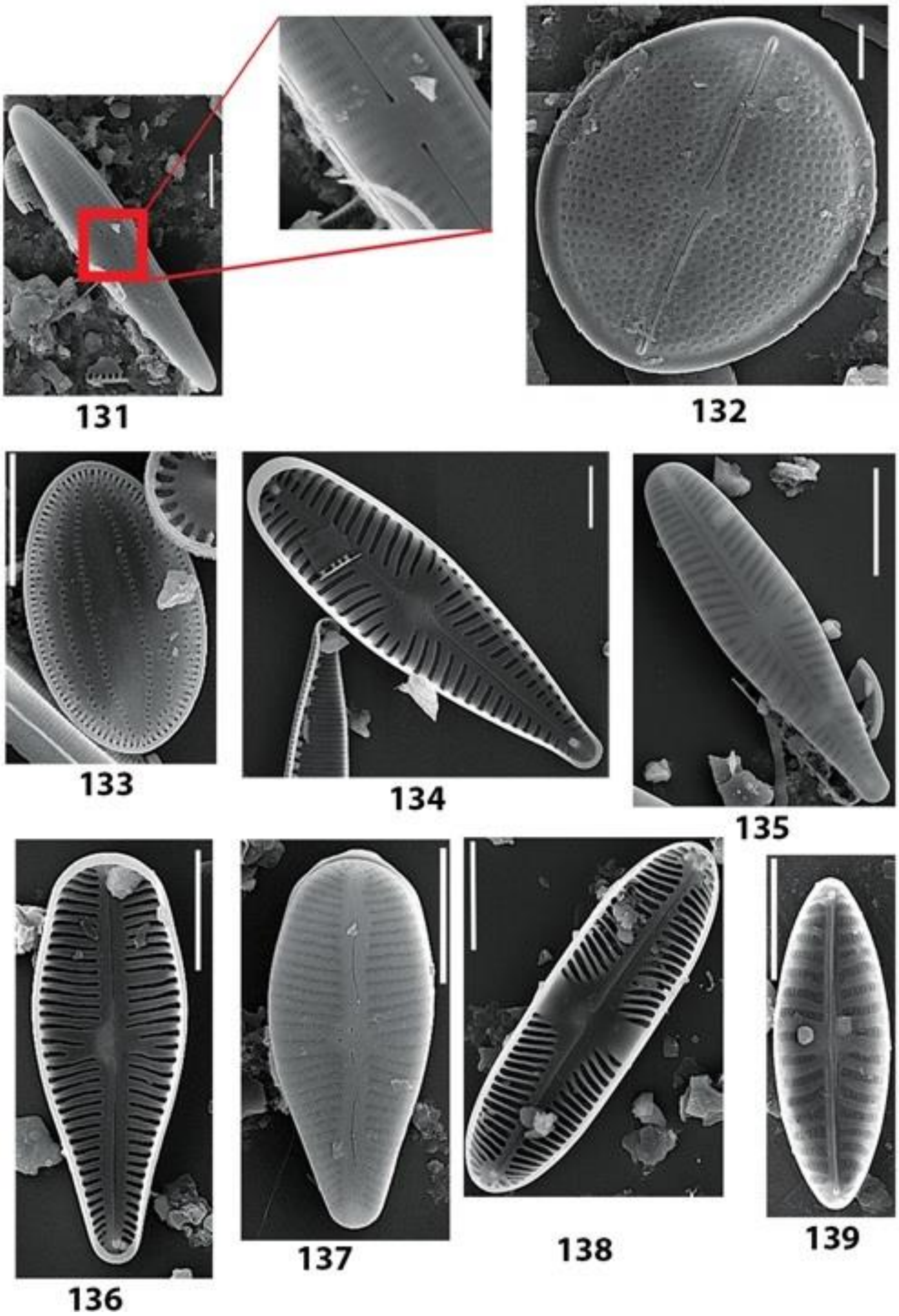

Fig. 12. SEM images of studied species. 131, *Rhoicosphenia abbreviata* (valve view); 132, *Cocconeis pediculus* (raphe valve); 133, *Cocconeis placentula* (without raphe); 134, *Gomphonema olivaceum*; 135, *Gomphonema olivaceum* (external view); 136, *Gomphonema italicum* (internal view); 137, *Gomphonema italicum* (external view); 138, *Pinnularia brebissonii*; 139, *Navicula* sp. Scale bar=10µm.

