IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

# DIATOMOLOGICAL MAPPING OF WATER BODIES IN GEVRA, CHHATTISGARH AND ITS APPLICATION IN FORENSIC DROWNING INVESTIGATIONS

*A preliminary diatomological database of five freshwater bodies of Gevra, Korba district, for use in medico-legal drowning investigations*

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***Abstract:*** Diatoms are unicellular siliceous algae that are widely distributed in aquatic environments and possess significant ecological as well as forensic importance. Owing to their species-specific distribution and resistance to decomposition, diatoms serve as valuable biological indicators for environmental assessment and play an important role in drowning investigations. The present study was undertaken to develop a preliminary diatomological map of selected freshwater bodies in the Gevra region of Korba district, Chhattisgarh, and to evaluate its forensic significance by documenting the diversity and distribution of diatom assemblages. Water samples were collected during the summer season (June) from five freshwater bodies located at Gevra (Shiv Mandir Pond), Beltikri (Basawat Pond), Gandhinagar, Azad Chowk, and Sirki Khurd (Sarwari Pond). Samples were processed using standard acid-digestion extraction techniques, and permanent slides were prepared and examined under light microscopy. Ten freshwater diatom genera were identified — Navicula, Fragilaria, Cymbella, Encyonema, Amphipleura, Microfissurata, Brebissonia, Neidiopsis, Cyclotella and Aulacoseira. The assemblage was dominated by pennate forms, with Aulacoseira as the only centric genus recorded. Navicula was the most abundant and widely distributed genus, while Fragilaria and Aulacoseira were moderately abundant; the remaining genera showed restricted, site-specific distributions reflecting differences in habitat and environmental conditions among the sampled water bodies. The coexistence of benthic and planktonic diatoms indicated considerable ecological heterogeneity within the study area despite the influence of coal-mining activity. These findings support the concept of diatomological mapping, whereby individual water bodies can be differentiated on the basis of their characteristic diatom profile, and establish baseline data toward a regional diatom database for Chhattisgarh that can assist in comparing diatoms recovered from victim tissues with those of candidate drowning sites in medico-legal casework.

***Index Terms*** **-** Diatomological mapping, forensic diatomology, freshwater diatoms, drowning investigation, Navicula, Gevra, Korba, Chhattisgarh, environmental monitoring, forensic science.

## I. INTRODUCTION

Human identification in forensic science involves establishing the identity of an individual or associating a person with a particular environment or event using scientific evidence. In forensic diatomology, this is achieved by analysing diatoms recovered from tissues, organs, clothing or belongings and comparing them with reference water samples or diatom databases to link an individual to a specific water body or drowning site [12]. Diatoms play a significant role in criminal investigations and medico-legal examinations because their silica cell walls persist even after decomposition, making them particularly useful in cases where classical autopsy signs of drowning have degraded or are absent. Comparison of diatom assemblages recovered from victim tissues with those present in environmental water samples assists in identifying the actual drowning site, while diatoms adhering to clothing, footwear or hair can establish associations between victims, suspects and specific aquatic environments.

Drowning is defined as the process of experiencing respiratory impairment resulting from submersion or immersion in a liquid medium, and represents one of the most common causes of accidental death worldwide [1]. Diagnosing drowning at autopsy remains challenging because classical findings — frothy fluid in the airways, pulmonary oedema and water in the stomach — are non-specific and often disappear with decomposition, prolonged immersion or skeletonisation. Distinguishing ante-mortem drowning (in which active respiration and circulation carry aspirated diatoms into the bloodstream and onward to distant organs) from post-mortem immersion (in which the absence of circulation restricts diatoms mainly to external surfaces or the airway) is a further major challenge in forensic pathology [7,8]. Diatom analysis has therefore emerged as an important adjunct in the examination of decomposed, skeletonized and drowned bodies.

