

# Diatom Flora of Kalath and Khirganga Thermal Springs of Himachal Pradesh, India

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## ABSTRACT

Diatoms are fascinating group of microorganisms; abundant in all aquatic habitats. They are used as reliable environmental indicators. In the present study diatoms flora of Kalath and Khirganga thermal springs of Kullu district, Himachal Pradesh were examined for the first time. Water temperature for these springs range between 39-48°C with neutral to slightly acidic pH. Total eighteen taxa of diatoms (Bacillariophyceae) reported during study belonging to seven genera. Diatom species of Nitrogen heterotrophic- *Nitzschia* and *Gomphonema* dominated in these thermal springs. It indicates water of these springs is rich in nitrogen due to pollution. Present study adds twelve new taxa to the algal flora of Himachal Pradesh.

**Keywords:** Thermal spring, Diatoms, Kullu.

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## INTRODUCTION

The thermal springs and streams are extreme environments in geologically active regions where temperature is influenced by geothermal sources and can range from 25° to 104°C. Temperature is not the only extreme condition for thermal organisms; most springs have elevated concentrations (50-150 mg/L) of inorganic ions ( $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$ ,  $\text{Na}^+$ ,  $\text{HCO}_3^-$ ,  $\text{SO}_4^{2-}$ ,  $\text{Cl}^-$ , Si, and  $\text{H}_2\text{S}$ ) and elevated pH (8-10). Thermal spring diatom flora has been studied by Ekins and Rushforth (1986) identified 56 diatom taxa from Cowboy hot spring. Schoeman and Archibald (1988) recorded 63 taxa of diatoms from Gross Barmen thermal spring, Namibia. Owen *et al.* (2008) present a comparative study of floras in hot spring systems of Iceland, New Zealand, and Kenya. Nikulina and Kocielek (2011) studied diatoms from hot springs from Kuril and Sakhalin island, Russia. Leira *et al.* (2017), Nikulina *et al.* (2016), Pumas *et al.* (2018) also studied thermal spring diatoms. Martinez-Goss (2019) reported diatoms in cyanobacterial mats of Coron hot water spring, Philippines.

As far as records of algal flora of thermal springs in India is concerned, Thomas and Gonzalves (1965a,b,c,d,e,f) studied algal flora of Akloli, Ganeshpuri, Tuwa, Palli, Sav thermal springs of western India and have reported several taxa of diatoms. Jana (1973) studied flora and fauna of thermal spring of Bakreswar, India and reported *Navicula* sp. and *Cyclotella* sp. as new in India at temperature range 43 to 51°C. Prasad and Srivastava (1965), Prasad *et al.* (1984) studied some diatoms from the thermal spring of Ladakh. They described 11 taxa of diatoms from Puga geothermal field at an altitude of 4350 meters. Two taxa viz., *Fragilaria construens* (Ehrenberg), var. *binodis* Grunow and *Cymbella parva* (W. Smith) Kirchner are recorded new to the Indian flora. Kha (2014) reported 74 taxa of diatoms from thermal springs of Ratnagiri district, Maharashtra. Mandal and Sarkar (2015) studied diatom flora of Bakreshwar thermal spring, West Bengal. Bhakta *et al.* (2016) studied algal diversity in four hot springs namely, Tarabela, Taptapani, Atri and Deulajhari of Odisha and recorded total fifty taxa belonging to thirty five genera under Cyanophyceae, Chlorophyceae, Charophyceae, and Bacillariophyceae. Das (2019) studied two thermal springs of Arunachal Pradesh and reported 19 taxa of diatoms.

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A perusal of the botanical history of thermal springs of Himachal Pradesh reveals that there are few records of thermal diatoms flora e.g., Rana (1987); Dwivedi and Misra (2015). Therefore, comprehensive picture of the thermal spring diatoms flora of Kalath and Khirganga is covered in the present investigation.

## MATERIALS AND METHODS

Random sampling technique has been applied in the algal collection procedure. Samples were collected in 2018 from Kalath (lat. 32.1856 and long. 77.1856) and Khirganga (lat. 31.993 and long. 77.5096) thermal springs, Kullu district, Himachal Pradesh. Temperature and pH of water was measured in each case with the help of Mercury Celsius thermometer and portable pH meter on the site respectively. The algal samples were preserved in 4% formalin solution and submitted in Phycology research lab, University of Lucknow. Slides were prepared of the Patrick and Reimer (1966) and mounted in DPX (Destyrene Phthalate Xylol). Microscopic studies were made by Nikon Labophot microscope E-400 with H-II photomicrographic attachment (Plate 1A-D).