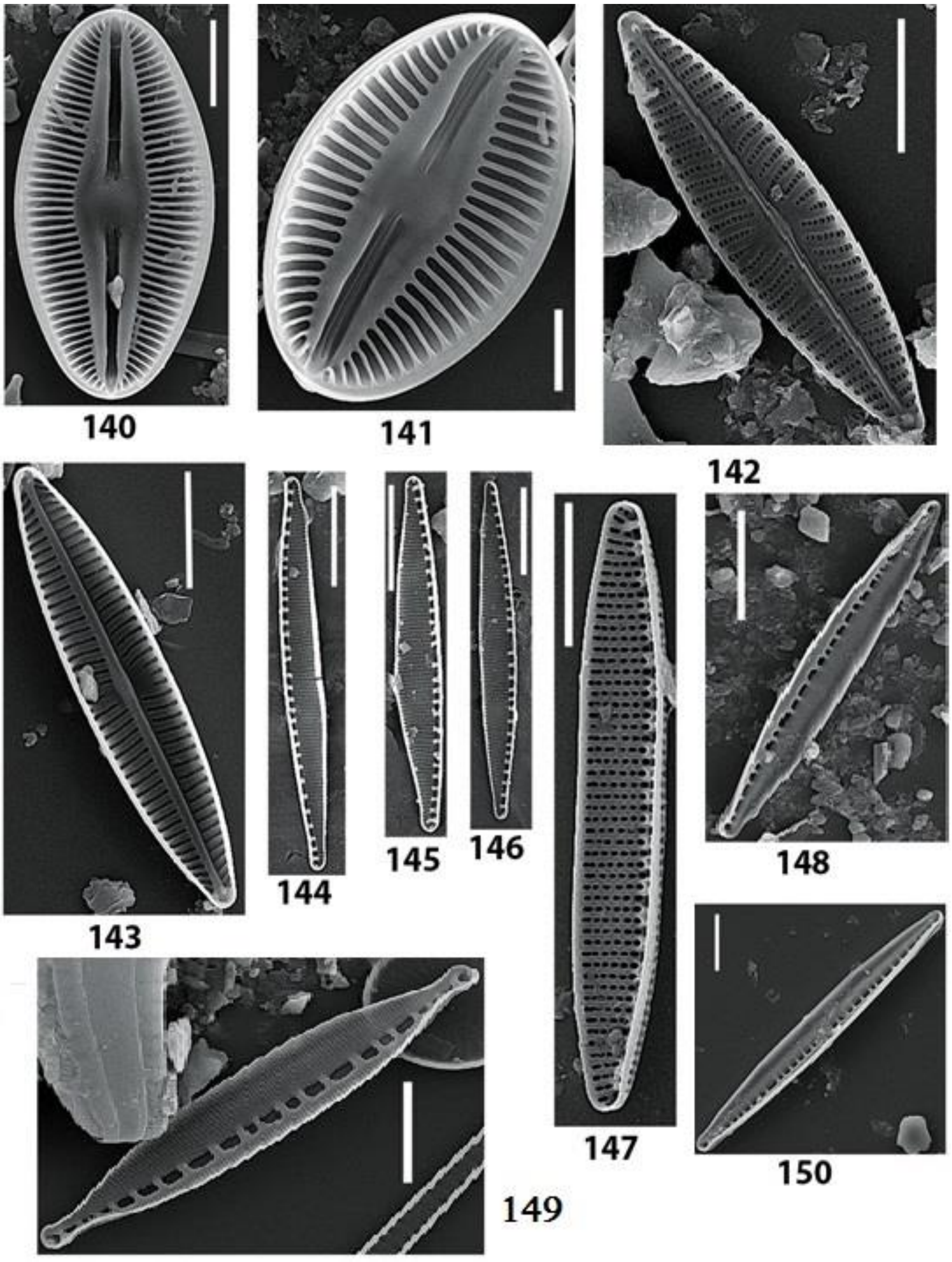

Fig. 13. SEM images of studied species. 140, *Diploneis parma*; 141, *Diploneis elliptica*; 142, *Navicula cryptotenella*; 143, *Navicula tripunctata*; 144-146, *Nitzschia* sp; 147, *Nitzschia amphibia*; 148-150, *Nitzschia dissipata*. Scale bar=10µm.

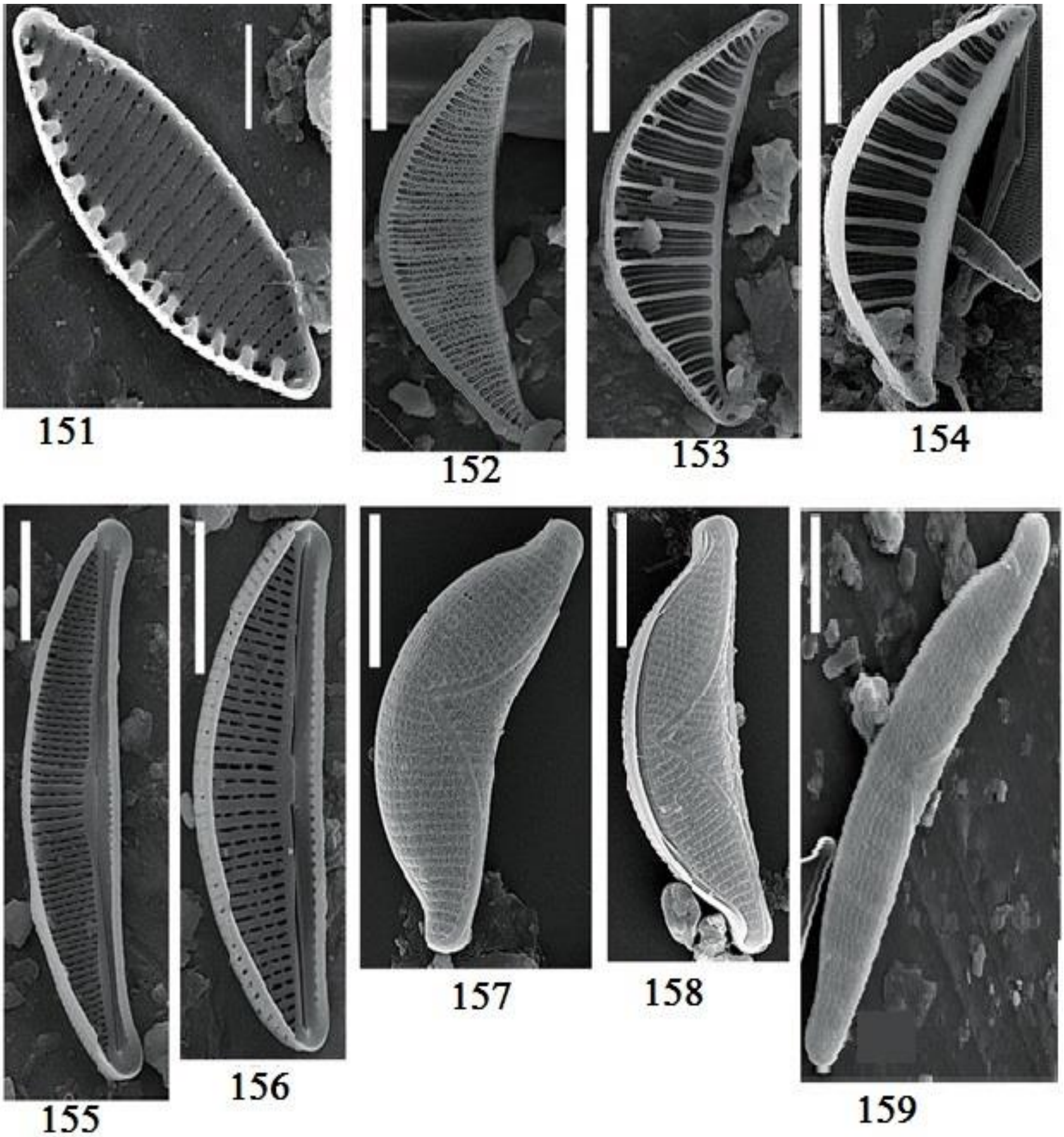

Fig. 14. SEM images of studied species. 151, *Nitzschia* sp.; 152, *Rhopalodia* cf. *musculus* (external view); 153-154, *Rhopalodia* cf. *musculus* (internal view); 155-156, *Halamphora veneta* (internal view); 157-158, *Epithemia sorex*; 159, *Epithemia adnata*. Scale bar=10µm.