Diatoms (class Bacillariophyceae) are microscopic, photosynthetic algae enclosed in a siliceous cell wall, the frustule, which is highly resistant to decomposition and chemical digestion. Based on frustule symmetry, diatoms are broadly classified into centric diatoms (radial symmetry, e.g. Cyclotella, Aulacoseira) and pennate diatoms (bilateral symmetry; further divided into araphid forms such as Fragilaria, and raphid forms such as Navicula, Cymbella and Encyonema, which possess a raphe enabling gliding movement). Because diatom species composition responds to pH, temperature, nutrient availability, substrate and anthropogenic influence, different water bodies tend to carry characteristic diatom assemblages — the ecological basis on which forensic diatomological mapping rests [11,12].

Forensic use of diatoms dates to early observations of microscopic algae in drowning victims in the early-to-mid twentieth century, notably Incze's 1942 demonstration of diatoms in the internal organs of drowning victims and Timperman's work in the 1960s validating the diatom test as a means of distinguishing ante-mortem drowning from post-mortem immersion [11]. A major advance relevant to this study was the concept of Diatomological Mapping (D-Map) introduced by Thakar and Singh (2010), who systematically surveyed ten water bodies of Punjab over two years across all four seasons, identifying 51 genera and 126 species and classifying them as commonly occurring, seasonal, rare or site-specific, thereby producing water-body-specific biological fingerprints usable in drowning-site identification [12]. Although similar work has since been reported from other parts of India, no comprehensive diatomological mapping has previously been undertaken for the water bodies of Gevra, Korba district — an area whose hydrology is strongly shaped by one of Asia's largest open-cast coal mines. The present study addresses this gap by documenting the diatom flora of five representative water bodies of the Gevra region and evaluating its forensic significance.

Chhattisgarh is a mineral-rich state in central India with a diverse range of aquatic ecosystems, including rivers, ponds, reservoirs, streams, wetlands, and groundwater systems. The state experiences a tropical climate with distinct seasonal variations, particularly during summer, monsoon, and winter. These seasonal and geographical variations influence important environmental parameters such as temperature, pH, nutrient availability, dissolved oxygen, turbidity, and water flow. Since diatoms are photosynthetic microorganisms that respond to changes in their surrounding environment, variations in these conditions can influence their growth, abundance, and distribution. Therefore, the diverse aquatic habitats of Chhattisgarh provide a suitable setting for studying diatom diversity and distribution.

Korba district is one of the important industrial and coal-mining regions of Chhattisgarh. The district contains extensive coal deposits and has several large-scale mining and thermal power activities. In addition to industrial infrastructure, the region contains numerous natural and human-influenced water bodies. These include ponds, streams, reservoirs, drainage channels, and water bodies associated with mining activities. The combination of diverse aquatic habitats and substantial industrial activity makes Korba an important region for studying the relationship between environmental conditions and aquatic microorganisms such as diatoms.

**Korba Is Called Chhattisgarh's "Industrial Hub" / "Power Capital"**

Korba is often referred to as the Industrial Hub of Chhattisgarh, enriched with the essential raw materials needed for power generation — coal and water.

- Four major thermal power plants (NTPC, KTPS, BALCO & BCPP, DSPM, CSEB East, CSEB West) together generate about 3,650 MW of electricity, plus a hydroelectric station at Machadoli, Bango.
- The Gevra open-cast mine in the Korba Coalfield is the largest open-cast coal mine in India and the second largest in Asia, producing around 140 million tonnes of coal a year about 17% of India's total coal output and 85% of Chhattisgarh's coal production.
- SECL (a profitable subsidiary of Coal India Limited) operates many of its key mines in the district, and BALCO — the single largest aluminium producer at one location in the country — is also based here.
- The NTPC Korba Super Thermal Power Plant alone draws coal from the Kusmunda and Gevra mines and uses the Hasdeo River as its cooling-water
- source.

So Gevra isn't just "a mining town" — it's the coal-supply engine for a cluster of power plants and an aluminium smelter, all drawing on and discharging into the same local water network your ponds belong to.