## Morphological identification

Taxonomical identifications were done by comparing each of the taxon with monographs of Hustedt (1930), Foged (1981), Gandhi (1999) and Karthick *et al.* (2013). Identifications were confirmed by cross-checking with the Algal database and



**Plate 1:** A&D: Showing Khirganga thermal spring, B. Map of sampling sites, C. Kalath thermal spring.

related research papers, journals. Diatom taxa reported in the present investigation have been arranged according to Hendey (1964).

## RESULTS

### 1. *Diatoma vulgaris* Bory (Pl. 2, Fig. A)

Tiffany, L. H., and Britton, M. E., 1952, pg. 230, pl. 61, fig. 686.  
**Description:** Valves elliptical-lanceolate, narrowed slightly towards the rounded poles; with very narrow pseudoraphe; valve length 15  $\mu\text{m}$  and breadth 4  $\mu\text{m}$ ; trans apical ribs, 7 in 10  $\mu\text{m}$ .

**Locality:** River side outflow on NH-3 near River Beas, Kalath, Kullu.  
**Collection number:** HP/KU/KL/S5.

### 2. *Navicula cryptocephala* Kützing (Pl. 2, Fig. D)

Kuetzing, F.T., 1849, pg. 75; Gandhi, H.P. 1999, pg. 35, Pl. II, fig. 70.  
**Description:** Valves linear-lanceolate with constricted produced somewhat capitate ends; raphe thin, straight median with distinct central nodules; striae lineate, short in central area, radiate in the middle becoming convergent towards apices; valve length 24  $\mu\text{m}$ , breadth 5  $\mu\text{m}$ ; striae 16-17 in 10  $\mu\text{m}$ .  
**Locality:** Near bathing pool area, Khirganga.  
**Collection number:** HP/KU/KH/S13.



**3. *Navicula zanonii* Hustedt (Pl. 2, Fig. E)**

Hustedt, 1949, pg. 92, pl. 5, fig. 1-5; Gandhi, H. P., 1959a, pg. 127, pl. II, fig. 48.

**Description:** Narrowly lanceolate with narrowed, constricted, produced acutely rounded ends; raphe is thin and straight; axial area is narrow, with circular central area; valve length 22 µm, breadth 5 µm; striae 20 in 10 µm.

**Locality:** Bathing pool in Shiv temple, Khirganga, Kullu.

**Collection number:** HP/KU/KH/S12.

**4. *Caloneis gracilis* H.P. Gandhi ex Karthik (Pl. 2, Fig. C)**

Gandhi, H.P., 1999, pl.1, fig. 16 a-b.

**Description:** Valves linear in the middle delicately convex, ends broadly rounded; raphe thin and straight with central pores distinct and distantly placed and terminal fissures curved; apices narrow, linear lanceolate; valve length 40 µm, breadth 7 µm; striae 25 in 10 µm.

**Locality:** Parvati Thermal water Kunda, Khirganga, Kullu.

**Collection number:** HP/KU/KH/S11.

**5. *Pinnularia macra* H.P. Gandhi (Pl. 2, Fig. B)**

Gandhi, H. P., 1999, pg. 227, pl. 7, fig. 287-288.

**Description:** Ends strongly constricted, broadly capitate and rounded; raphe thin and straight with central pores unilaterally inclined and terminal fissures curved; axial area is more or less lanceolate, central area large, rhomboid; valve length 21 µm, breadth 3 µm; striae 18 in 10 µm.

**Locality:** River side outflow on NH-3 near River Beas, Kalath, Kullu.

**Collection number:** HP/KU/KL/S5.

**6. *Gomphonema lagenula* Kützing (Pl. 2, Fig. F)**

Karthick, B., Hamilton, P.B. & Kociolek, J.P., 2013, pl. 79.