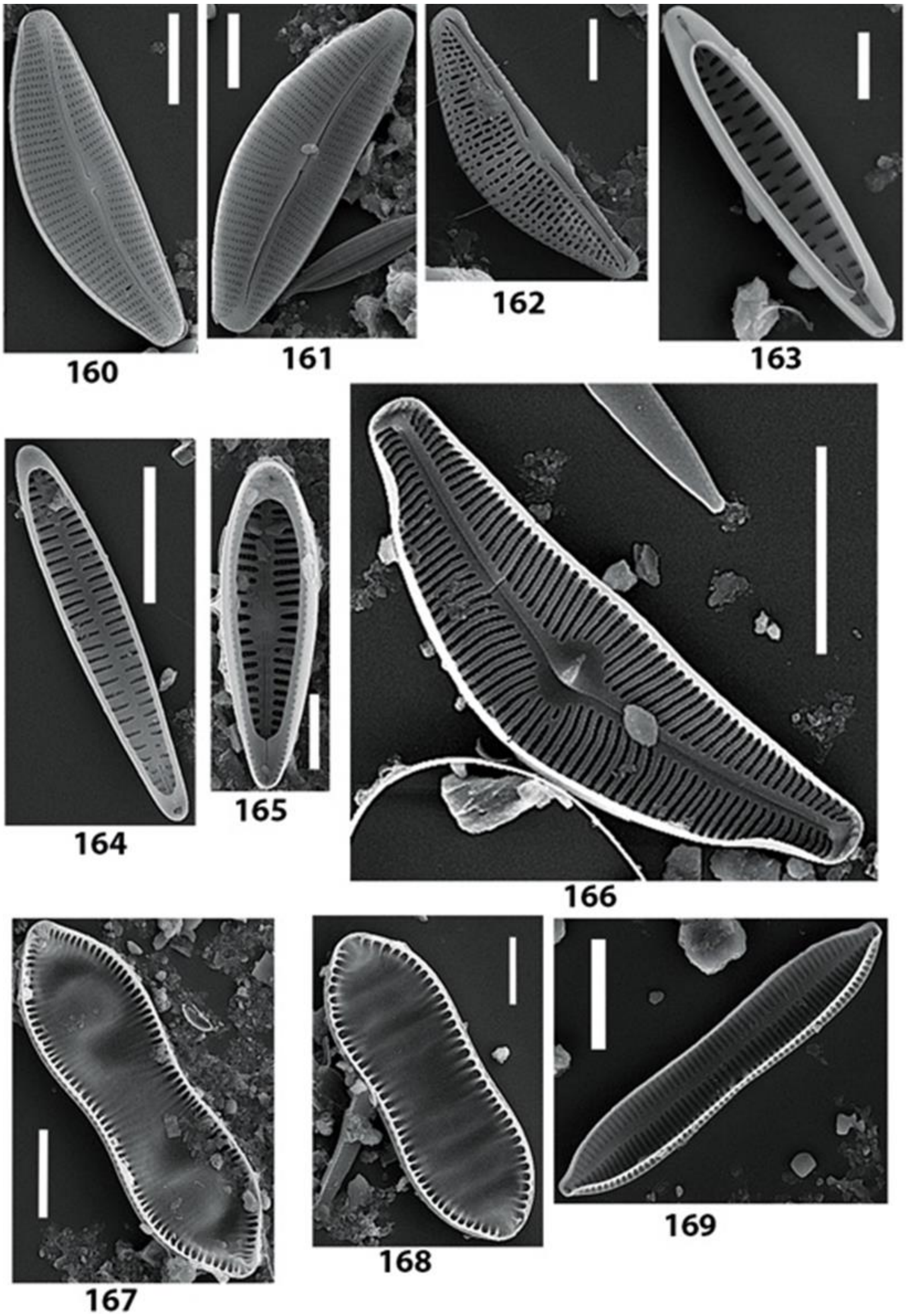

Fig. 15. SEM images of studied species. 160-161, *Cymbella compacta*; 162, *Halamphora veneta* (external view); 163-165, *Rhoicosphenia abbreviate* (internal view); 166, *Cymbella tumida*; 167-168, *Cymatopleura apiculata*; 169, *Tryblionella apiculata*. Scale bar=10µm.

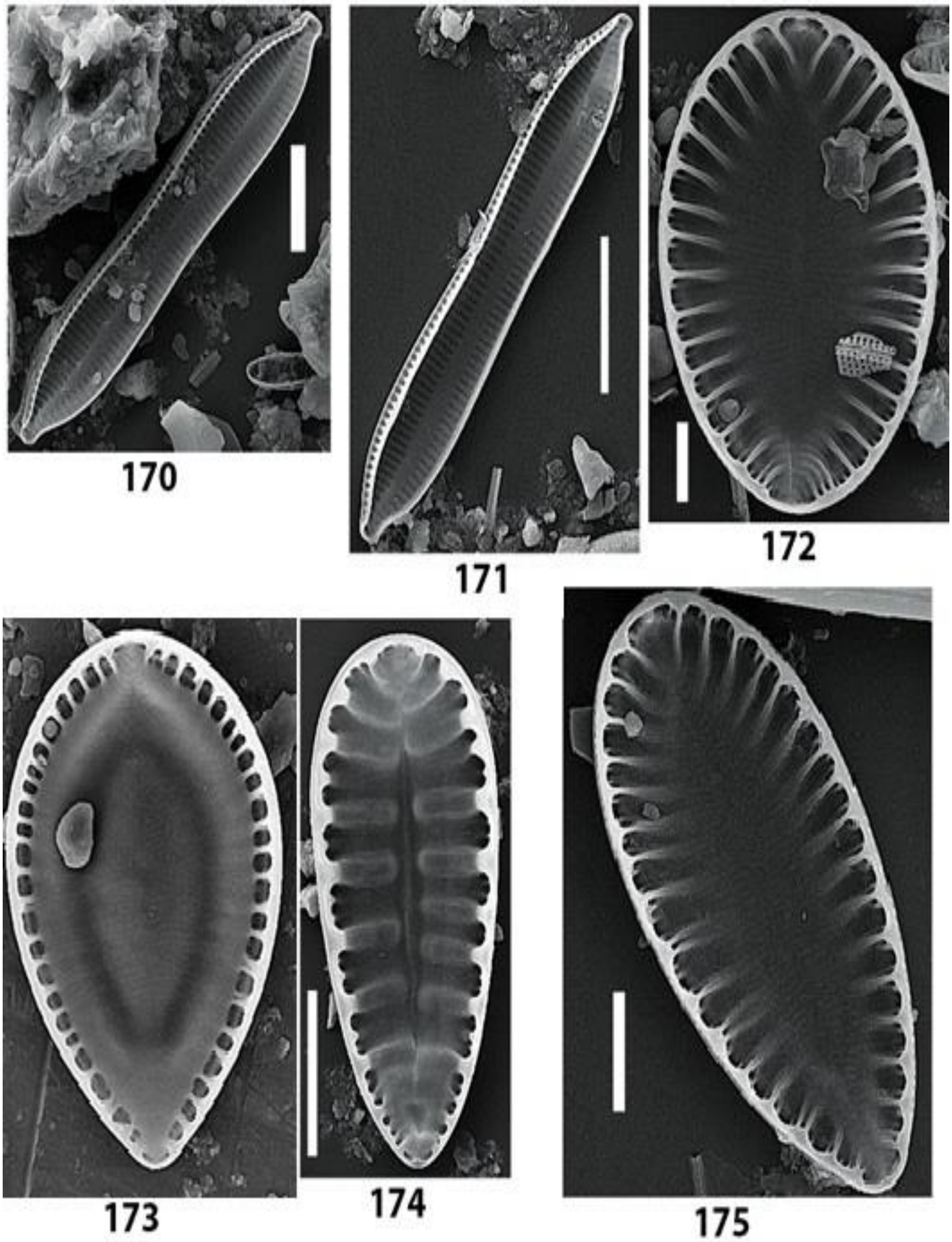

Fig. 16. SEM images of studied species: 170-171, *Tryblionella apiculata*; 172, *Surirella crumena*; 173, *Surirella peisonis*; 174, *Surirella lange-bertalotti*; 175, *Surirella robusta*. Scale bar=10µm.