**Why This Industrial Setting Matters for Diatom Growth**

This is the ecological link worth spelling out in your discussion section. Diatoms are unusually sensitive, fast-responding bioindicators, and several well-documented mechanisms connect coal/power-industry activity to the kind of assemblage differences you found across your five ponds:

- **Fly ash and coal-combustion effluent**: studies of ash-basin effluent from coal-fired power plants have shown reduced biotic diversity at affected sites, with abiotic parameters like temperature, turbidity, dissolved oxygen and pH all shifting, and metal leachates (Cd, Cr, Cu, Hg, Zn) building up in the water and biota.
- **Heavy-metal loading from mining**: diatom communities have been shown to carry a marked, lasting signature of heavy-metal contamination in water and sediment following mine-related pollution events, and more broadly diatoms respond to elevated metal concentrations both at the community level — with tolerant taxa replacing sensitive ones — and at the individual level, through frustule and cell-shape abnormalities. SpringerScienceDirect

- **Acid mine drainage**: streams receiving acid mine drainage typically show reduced diatom abundance, with green algae becoming dominant instead — relevant to the acidic-seepage explanation you floated for the Azad Chowk/Beltikri assemblage. ResearchGate
- **Fly-ash pH dependency**: the leaching of trace heavy metals from fly ash is strongly pH-dependent, with most metals leaching more readily as pH decreases — so ash-pond chemistry can vary a lot depending on local conditions, which helps explain why your five ponds (all within a few km of each other) showed such different assemblages rather than one uniform "mine-influenced" signature.
- it's very plausibly the reason your five ponds, despite being close together, produced genuinely different diatom profiles. Each pond likely sits at a different point in a gradient of turbidity, metal load, pH and thermal/nutrient input created by the surrounding mining and power infrastructure.

The **Gevra region of Korba district** is particularly significant because of the extensive open-cast coal-mining activities in the area. Mining can modify the surrounding landscape and influence nearby aquatic systems through mine-water discharge, surface runoff, suspended particles, and changes in drainage patterns. The region may also receive inputs associated with industrial, domestic, and agricultural activities. These influences can alter physicochemical characteristics of water, including pH, turbidity, electrical conductivity, total dissolved solids, nutrient concentrations, and dissolved oxygen. The dissertation document specifically notes that coal-mine runoff, suspended coal dust, fly ash, industrial wastewater, domestic sewage, and agricultural runoff may contribute to changes in these environmental characteristics.

Such environmental variation is important for **diatom growth and distribution** because diatoms are closely associated with the physical and chemical characteristics of their aquatic habitats. Different genera have different environmental tolerances and ecological preferences. For instance, changes in pH, nutrient availability, water movement, light penetration, substrate characteristics, and dissolved oxygen can influence which diatom taxa are able to grow successfully in a particular water body. Consequently, two water bodies located relatively close to one another may contain different diatom assemblages because their environmental conditions are not identical.

The industrial nature of the Gevra region therefore does not simply mean that industrial activity increases or decreases diatom growth. Rather, **industrial and mining activities can modify the environmental conditions that determine diatom growth and community composition**. Some diatom taxa may tolerate or benefit from particular changes in nutrient availability or water chemistry, whereas other taxa may become less abundant under those conditions. This can produce differences in the relative abundance and distribution of diatom genera between sampling locations.

This environmental heterogeneity is particularly relevant to your **diatomological mapping study**. By documenting the diatom genera occurring in different water bodies of the Gevra region, the study establishes a preliminary record of the diatom assemblages associated with individual locations. If particular combinations of genera or abundance patterns are consistently associated with particular water bodies, these profiles can serve as **regional reference information**. Such information has potential forensic importance because, in a drowning investigation, diatoms recovered from a victim may be compared with diatoms present in suspected water bodies. Therefore, the environmental diversity created by the natural and industrial characteristics of Gevra provides a useful basis for developing a preliminary diatomological map and establishing baseline data for future forensic investigations.