**Description:** Valves linear-lanceolate, with rounded to sub-rostrate apices; central area broad; raphe thick; striae are distinctly placed, thick; valve length 22 µm, breadth 6 µm; striae 17 in 10 µm.

**Locality:** Parvati Thermal water Kunda, Khirganga, Kullu.

**Collection number:** HP/KU/KH/S11

**7. *Gomphonema parvulum* (Kützing) Kützing (Pl. 2, Fig. G)**

Foged, N., 1981, pg. 645, pl. 10, fig. 17.

**Description:** Valves small, linear, lanceolate-clavate with slightly constricted produced rounded apex and gradually attenuated rounded base; raphe thin, median straight, with distinct central nodules, having an isolated puncta on opposite side; striae linear, radiate and slightly distinctly placed in middle; valve length 13 µm, breadth 6 µm; striae 16 in 10 µm.

**Locality:** Main bathing pool, Kalath, Kullu.

**Collection number:** HP/KU/KL/S3.

**8. *Rhopalodia gibba* (Ehrenberg) O. Müller (Pl. 2, Fig. H)**

Karthick, B., Hamilton, P.B. & Kociolek, J.P., 2013, pl. 106 & 107.

**Description:** Cells in girdle view broadly linear with median inflation and rounded poles; valves broadly lunate with straight ventral sides and recurved acute poles; valve length 27 µm, breadth 4 µm; costae 8-9 in 10 µm alternating with 3-4 rows of alveoli 11-12 in 10 µm.

**Locality:** Bathing pool in Shiv temple, Khirganga, Kullu.

**Collection number:** HP/KU/KH/S12.

**9. *Rhopalodia gibberula* (Ehrenberg) O. Müller (Pl. 2, Fig. I)**

Hustedt, 1930, pg. 391, fig. 742; Karthick, B., Hamilton, P.B. & Kociolek, J.P., 2013, Pl. 107

**Description:** Cell-wall elliptical with flat ends in girdle view; valve length 29 µm and breadth 7 µm; costae 3-4 in 10 µm, alternating with rows of alveoli 15-16 in 10 µm.

**Locality:** River side outflow on NH-3 near River Beas, Kalath, Kullu.

**Collection number:** HP/KU/KL/S5.

**10. *Rhopalodia musculus* (Kützing) O. Müller (Pl. 2, Fig. J&K)**

Hustedt, 1930, pg. 392, fig. 745; Karthick, B., Hamilton, P.B. & Kociolek, J.P., 2013, pl. 108.

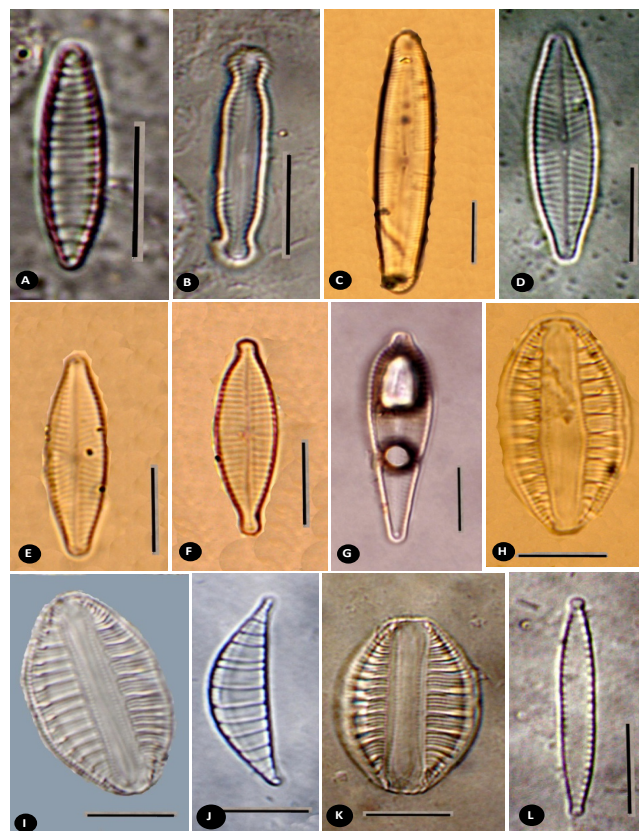
**Description:** Valves semi-elliptical, strongly convex along the dorsal margin, tapering to narrow rounded ends; raphe is located in the canal along the dorsal margin; valve length 30 µm, breadth 6 µm; costae 4-5 in 10 µm; striae in 10 µm.