Table 3. List of identified species in the Sufi Chai River. ID reference refers to the source of species identification keys. Locality reference refers to the person who identified the species in Iran. * Representing new record for diatom flora of Iran.

Number	Taxa	ID reference	Locality reference	Station
1	*Achnanthes brevipes* C. Agardh	Algae base (www.algaebase.org)	(Atazadeh & al. 2007; Soltanpour-Gargari & al. 2011)	S1- S3
2	*Amphora paracopulata* (Kütz.) Schoeman and R.E.M. Archibald *	Algae base	-	S6
3	*Bacillaria paxillifera* (O.F. Müll.) N.I. Hendey	(Kulikovskiy & al. 2016)	(Panahy-Mirzahasanlou & al. 2018)	S5-S7
4	*Caloneis amphisbaena* (Bory) Cleve	(Kulikovskiy & al. 2016)	(Yadollahi and Atazadeh 2024; Compere 1981)	S2
5	*Caloneis silicula* (Ehrenberg)Cleve	Algae base	(Kheiri & al. 2018)	S5
6	*Cocconeis euglypta* Ehrenberg	(Kulikovskiy & al. 2016)	(Compere 1981)	S2-S3
7	*Cocconeis pediculus* Ehrenberg	(Kulikovskiy & al. 2016; Hofmann, Werum, and Lange-Bertalot 2011)	(Atazadeh & al. 2007)	All St
8	*Cocconeis placentula* Ehrenberg	(Kulikovskiy & al. 2016; Hofmann, Werum, and Lange-Bertalot 2011)	(Zarei-Darki. 2009)	All St
9	*Ctenophora pulchella* (Ralfs ex Kütz.) D.M.Williams and Round *	Algae base	-	S3
10	*Cyclotella atomus* Hust	(Kulikovskiy & al. 2016)	(Yadollahi and Atazadeh 2024)	S1-S2-S3-S7
11	*Cyclotella meneghiniana* Kützing	(Kulikovskiy & al. 2016)	(Kheiri. 2018; Soltanpour-Gargari & al. 2011)	S5-S6
12	*Cymatopleura apiculata* W. Smith*	(Kulikovskiy & al. 2016)	(Mehrjuyan and Atazadeh 2022)	S1-S2-S4-S5
13	*Cymatopleura solea* (Brébisson) W.Smith	(Kulikovskiy & al. 2016; Hofmann, Werum, and Lange-Bertalot 2011)	(Mehrjuyan and Atazadeh 2022)	S3 S5
14	*Cymbella compacta* Østrup	(Kulikovskiy & al. 2016; Hofmann, Werum, and Lange-Bertalot 2011)	(Yadollahi and Atazadeh 2024; Safiallah & al. 2020)	S1-S2-S3-S4
15	*Cymbella helvetica* Kützing	(Kulikovskiy & al. 2016; Hofmann, Werum, and Lange-Bertalot 2011)	(Compere 1981; Soltanpour-Gargari & al. 2011)	S1
16	*Cymbella neocistula* Krammer	(Kulikovskiy & al. 2016; Hofmann, Werum, and Lange-Bertalot 2011)	(Yadollahi and Atazadeh 2024; Naseri & al . 2025)	S2
17	*Cymbella neolanceolata* W. Silva	(Kulikovskiy & al. 2016)	(Kheiri & al. 2018)	S1
18	*Cymbella tumida* (Bréb.ex Kütz.) van Heurck	(Kulikovskiy & al. 2016; Hofmann, Werum, and Lange-Bertalot 2011)	(Nejadsattari. 2005)	S7
19	*Diatoma moniliformis* Kütz.	(Kulikovskiy & al. 2016; Hofmann, Werum, and Lange-Bertalot 2011)	(Soltanpour-Gargari & al. 2011)	S1

Table 3. continued.

Number	Taxa	ID reference	Locality reference	Station
20	*Diatoma vulgaris* Bory	(Kulikovskiy & al. 2016; Hofmann, Werum, and Lange-Bertalot 2011)	(Yadollahi and Atazadeh 2024; Zarei-Darki. 2011)	All St
21	*Diploneis elliptica* (Kütz.) Cleve	Algae base	(Nasrollahzadeh Saravi & al. 2015)	S5
22	*Diploneis parma* Cleve	(Miho & al. 2018)	(Soltanpour-Gargari, Lodenius, and Hinz. 2011; Zarei-Darki. 2011)	S1
23	*Encyonema caespitosum* (Ehrenberg) De Toni	(Kulikovskiy & al. 2016; Hofmann, Werum, and Lange-Bertalot 2011)	(Kheiri 2019)	S1
24	*Encyonema minutum* (Hilse) D.G.Mann	(Kulikovskiy & al. 2016; Hofmann, Werum, and Lange-Bertalot 2011)	(Kheiri et al. 2018)	All St
25	*Encyonema leibleinii* (C.Agardh) W.J.Silva, R.Jahn, T.A.V.Ludwig and M.Menezes	Algae base	(Mehrjuyan and Atazadeh 2022 Adl & al. 2020)	7
26	*Encyonema silesiacum* (Bleisch in Rabenh.) D.G.Mann	Algae base	(Mehrjuyan and Atazadeh 2022)	S1-S4
27	*Epithemia adnata* (Kütz.) Bréb.	Algae base	(Zarei-Darki. 2011)	S7
28	*Epithemia sorex* Kütz.	(Kulikovskiy & al. 2016; Hofmann, Werum, and Lange-Bertalot 2011)	(Nejadsattari. 2005)	S7
29	*Epithemia selengensis* Kütz *.	(Kulikovskiy & al. 2016)	-	S1
30	*Eunotia mucophila* Lange-Bert*	(Kulikovskiy & al. 2016; Hofmann, Werum, and Lange-Bertalot 2011)	-	S5
31	*Fragilaria recapitellata (*Lange-Bert. and Metzeltin	(Kulikovskiy & al. 2016; Hofmann, Werum, and Lange-Bertalot 2011)	Yadollahi and Atazadeh 2024	S2
32	*Fragilaria vaucheriae* (Kütz.) Petersen	(Kulikovskiy & al. 2016; Hofmann, Werum, and Lange-Bertalot 2011)	(Compere. 1981)	All st
33	*Frustulia vulgaris* (Thwaites) De Toni	(Hofmann, Werum, and Lange-Bertalot 2011; Kulikovskiy & al. 2016)	(Atazadeh & al. 2007)	S3
34	*Gomphonema augur* Ehrenberg *.	(Hofmann, Werum, and Lange-Bertalot 2011)	-	S1
35	*Gomphonema italicum* Kützing *.	(Kulikovskiy & al. 2016; Hofmann, Werum, and Lange-Bertalot 2011)	(Yadollahi and Atazadeh 2024)	S4-S7
36	*Gomphonema laticollum* E. Reichardt*.	(Kulikovskiy & al. 2016)	(Yadollahi and Atazadeh 2024	S1-S2
37	*Gomphonema olivaceum* (Hornemann) Brébisson	(Hofmann, Werum, and Lange-Bertalot 2011)	(Atazadeh & al. 2007)	All St
38	*Gomphonema parvulum* (Kützing) Kützing	(Hofmann, Werum, and Lange-Bertalot 2011; Kulikovskiy & al. 2016)	(Compère. 1981; Zarei-Darki. 2011)	All St

Table 3. continued.