## II. REVIEW OF LITERATURE

### 2.1 International and National Studies

International studies on fabric-associated diatoms have shown that diatoms can transfer to and be recovered from clothing, with hydrogen-peroxide digestion yielding the highest recovery and prolonged immersion increasing diatom attachment, supporting the use of diatoms as trace evidence linking victims or suspects to specific aquatic environments. Review literature on forensic diatomology has similarly emphasized the value of diatoms as reliable geographical tracers and highlighted the growing role of automated scanning electron microscopy and DNA barcoding in improving identification accuracy.

Within India, Thakar and Singh's (2010) Diatomological Mapping of Punjab's water bodies remains the foundational national study, establishing that every water body possesses a characteristic diatom assemblage that can serve as a biological fingerprint for drowning-site identification [12]. Subsequent autopsy-based work in Punjab analysing fifty suspected drowning cases detected diatoms in 86% of cases, with genera recovered from internal organs (including Synedra, Achnanthidium, Aulacoseira, Pinnularia and Navicula) closely matching those of the recovery-site water. Studies on the Ganga River at Vindhyachal and on water bodies of Jaipur, Rajasthan, have similarly reported site-specific diatom occurrence — in the latter, Navicula occurred at every site sampled while Melosira showed a restricted distribution — reinforcing the principle that diatom mapping can distinguish individual water bodies.

### 2.2 Studies from Chhattisgarh and the Research Gap

Regional work in Chhattisgarh has documented diatom diversity in ponds of Durg district and across the Mahanadi, Kharun, Shivnath, Doodhnadi and Hasdeo river systems (34 genera identified, including Navicula, Nitzschia, Pinnularia, Cymbella, Synedra, Fragilaria, Eunotia and Cyclotella), as well as phytoplankton-based trophic assessment of Bango Dam, Korba, which recorded sixty-six algal species (including pennate and centric diatoms) and classified the reservoir as highly eutrophic. These studies confirm that diatom assemblages in Chhattisgarh vary with geography, climate and water chemistry, underscoring the need for locally generated reference data. However, no diatomological mapping had previously been carried out for the aquatic ecosystems of Gevra, where large-scale open-cast coal mining is likely to impose a distinct hydro-chemical signature on local water bodies not captured by existing state-level surveys. The present study was designed to close this specific gap.

## III. STUDY AREA AND METHODOLOGY

### 3.1 Study Area

The study was conducted in the Gevra region of Korba district, Chhattisgarh (approximately 22°35' N, 82°68' E; mean elevation ~252 m), encompassing localities such as Gevra, Dipka, Beltikri, Sirki Khurd and Azad Chowk. The area is dominated by the Gevra Open-Cast Coal Mine, operated by South Eastern Coalfields Limited (SECL), one of the largest coal mines in Asia. The local water bodies form a mosaic of natural/semi-natural habitats — village ponds, seasonal ponds, streams and tributaries associated with the Hasdeo River system — and anthropogenic/mine-associated water bodies, including mine-pit lakes, settling/sedimentation ponds, rainwater accumulation pits and water-filled abandoned mining voids. The climate is tropical monsoonal with three distinct seasons (hot dry summer, March-June; south-west monsoon, June-September, ~1300-1500 mm annual rainfall; and mild winter, November-February). Coal mining, associated fly ash and coal-dust runoff, industrial wastewater and, seasonally, domestic sewage and agricultural runoff can alter the nutrient status, turbidity, pH, conductivity and heavy-metal content of the local water bodies, which is expected to influence which diatom taxa become dominant at a given site.

### 3.2 Sample Collection

Five water bodies representative of the study area were selected for sampling: Shiv Mandir Pond (Gevra), Basawat Pond (Beltikri), Gandhinagar Pond, Azad Chowk Pond, and Sarwari Pond (Sirki Khurd). Surface water/periphyton grab samples were collected from each site during the summer season (June) in labelled, sterile sample containers, with sampling stations positioned to capture both the limnetic (open-water) zone and the littoral margins of each water body, since the limnetic zone typically carries the highest concentration of planktonic diatoms while littoral stations better represent benthic/attached forms.