**Locality:** Bathing pool in Shiv temple, Khirganga, Kullu.

**Collection number:** HP/KU/KH/S13.

**11. *Nitzschia allansonii* Cholnoky (Pl. 2, Fig. L)**

Cholnoky, 1958, pg. 257, fig. 24-27; Gandhi, H.P., 1999, pg. 197, pl. 6, fig. 190.



**Plate 2:** A. *Diatoma vulgaris*, B. *Pinnularia macra*, C. *Caloneis gracilis*, D. *Navicula cryptocephala*, E. *Navicula zanonii*, F. *Gomphonema lagenula*, G. *Gomphonema parvulum*, H. *Rhopalodia gibba*, I. *Rhopalodia gibberula*, J&K. *Rhopalodia musculus*, L. *Nitzschia allansonii*.

**Description:** Valves lanceolate, ends narrowed capitate or subcapitate rounded; keel punctae small rounded about 10-11 in 10  $\mu\text{m}$ , in the middle part some of them distantly set; striae fine, fairly distinct and finely punctuate; valve length 23  $\mu\text{m}$ , breadth 3  $\mu\text{m}$ ; keel punctae 10-11 in 10  $\mu\text{m}$ .

**Locality:** Parvati thermal water kunda, Khirganga, Kullu.

**Collection number:** HP/KU/KH/S11.

### 12. *Nitzschia alpina* Hustedt (Pl. 3, Fig. A)

Hustedt, F., 1942, pg. 124-197, 225-280; fig. 60-65.

**Description:** Valves linear to lanceolate, bluntly rounded to rostrate apices; fibulae equidistant; valve length 14  $\mu\text{m}$ , breadth 4  $\mu\text{m}$ ; striae 20 in 10  $\mu\text{m}$ .

**Locality:** River side outflow on NH-3 near River Beas, Kalath, Kullu.

**Collection number:** HP/KU/KL/S5.

### 13. *Nitzschia amphibia* Grunow (Pl. 3, Fig. B)

Gandhi, H. P., 1999, pg. 56, pl. III, fig. 125; Karthick, B., Hamilton, P.B. & Kociolek, J.P., 2013, pl.123.

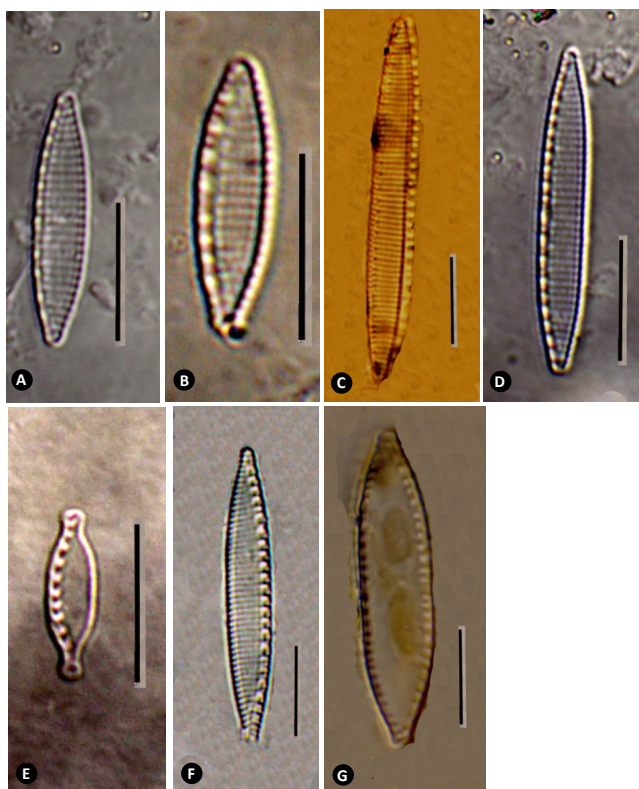
**Description:** Valves short, linear-lanceolate with slightly constricted produced, sub-rostrate ends; carnial dots big, rounded; median two slightly placed apart; striae coarse, indistinctly punctuate, valve length 15  $\mu\text{m}$ , breadth 2.4  $\mu\text{m}$ ; striae 20 in 10  $\mu\text{m}$ .