Number	Taxa	ID reference	Locality reference	Station
39	*Gomphonema capitatum* Ehrenberg	(Hofmann, Werum, and Lange-Bertalot 2011; Kulikovskiy & al. 2016)	-	S1-S2-S3-S4
40	*Halamphora veneta* (Kütz.) Levkov	Algae base	(Zarei-Darki. 2011)	S6
41	*Hannaea arcus* (Ehrenb.) R.M.Patrick	(Kulikovskiy & al. 2016; Hofmann, Werum, and Lange-Bertalot 2011)	(Kheiri & al. 2018)	All St
42	*Hantzschia amphioxys* (Ehrenb.) Grunow in Cleve and Grunow	(Hofmann, Werum, and Lange-Bertalot 2011; Kulikovskiy & al. 2016)	(Kheiri & al. 2018; Yadollahi and Atazadeh 2024)	S5
43	*Hippodonta capitata* (Ehrenberg) Lange-Bertalot, Metzeltin & Witkowski*	(Kulikovskiy & al. 2016; Hofmann, Werum, and Lange-Bertalot 2011)	-	S2
44	*Melosira varians* C.Agardh	(Kulikovskiy & al. 2016; Hofmann, Werum, and Lange-Bertalot 2011)	(Atazadeh & al. 2007; Ramezanpour. 2004)	S1-S2-S3-S4-
45	*Navicula capitatoradiata* H.Germ. ex Gasse	(Kulikovskiy & al. 2016; Hofmann, Werum, and Lange-Bertalot 2011)	(Kheiri & al. 2018)	All St
46	*Navicula cryptotenella* Lange-Bertalot	Algae base	(Atazadeh & al. 2007)	S1
47	*Navicula lanceolata* (C.Agardh) Ehrenb	(Kulikovskiy & al. 2016; Hofmann, Werum, and Lange-Bertalot 2011)	(Zarei-Darki 2011; Shams and Afsharzadeh. 2007)	S1-S2-S3--
48	*Navicula splendicula* vanLandingham*.	(Hofmann, Werum, and Lange-Bertalot 2011)	(Kheiri & al. 2018)	S1-S2-S3
49	*Navicula tripunctata* (O.F.Müll.) Bory	(Hofmann, Werum, and Lange-Bertalot 2011)	(Compère. 1981; Adl & al. 2020)	All St
50	*Nitzschia acidoclinata* Lange-Bert*.	Algae base	-	S6
51	*Nitzschia amphibia* Grunow	Algae base	(Yadollahi and Atazadeh 2024)	S6
52	*Nitzschia brevissima* Grunow in Van Heurck*.	Algae base	-	
53	*Nitzschia dissipata* (Kütz.) Rabenh.	(Hofmann, Werum, and Lange-Bertalot 2011; Kulikovskiy & al. 2016)	(Compère 1981; Atazadeh & al. 2007)	All St
54	*Nitzschia fasciculata* (Grunow) Grunow*.	Algae base	-	S7
55	*Nitzschia frustulum* (Kützing) Grunow*.	Algae base	-	S6
56	*Nitzschia linearis*	Algae base	(Kheiri & al. 2018)	S7
57	*Nitzschia palea* (Kütz.) W.Sm.	(Hofmann, Werum, and Lange-Bertalot 2011; Kulikovskiy & al. 2016)	(Kheiri & al. 2018; Compère. 1981)	All St
58	*Nitzschia paleacea* Grunow in Van Heurck	(Hofmann, Werum, and Lange-Bertalot 2011)	(Noroozi & al . 2009)	S5-S6
59	*Nitzschia paleaformis* Hustedt	(Hofmann, Werum, and Lange-Bertalot 2011)	(Safiallah & al. 2020)	S6
60	*Nitzschia perminuta* (Grunow in Van Heurck) H.Perag.	(Hofmann, Werum, and Lange-Bertalot 2011; Kulikovskiy & al. 2016)	(Compère 1981; Soltanpour-Gargari, Lodenius, and Hinz. 2011)	S2-S3

Table 3. continued.