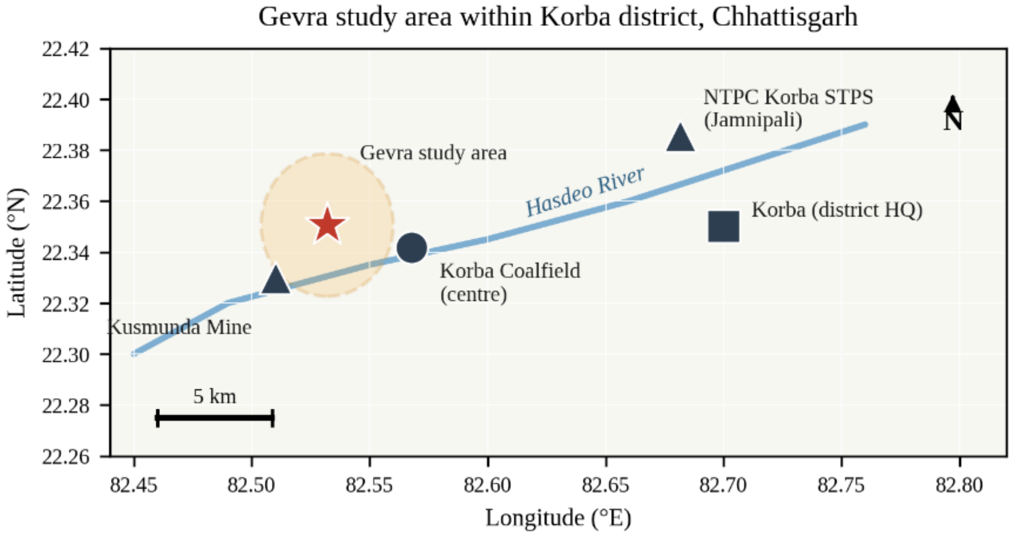
| Sl. No. | Water Body | Locality | Habitat Type |
|---|---|---|---|
| 1 | Shiv Mandir Pond | Gevra | Village pond, near mine periphery |
| 2 | Basawat Pond | Beltikri | Village pond |
| 3 | Gandhinagar Pond | Gandhinagar | Settlement-associated pond |
| 4 | Azad Chowk Pond | Azad Chowk / Jhawar | Urban/peri-urban pond |
| 5 | Sarwari Pond | Sirki Khurd / Rati Nagar | Village pond, mine-influenced catchment |

**Table 1: Water bodies selected for sampling in the Gevra region**

### 3.3 Sample Processing and Identification

Samples were processed using the standard acid-digestion method for diatom extraction: sub-samples were digested using concentrated nitric acid with gentle heating to oxidise organic matter, cooled, and centrifuged at 3000-5000 rpm for 10-15 minutes; the supernatant was discarded and the residual pellet washed repeatedly with distilled water to remove acid residues. Cleaned sediment was mounted on glass slides and examined under a light microscope, initially at low magnification (10x) followed by detailed examination at 40x and 100x (oil immersion). Diatoms were identified to genus level on the basis of valve shape, symmetry, raphe structure and striae pattern, using standard taxonomic literature and cross-referenced against online diatom taxonomic resources.