**Locality:** River side outflow on NH-3 near River Beas, Kalath, Kullu.

**Collection number:** HP/KU/KL/S5.

### 14. *Nitzschia capitellata* Hustedt (Pl. 3, Fig. C)

Hustedt, F., 1938, pg. 474, pl. 41, fig. 26 & 27.



**Plate 3:** A. *Nitzschia alpina*, B. *Nitzschia amphibia*, C. *Nitzschia capitellata*, D. *Nitzschia communis*, E. *Nitzschia elegantula*, F. *Nitzschia liebethruthii*, G. *Nitzschia thermalis*.

**Description:** Valves long, linear with parallel margins and broadly cuneate slightly constricted rounded-capitate ends; carinal dots coarse, very slightly elongated; median two somewhat distinctly placed; striae very fine, lineate, delicate, parallel throughout the valve; valve length 40  $\mu\text{m}$ , breadth 5  $\mu\text{m}$ ; striae 20 in 10  $\mu\text{m}$ .

**Locality:** Bathing pool in Shiv temple, Khirganga, Kullu.

**Collection number:** HP/KU/KH/S12.

### 15. *Nitzschia communis* Rabenhorst (Pl. 3, Fig. D)

Grunow, 1862, pg. 561, 578, pl. 12, fig. 18.

**Description:** Valves linear with rounded apices; fibula relatively large and distinct, about 10-15 in 10  $\mu\text{m}$ ; striae resolved in the light microscope but very fine; valve length 28  $\mu\text{m}$ , breadth 3  $\mu\text{m}$ ; striae 30 in 10  $\mu\text{m}$ .

**Locality:** Outflow in Hotel, Kalath, Kullu.

**Collection number:** HP/KU/KL/S4.

### 16. *Nitzschia elegantula* Grunow (Pl. 3, Fig. E)

Gandhi, H. P., 1999, pg. 62, pl. III, fig. 134-135; Karthick, B., Hamilton, P. B. & Kociolek, J. P., 2013, pl. 125.

**Description:** Valves linear-lanceolate to lanceolate; apices rounded to sub rostrate; valve length 10  $\mu\text{m}$ , breadth 3  $\mu\text{m}$ ; striae 18 in 10  $\mu\text{m}$ .

**Locality:** Outflow in Hotel, Kalath, Kullu.

**Collection number:** HP/KU/KL/S4.

### 17. *Nitzschia liebethruthii* Rabenhorst (Pl. 3, Fig. F)

Busse, S. & Snoeijis, P., 2003, pg. 42, fig. 451-464.

**Description:** Valves linear-lanceolate, with margins more or less parallel; apices attenuated, but not protracted, and narrowly rounded; central gap in the fibulae or central nodule present; fibulae distinct with a density of 10-12 in 10  $\mu\text{m}$ ; valve length 30  $\mu\text{m}$ , breadth 4.5  $\mu\text{m}$ ; striae 18 in 10  $\mu\text{m}$ .

**Locality:** Near bathing pool area, Khirganga.

**Collection number:** HP/KU/KH/S13.

### 18. *Nitzschia thermalis* (Ehrenberg) Auerswald (Pl. 3, Fig. G)

Hustedt, 1949, pg. 130, pl. 11, fig. 63-64. Gandhi, H.P., 1999, pg. 221, pl. 6, fig. 221-227.

**Description:** Valves linear with parallel edges and concave or wedge shaped narrowed, more or less protracted ends, 31  $\mu\text{m}$  long and 7  $\mu\text{m}$  broad; keel pointed small, rounded, and present throughout the margins of valve, 8-10 in 10  $\mu\text{m}$ ; striae not clearly seen in light microscope.