Number	Taxa	ID reference	Locality reference	Station
61	*Nitzschia recta* Hantzsch ex Rabenh.	(Kulikovskiy & al. 2016)	(Yadollahi and Atazadeh 2024; Zarei-Darki. 2011)	All St
62	*Nitzschia supralitorea* Lange-Bertalot	(Hofmann, Werum, and Lange-Bertalot 2011; Kulikovskiy & al. 2016)	(Compère. 1981; Zarei-Darki. 2011)	S3-S6-S7
63	*Nitzschia sigma* (Kütz.) W.Sm.	Algae base	(Bagheri and Fallahi. 2014. Compère. 1981.)	S7
64	*Nitzschia vermicularis* Kützing) Hantzsch	(Hofmann, Werum, and Lange-Bertalot 2011; Kulikovskiy & al. 2016)	(Atazadeh & al. 2007)	S1
65	*Nitzschia vitrea* G. Norman	Algae base	(Compère. 1981, Zarei-Darki. 2011)	S6-S7
66	*Pinnularia brebissonii* (Kütz.) Rabenh.	(Kulikovskiy & al. 2016)	(Yadollahi and Atazadeh 2024)	S5-S6
67	*Pinnularia microstauron* (Ehrenb.) Cleve	(Kulikovskiy & al. 2016)	(Compère. 1981)	S2
68	*Pinnularia viridiformis* Krammer*.	Algae base	Yadollahi and Atazadeh 2024	S2
69	*Planothidium reichardtii* Lange-Bertalot and Werum*.	(Kulikovskiy & al. 2016)	-	S4-S5
70	*Reimeria sinuata* (W.Greg.) Kociolek and Stoermer	(Hofmann, Werum, and Lange-Bertalot 2011; Kulikovskiy & al. 2016)	(Ghavam and Atazadeh 2024)	All St
71	*Rhoicosphenia abbreviata* (C.Agardh) Lange-Bert.	(Hofmann, Werum, and Lange-Bertalot 2011; Kulikovskiy & al. 2016)	(Atazadeh & al. 2007)	All St
72	*Rhopalodia musculus* Kütz.	Algae base	(Compère. 1981)	S1
73	*Rhopalodia gibba* (Ehrenberg) O. Müller	(Hofmann, Werum, and Lange-Bertalot 2011; Kulikovskiy & al. 2016)	(Noroozi & al.. 2009)	S1
74	*Rhopalodia parallela* (Grunow) O. Müller*.	Algae base	-	S4
75	*Sellaphora pupula* (Kützing) Mereschkovsky	(Hofmann, Werum, and Lange-Bertalot 2011; Kulikovskiy & al. 2016)	(Kheiri & al. 2018	All St
76	*Stauroneis* sp	(Kulikovskiy & al. 2016; Hofmann, Werum, and Lange-Bertalot 2011)	-	S2
77	*Staurosirella martyi* (Hérib.) E.Morales and Manoylov	Algae base	(Zarei-Darki. 2009)	S2
78	*Stephanodiscus medius* Håk*.	(Kulikovskiy & al. 2016)	-	S5-S6
79	*Stephanodiscus neoastraea* Håkansson & Hickel	Algae base	(Kheiri 2019; Panahy-Mirzahasanlou & al. 2018)	S1
80	*Surirella angusta* Kütz.	(Hofmann, Werum, and Lange-Bertalot 2011; Kulikovskiy & al. 2016)	(Kheiri 2019; Panahy-Mirzahasanlou & al. 2018)	S1-S2-S3-S4-S7
81	*Surirella brebissonii* Krammer & Lange-Bertalot	(Kulikovskiy & al. 2016; Hofmann, Werum, and Lange-Bertalot 2011)	(Soltanpour-Gargari, Lodenius, and Hinz. 2011)	All St
82	*Surirella crumena* Bréb. ex Kütz*.	Algae base	-	S2-S3-

Table 3. continued.

Number	Taxa	ID reference	Locality reference	Station
83	*Surirella minuta* Brébisson ex Kützing,	(Hofmann, Werum, and Lange-Bertalot 2011; Kulikovskiy & al. 2016)	-	S1-S2-S3-S4-S6
84	*Surirella long-bertolotti* Krammer & Lange-Bertalot*.	Algae base	-	S1-S2
85	*Surirella robusta* Ehrenberg	Algae base	(Zarei-Darki, 2011)	S2-S3
86	*Surirella peisonis* Pantocsek	Algae base	(Compère. 1981)	S1-S3
87	*Tabularia fasciculata* (C.Agardh) D.M.Williams and Round	Algae base	(Compère. 1981; Panahy-Mirzahasanlou. 2018)	S5
88	*Tryblionella apiculata* W.Greg.	Algae base	(Compère. 1981)	S5-S6
89	*Tryblionella hungarica* (Grunow) Frenguelli	Algae base	(Compère. 1981. Panahy-Mirzahasanlou. 2018)	S7
90	*Ulnaria ulna* Nitzsch Compère	(Kulikovskiy & al. 2016)	(Atazadeh & al. 2007. ; Ramezanpour. 2004)	All St

DISCUSSION

Diatom taxonomy in Iran is fairly new field of study with a few experts, resulting in limited research on the identification of Iran diatoms. Our understanding of the diatom community in Iran is primarily based on a few studies conducted in freshwater habitats across various regions of the country. So far, a few lakes, wetlands, marshes, and rivers have been investigated. However, there are still gaps in our knowledge of the diatom flora of Iran due to the limited number of floristic studies and the scarcity of taxonomic literature and resources. As a result, the number of species, their biogeography, and distribution of Iran's diatoms are unclear.

The diatom flora observed in these locations differs from that of the Sufi Chai River. Based on the measured chemical factors (as shown in Table 2), the pollution gradient increases from the upstream to the downstream sections of the river due to concentrations of nutrients (NO_3 and PO_4) also increasing downstream. Consequently, algal biomass including (e.g. dry weight, biovolume, and chlorophyll-*a*) tends to be higher at the downstream stations of the Alavian Dam compared to the downstream stations. Similar findings have been reported in the Gharasou River, western Iran (Atazadeh & al., 2007). Comparing the diatom flora of the Sufi Chai River with findings from other studies in Iran, some similarities can be observed. Some common types of diatoms include *Cocconeis placentula*, *Encyonema minutum*, *Gomphonema olivaceum*, *Navicula tripunctata*, *Nitzschia dissipata*, *Sellaphora pupula*, and *Ulnaria ulna*. The most common diatom species are cosmopolitan and thrive in nutrient-rich environments. The genera *Nitzschia* and *Surirella* had the highest number of identified species. Previous floristic studies in Iran also noted that *Nitzschia*, *Navicula*, and *Gomphonema* had the greatest diversity (Atazadeh & al., 2007; Panahy-Mirzahasanlou & al., 2018; Kheiri & al., 2018; Yadollahi & Atazadeh, 2024). Many deformed species of *Diatoma vulgaris* were notably observed at the first sampling station. Given the mountainous and high-altitude nature of the region, it can be inferred that there may be mineral deposits of heavy metals present (Dela-Cruz & al. 2006). Diatoms are most abundant on rocks in shallow areas that are underwater and exposed to sunlight (Atazadeh, 2023). As water depth increases and sunlight decreases, the abundance of diatoms tends to decline. Additionally, high water velocity and turbidity can dislodge diatoms from rocks, causing them to settle on surfaces where water currents are slower. Consequently, these rocks can be used to assess water quality and measure biomass. The information collected indicates that a decrease in biomass upstream of the river has increased the diatom diversity. In contrast, in downstream of the river, the rise in pollution-resistant species has led to a decrease in biodiversity while biomass has increased. Additional work on the diatom ecology, systematics and biogeography is needed to define the environmental drivers and ecological gradients controlling diatom assemblage and distribution in Sufi Chai River and Lake Urmia Basin.

ACKNOWLEDGMENTS

We wish to express our appreciation to the University of Tabriz (Iran) for its technical support.

REFERENCES

Adl, M.M., Iranbakhsh, A., Noroozi, M., Asri, Y. & Saadatmand, S. 2020: Epipelic diatoms flora of Kordan River, Alborz province in Iran. -Modern Phytomorphology 14: 40-48.

Afsharzadeh, S., Rahiminezhhad, M., Nezhadstari, T. & Ebrahimnezhad, M. 2003: Study of algal flora in Zayandehrood River. -Iranian Journal of Biology 14 (12): 32-45. https://www.sid.ir/paper/21155/en.

APHA 2005: Standard methods for the examination of water and wastewater,21st edition. American Public Health Association, Washington, DC.