**(A)**




**(B)**

**Fig. 1: (A) Location of Chhattisgarh within India; (B) Korba district showing Gevra and surrounding localities**

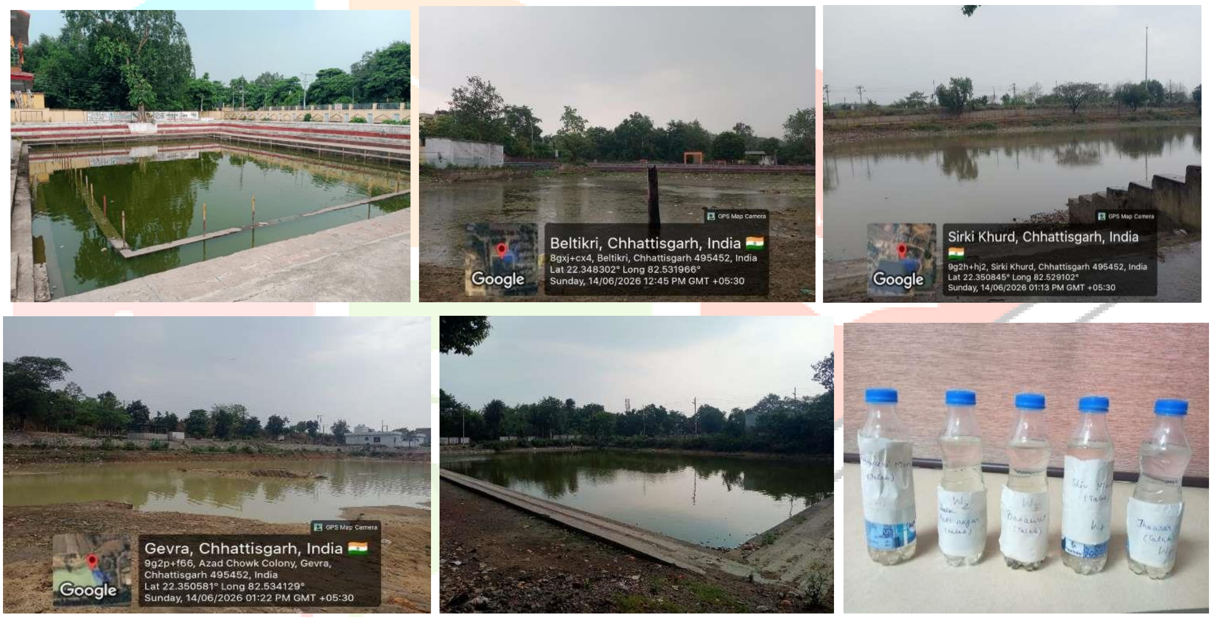



**Fig. 2: Sampling sites - Shiv Mandir Pond, Basawat Pond, Gandhinagar Pond, Azad Chowk Pond, Sarwari Pond, and water sample collection**

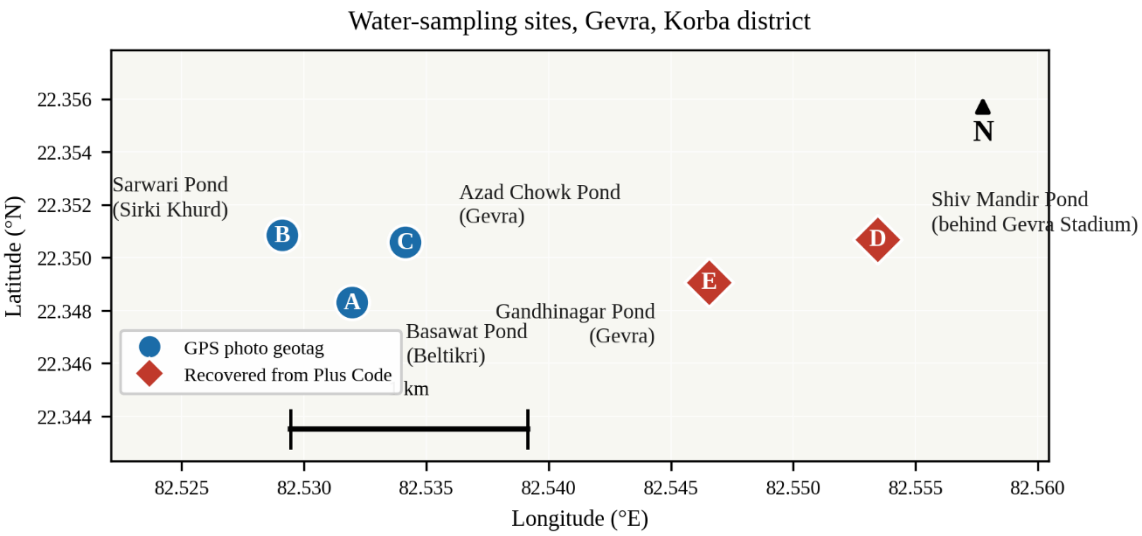



**Fig 3: Sampling sites around the Gevra coal mining complex**

**Test performed**

**1. Water sample collection**

- Collect a known volume of water from the selected sampling point.
- For a limnetic sample, collect water from the **open-water zone**, away from the immediate shoreline.
- Record the sampling site, date, time, depth, and environmental conditions.