**Locality:** Outflow in Hotel, Kalath, Kullu.

**Collection number:** HP/KU/KL/S4.

## DISCUSSION

*Nitzschia*, *Gomphonema*, *Cymbella*, *Navicula*, *Pinnularia* and *Rhopalodia* are some common genera reported in thermal springs of India (Table 1). Diatom species of Nitrogen heterotrophic- *Nitzschia* and *Gomphonema* dominate in Kalath and Khirganga thermal springs (Table 2). It indicates water of these springs is rich in nitrogen due to pollution. Findings are supported by Bhardwaj (2012). Water temperature for these springs range between 39-48°C with neutral to slightly acidic pH. Total eighteen taxa of diatoms (Bacillariophyceae)

**Table 1:** List of Diatoms observed in thermal springs in the India.

S.N.	Name of Species	Occurrence	Reference
1.	<i>Fragilaria virescens</i> var. <i>birostrata</i> f. <i>paucicostata</i> , <i>Pinnularia santapau</i> , <i>Cymbella ehrenbergii</i> f. <i>thermalis</i> , <i>Cymbella ehrenbergii</i> var. <i>elongata</i> f. <i>orientalis</i> , <i>Hantzschia virgata</i> var. <i>lata</i> , <i>Surirella tenera</i> var. <i>indica</i> , <i>Synedra tabulata</i> var. <i>elliptica</i> f. <i>angusta</i> , <i>Diploneis hyperborea</i> f. <i>minor</i> , <i>Nitzschia sigma</i> f. <i>indica</i> , <i>Stauroneis acuta</i> var. <i>tenuis</i> f. <i>thermalis</i> , <i>Pinnularia episcopalis</i> var. <i>elongate</i> , <i>Nitzschia latestriata</i> var. <i>minor</i> f. <i>intermedia</i> , <i>Cyclotella compta</i> var. <i>irregularis</i> , <i>Diploneis smithii</i> var. <i>rhombica</i> f. <i>maior</i> , <i>Surirella robusta</i> var. <i>splendida</i> f. <i>ovate</i> , <i>Surirella desikachariensis</i>	Palli, Lasundra, Tuwa, Tooral, Rajewadi, Sav hot spring, Maharashtra	Thomas and Gonzalves (1965a,b,c,d,e,f)
2.	<i>Navicula</i> sp., <i>Cyclotella</i> sp.	Bakreswar thermal spring, West Bengal	Jana (1973)
3.	<i>Fragilaria construens</i> , <i>Fragilaria pinnata</i> , <i>Navicula cryptocephala</i> , <i>Navicula cuspidate</i> , <i>Navicula dicephala</i> , <i>Navicula variostrata</i> , <i>Stauroneis phoenicentron</i> , <i>Cymbella gastroides</i> , <i>Cymbella kolbei</i> , <i>Cymbella parva</i> , <i>Rhopalodia gibba</i>	Puga geothermal spring, Ladakh	Prasad <i>et al.</i> (1984)
4.	<i>Amphora</i> , <i>Colonies</i> , <i>Cymbella</i> , <i>Diatoma</i> , <i>Diploneis</i> , <i>Epithemia</i> , <i>Fragilaria</i> , <i>Gomphonema</i> , <i>Pinnularia</i> , <i>Synedra</i> (species not mentioned)	Potter's Hill, Lower Summer Hill and Barrier natural springs of Shimla, H.P.	Rana (1987)
5.	<i>Achnanthes lanceolate</i> var. <i>rostrata</i> , <i>Caloneis silicula</i> v. <i>minuta</i> , <i>Diploneis domblittensis</i> , <i>Anomoeoneis brachysira</i> v. <i>genuine</i> , <i>A. sphaerophora</i> , <i>Navicula viridula</i> v. <i>rostellata</i> , <i>Pinnularia brebissoni</i> v. <i>hybrid</i> , <i>Amphora coffeaeformis</i> v. <i>africana</i> f. <i>elongatum</i> , <i>A. ovalis</i> , <i>A. veneta</i> , <i>Cymbella claasseniae</i> , <i>Gomphonema parvulum</i> v. <i>exilissimum</i> , <i>Denticula thermalis</i> , <i>Nitzschia. epithemioides</i> , <i>N. hybrid</i> , <i>N. philippinarum</i> , <i>N. sigma</i> , <i>N. subtilis</i> and <i>N. Thermalis</i>	Palvani Unhahre thermal spring, Ratnagiri, Maharashtra	Kha (2014)
6.	<i>Coscinodiscus</i> sp., <i>Synedra</i> sp., <i>Pinnularia</i> sp., <i>Rhopalodia</i> sp., <i>Gomphonema</i> sp., <i>Hantzschia</i> sp.	Bakreswar thermal spring, West Bengal	Mandal and Sarkar (2015)
7.	<i>Achnanthes lanceolata</i> , <i>Cocconeis striata</i> , <i>Navicula fluens</i> , <i>Navicula microspora</i> , <i>Navicula protracta</i> , <i>Navicula exilis</i> , <i>Halamphora veneta</i> , <i>Nitzschia obtuse</i> , <i>Nitzschia vasnii</i> , <i>Rhopalodia gibberula</i> , <i>Rhopalodia operculata</i> , <i>Surirella minuta</i>	Tarabela, Taptapani, Deulajhari thermal spring, Odisha	Bhakta <i>et al.</i> (2016)
8.	<i>Melosira varians</i> , <i>Ulnaria ulna</i> , <i>Cocconeis placentula</i> , <i>Diademesis confervacea</i> , <i>Craticula halophila</i> , <i>Diploneis elliptica</i> , <i>Pinnularia microstauron</i> , <i>Anomoeoneis sphaerophora</i> , <i>Gomphonema acuminatum</i> , <i>Gomphonema olivaceum</i> , <i>Gomphonema parvulum</i> , <i>Encyonema minutum</i> , <i>Encyonema silesiacum</i> , <i>Cymbella novaezealandiana</i> , <i>Cymbella tumida</i> , <i>Didymosphaenia geminata</i> , <i>Denticula tenuis</i> , <i>Nitzschia frustulum</i> , <i>Simonsenia delognei</i>	Dirang and Kitpi hot spring, Arunachal Pradesh	Das (2019)