Atazadeh, E. 2023: Monitoring of rivers and streams conditions using biological indices with emphasis on Algae: a comprehensive descriptive review toward river management, River Basin Management-Under a Changing Climate. IntechOpen. https://doi.org/10.5772/intechopen/105749

Atazadeh, E., Barton, A., Shirinpour, M., Zarghami, M. & Rajabifard, A. 2020: River management and environmental water allocation in regulated ecosystems of arid and semiarid regions–a review. -Fundamental and Applied Limnology 193: 327-345. https://doi.org/10.1127/fal/2020/1286

Atazadeh, E., Gell, P., Mills, K., Barton, A. & Newall, P. 2021: Community structure and ecological responses to hydrological changes in benthic algal assemblages in a regulated river: application of algal metrics and multivariate techniques in river management. -Environmental Science and Pollution Research 28: 39805-39825. https://doi.org/10.1007/s11356-021-13546-w

Atazadeh, E. & Sharifi, M. 2012: Influence of zinc on productivity and species composition in algal periphyton communities. -Algological Studies 138: 57-73. https://doi.org/10.1127/1864-1318/2012/0011

Atazadeh, E., Sharifi, M. & Kelly, M. 2007: Evaluation of the trophic diatom index for assessing water quality in River Gharasou, western Iran. -Hydrobiologia 589: 165-173. https://doi.org/10.1007/s10750-007-0736-0

Bahls, L., Boynton, B. & Johnston, B. 2018: Atlas of diatoms (Bacillariophyta) from diverse habitats in remote regions of western Canada. -PhytoKeys 105: 1-186. https://doi.org/10.3897/phytokeys.105.23806

Bagheri, S. & Fallahi, M. 2014: Checklist of Phytoplankton Taxa in the Iranian Waters of the Caspian Sea. -Caspian Journal of Environmental Scinces 12 (1): 81–97.

Bosetti, C., McLaughlin, C., Tarone, R.E., Pira, E. & Vecchia, C. 2008: Formaldehyde and cancer risk: a quantitative review of cohort studies through 2006. -Annals of Oncology 19: 29-43. https://doi.org/10.1093/annonc/mdm202

Barinova, S. 2017: How to align and unify the cell counting of organisms for bioindication. -International Journal of Environmental Sciences and Natural Resources 2(2): 555-585. https://doi.org/10.19080/IJESNR.2017.02.555585

Battarbee, R.W. 1986: Diatom analysis. Handbook of Holocene palaeoecology and palaeohydrology: 527-570.

Compère, P.1981: Algues des deserts d Iran, Bulletin du Jardin botanique national de Belgique/Bulletin van de Nationale Plantentuin van Belgie: 3-40.

Dela-Cruz, J., Pritchard, T., Gordon, G. & Andajani, P. 2006: The use of periphytic diatoms as a means of assessing impacts of point source inorganic nutrient pollution in south-eastern Australia. -Freshwater Biology 51: 951-972. https://doi.org/10.1071/MF06220

Fallahi, M. 1991: Plankton survey in the Southrn part of the Caspian Sea. -Iranian Fisheris Bulletin. 1–38.

Ghavam, A. & Atazadeh, E. 2024: Study of genus *Reimeria* (Bacillariophyta) in the Kordan and Hazarband Rivers in the Central Alborz, Northern Iran. - Taxomony and Biosystematics 16(60): 35-44. https://doi.org/10.22108/tbj.2024.141551.1265

Haghshenas, S.S., Neshaei, M.A.L., Pourkazem, P. & Haghshenas, S.S. 2016: The risk assessment of dam construction projects using fuzzy TOPSIS (case study: Alavian Earth Dam). -Civil Engineering Journal. 2(4): 158-167. https://doi.org/10.28991/cej-2016-00000022

Hill, B.H., Herlihy, A.T., Kaufmann, P.R., Stevenson, R.J., McCormick, F.H. & Johnson, C.B. 2000: Use of periphyton assemblage data as an index of biotic integrity. -Journal of the North American Benthological Society 19: 50-67. https://doi.org/10.2307/1468281

Hilmer, T. & Bate, G.C. 1990: Covariance analysis of chlorophyll distribution in the Sundays River estuary, Eastern Cape. -Southern African Journal of Aquatic Sciences. 16: 37-59. https://doi.org/10.1080/10183469.1990.10557366

Hofmann, G., Werum, M. & Lange-Bertalot, H. 2011: Diatomeen im Süsswasser-Benthos von Mitteleuropa. Koeltz Scientific Books, Königstein: 1-908.

Kelly, M.G. & Whitton, B.A. 1995: The Trophic Diatom Index: a new index for monitoring eutrophication in rivers. -Journal of Applied Phycology 7: 433-444. https://doi.org/10.1007/BF00003802

Kheiri, S., Solak, C., Edlund, M., Spaulding, S., Nejadsattari, T., Asri,Y. & Hamdi, M. 2018: Biodiversity of diatoms in the Karaj River in the Central Alborz, Iran. -Diatom Research 33: 355-380. https://doi.org/ 10.1080/0269249X.2018.1557747

Kheiri, S. 2019: Diatom Diversity in the Spring and Spring-fed River of Tizab Region (Central Alborz), Iran. -Journal of Phycological Research 3(2): 408-420. https://doi.org/10.29252/JPR.3.2.408

Krammer, K. 2000: Diatoms of Europe. Vol. 1. The genus Pinnularia. Ruggell: ARG Gantner Verlag KG.

Krammer, K. & Lange-Bertalot, H. 1986: Bacillariophyceae. 1. Teil. Naviculaceae. Süßwasserflora von Mitteleuropa, Band 2/1. Gustav Fischer Verlag, Stuttgart, pp. 876.

Krammer, K. & Lange-Bertalot, H. 1991a: Bacillariophyceae. 3. Teil. Centrales, Fragilariaceae, Eunotiaceae. Süßwasserflora von Mitteleuropa, Band 2/3. Gustav Fischer Verlag, Stuttgart, pp. 598.

Krammer, K. & Lange-Bertalot, H. 1991b: Bacillariophyceae. 4. Teil. Achnanthaceae, kritsche erganzungen zu Navicula (Lineolatae) und Gomphonema Gesamliteraturverzeichnis. Süßwasser flora von Mitteleuropa, Band 2/4. Gustav Fischer Verlag, Stuttgart, pp. 468.

Kulikovskiy, M., Glushchenko, A., Genkal, S. & Kuznetsova, I. 2016: Identification book of diatoms from Russia. Filigran, Yaroslav. Russia.

Lange-Bertalot, H. 2001: Navicula sensu stricto, 10 genera separated from Navicula sensu lato, Frustulia, Diatoms of Europe: Diatoms of the European inland waters and comparable habitats, 2. Fischer Verlag, Stuttgart, pp. 984.