**2. Concentration of the sample**

- Filter the measured water volume through an appropriate plankton/diatom net or membrane filter.
- Alternatively, allow the sample to settle and collect the sedimented material.
- Transfer the concentrated material into a clean centrifuge tube.

**3. Centrifugation**

- Centrifuge the concentrated sample to separate the particulate fraction.
- Discard the supernatant carefully and retain the pellet containing diatoms and other particulate material.

**4. Digestion / removal of organic matter**

For a conventional **hydrogen-peroxide digestion**, which is generally suitable when the objective is to preserve diatom morphology:

- Add hydrogen peroxide to the concentrated sample.
- Allow oxidation of the organic material.
- Gentle heating may be used to accelerate digestion, following the validated laboratory protocol.
- Continue until most of the organic material has been removed and a relatively clean diatom-rich residue remains.

**5. Washing**

- Centrifuge the digested material.
- Carefully remove the supernatant.
- Add distilled/deionized water.
- Resuspend and centrifuge again.
- Repeat the washing process until residual reagent is adequately removed.

**6. Final concentration**

- Retain the cleaned pellet containing the diatom frustules.
- Resuspend it in a small, known volume of distilled water.

**7. Slide preparation**

- Place a small drop of the suspension onto a clean microscope slide.
- Allow it to dry evenly.
- Mount using an appropriate permanent mounting medium if permanent slides are required.

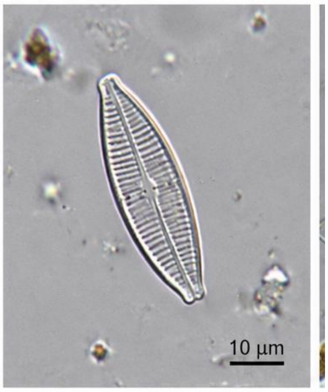
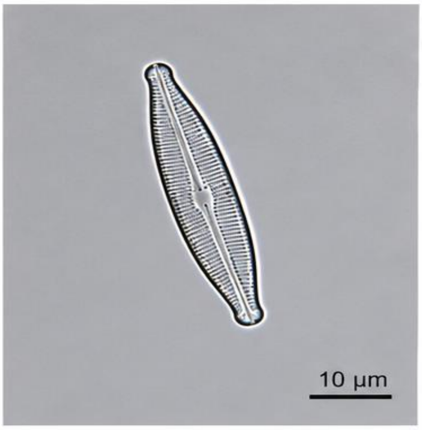
### 8. Microscopic examination

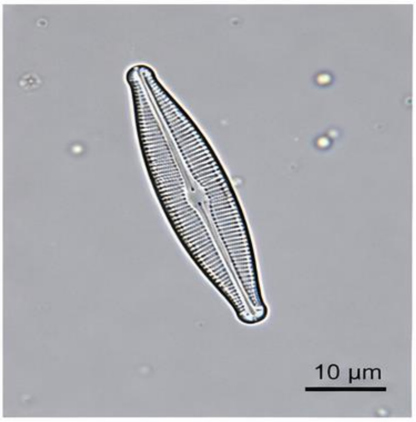
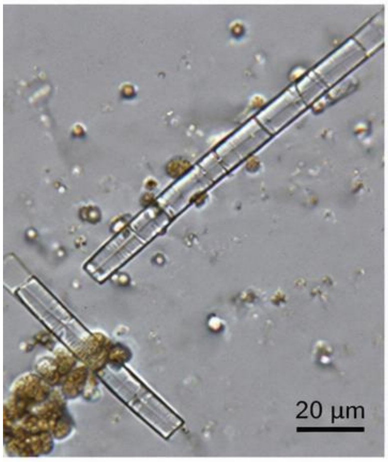
- Examine initially under low magnification.
- Examine characteristic structures at higher magnification.