**Table 2:** List of Diatoms observed in two thermal springs.

S.N.	Name of species	Kalath	Khirganga	Water temperature (°C)	Water pH
1.	<i>Diatoma vulgare</i>	++	-	40	6.8
2.	<i>Pinnularia macra</i>	++	-	40	6.8
3.	<i>Caloneis gracilis</i>	-	+	48	6.6
4.	<i>Navicula cryptocephala</i>	-	+	41	6.6
5.	<i>Navicula zanonii</i>	-	+	41	6.5
6.	<i>Gomphonema parvulum</i>	+	-	43	6.8
7.	<i>Gomphonema lagenula</i>	-	+	48	6.6
8.	<i>Rhopalodia gibberula</i>	++	++	40	6.8
9.	<i>Rhopalodia musculus</i>	+++	+++	39	6.7
10.	<i>Rhopalodia gibba</i>	-	+	43	6.7
11.	<i>Nitzschia alpine</i>	+++	-	40	6.8
12.	<i>Nitzschia allansonii</i>	-	+	48	6.6
13.	<i>Nitzschia amphibia</i>	++	-	40	6.8



S.N.	Name of species	Kalath	Khirganga	Water temperature (°C)	Water pH
14.	Nitzschia capitellata	-	+	43	6.5
15.	Nitzschia communis	++	-	40.5	6.7
16.	Nitzschia elegantula	++	-	40.5	6.7
17.	Nitzschia liebethuthii	-	+++	39	6.7
18.	Nitzschia thermalis	+	-	41	6.7

(+++ = abundant, ++ = adequate, + = few, - = absent)

reported during study belonging to seven genera. Diatom flora of these thermal springs were studied first time. Species richness increases with decrease in temperature (Table 2). Genus *Rhopalodia* mainly found at higher altitudes (2000-3250 m) were recorded in Kalath and Khirganga at 39 to 48°C. Mandal and Sarkar (2015) also reported *Rhopalodia* sp. from Bakreswar thermal spring at 35 to 48°C. Diatoms are critical components of thermal spring ecosystems. They are sensitive to nutrient pollution, making them a potentially useful indicator of ecosystem change. Their species composition and biomass were affected by water quality and habitat alteration and can be informative indicators of environmental condition. Present study adds twelve new taxa to algal flora of Himachal Pradesh viz., *Navicula zanonii*, *Caloneis gracilis*, *Pinnularia macra*, *Gomphonema lagenula*, *Rhopalodia gibberula*, *R. musculus*, *Nitzschia allansonii*, *N. alpine*, *N. communis*, *N. elegantula*, *N. liebethuthii*, *N. thermalis*.

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