Lecointe, C., Coste, M. & Prygiel, J. 1993: Omnidia: software for taxonomy, calculation of diatom indices and inventories management. -Hydrobiologia. 90: 509-513. https://doi.org/10.1007/BF00028048

Mehrjuyan. S.R. & Atazadeh, E. 2022: Study of the genera Encyonema, Craticula, and Cymatopleura (Bacillariophyta) in the western rivers of Lake Urmia, Iran. -The Iranian Journal of Botany 28(2): 182-199. https://doi.org/10.22092/IJB.2022.128207

Miho, A., Ngjela, K., Hoxha, B., Sejdo, I. & Meço, M. 2018: Diversity of diatoms and related quality of free-flowing rivers in Albania (the Vjosa catchment). -Acta ZooBot Austria 155: 107-134.

Mobasheri, M., Taghavi, L., & Nabavi, S.M.B. 2022: Investigating Water Quality of Sufi Chay River using macrobenthos indicators. -Journal of Environmental Science and Technology 24: 31-47. https://sid.ir/paper/1064122/en

Naseri, A., Nooorzi, M., & Blanco, S. 2025: A checklist of diatoms with four endemic records and phytogeographical distribution from water habitats of Iran. -Phytotaxa 695(2): 150-206.

Naseri, A., Noroozi, M., Asri, Y. Iranbakhsh, A. Saadatmand, S. & Atazadeh, E. 2022: Diatom taxonomy and environmental drivers of biodiversity in the Taleghan River and reservoir in Central Alborz, Iran. -Diatom Research 37: 199-226. https://doi.org/10.1080/0269249X.2022.2123049

Nasrollahzadeh, H., Makhlough, A., Rahmati, R., Tahami, F. & Golaghaei, M. 2015: Study on stable and disturbance status of the Caspian Sea ecosystem (Iranian coasts) based on changes of phytoplankton community structure. -Journal of Marine Biology 7: 27-44. https://doi.org/10.48308/JPR.2024.236835.1087

Nejadsattari, T. 2005: The diatom flora of lake Neure, Iran. -Diatom Research 20: 313-33. https://doi.org/10.22092/ijb.2020.351698.1296

Noroozi, M., Naqunezhad, A. & Mehrvarz, S. 2009: Algal flora in first Iranian land-marine the Boujagh National Park. -International Journal on Algae 11 (3): 276-288. https://doi.org/10.1615/InterJAlgae.v11.i3.70

Nusch, EA. 1980b: Comparison of different methods for chlorophyll and phaeopigment determination. -Arch Hydrobiol Beih Ergebn Limnol 14: 14-36.

Panahy-Mirzahasanlou, J., Nejadsattari, T., Ramezanpour, Z., Imanpour-Namin, J. & Asri, Y. 2018: The epilithic and epipelic diatom flora of the Balikhli River, Northwest Iran. -Turkish Journal of Botany. 42: 518-32. https://doi.org/10.3906/bot-1711-46

Parikhani, F., Atazadeh, E., Razeghi, J., Mosaferi, M., & Kulikovskiy, M. 2023: Using Algal Indices to Assess the Ecological Condition of the Aras River, Northwestern Iran. - Journal of Marine Science and Engineering, 11(10): 1867-1885. https://doi.org/10.3390/jmse11101867

Ramezanpour, Z. 2004: Ecological study of phytoplankton of the Anzali lagoon. - Czech Phycology Olomouc 4: 145-154.

Reid, M., Tibby, J., Penny, D. & Gell, P. 1995: The use of diatoms to assess past and present water quality. -Australian Journal of Ecology. 20: 57-64. https://doi.org/10.1111/j.1442-9993.1995.tb00522.x

Safiallah, S., Saadatmand, S., Kheiri, S. & Iranbakhsh, A. 2020: Biodiversity of diatoms in the Kashkan River in the Zagros Mountains, western Iran. -The

Iranian Journal of Botany 26: 141-61. https://doi.org/10.22092/ijb.2020.351698.1296

Shams, M. & S, Afsharzadeh. 2007: Taxonomic study of Diatoms in Zayandeh Rood Dam Lake. -Rostaniha 8(2): 160-175.

Solak, C., Alakananda, B., Kulikovskiy, M., Blanco, S., Kaleli, A. & Yilmaz, E. 2019: Distribution of nitzschioid diatoms in Kütahya waters. -Oceanological and Hydrobiological Studies. 48: 140-164. https://doi.org/10.1515/ohs-2019-0014

Soltanpour-Gargari, A., Lodenius, M. & Friedel H. 2011: Epilithic diatoms (Bacillariophycae) from streams in Ramsar, Iran. -Acta Botanica Croatica 70: 167-90. https://doi.org/10.2478/v10184-010-0006-5

Stevenson, J. 2014: Ecological assessments with algae: a review and synthesis. -Journal of Phycology 50: 437-461. https://doi.org/10.1111/jpy.12189

Stevenson, R.J. & Sabater, S. 2010: Understanding effects of global change on river ecosystems: Science to support policy in a changing world. In the book: Global Change and River Ecosystems-Implications for Structure, Function and Ecosystem Services. -Springer: 3-18. https://doi.org/10.1007/978-94-007-0608-8_2

Swenberg, J., Moeller, B., Lu, K., Rager, J.C., Fry, R. & Starr, T. 2013: Formaldehyde carcinogenicity research: 30 years and counting for mode of action, epidemiology, and cancer risk assessment. -Toxicologic pathology 41: 181-89. https://doi.org/10.1177/0192623312466459

Taylor, J.C., Prygiel, J., Vosloo, A., De La Rey, P.A. & Van Rensburg, L. 2007: Can diatom-based pollution indices be used for biomonitoring in South Africa. A case study of the Crocodile West and Marico water management area. -Hydrobiologia 592: 455–464. https://doi.org/10.1007/s10750-007-0788-1

Van der Werff, A. 1955: A new method of concentrating and cleaning diatoms and other organisms. -Internationale Vereinigung für theoretische und angewandte Limnologie Verhandlungen. 12: 276-77. https://doi.org/10.1080/03680770.1950.11895297

Williams, O.E., Beckett, R. & Maxwell, D. 2016: Marine phytoplankton preservation with Lugol’s: a comparison of solutions. -Journal of Applied Phycology 28: 1705-1712. https://doi.org/10.1007/s10811-015-0704-4

Yadollahi, Z. & Atazadeh, E. 2024: Biodiversity of Diatoms and Their Relationship with Environmental Factors in the Ahar-Chai River, Northwest Iran. -Taxonomy and Biosystematics 15(3): 41-64. https://doi.org/10.22108/tbj.2024.137841.1233

Zarei-Darki, B. 2009: Taxonomic structure of the algal flora of Iran, Bangladesh. -Journal of Plant Taxonomy 16: 185-194. https://doi.org/10.3329/bjpt.v16i2.3933

Zarei-Darki, B. 2011: Species composition and ecology of the diatoms in the Gavkhuni wetland (Iran). -Вісник Харківського національного аграрного університету. Серія Біологія. 1: 110-117.