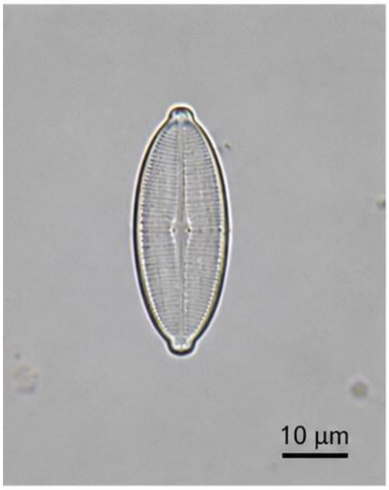
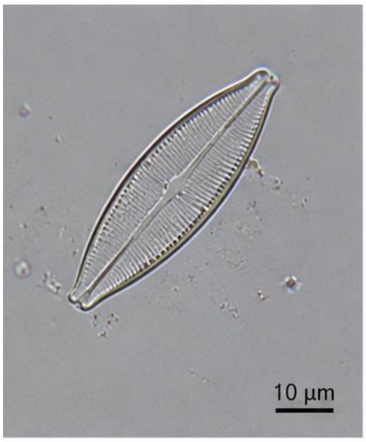
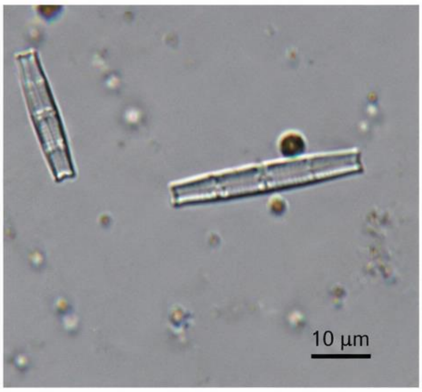
### 9. Identification

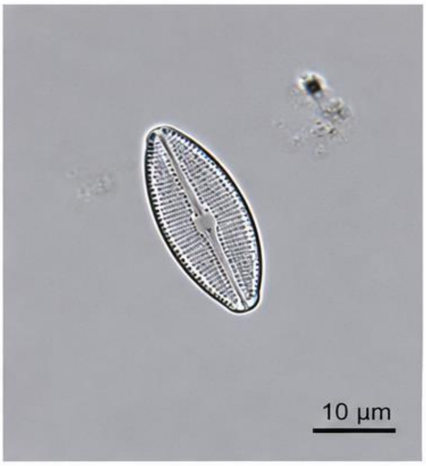
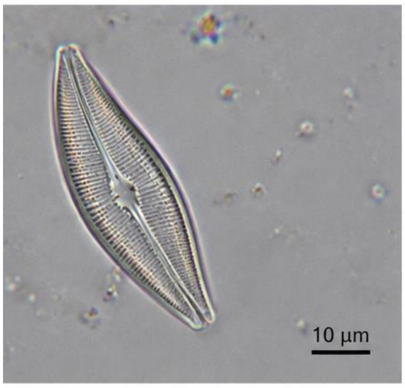
- Compare morphological characteristics with appropriate taxonomic keys/reference databases.
- Identify the diatoms to genus or species level where morphology permits.

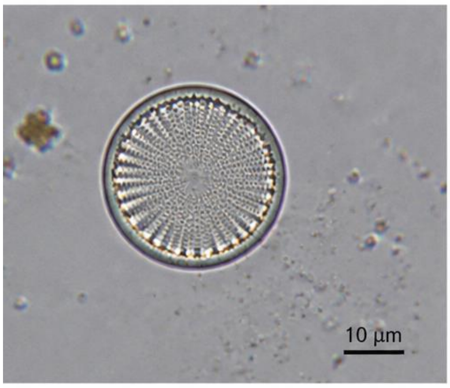
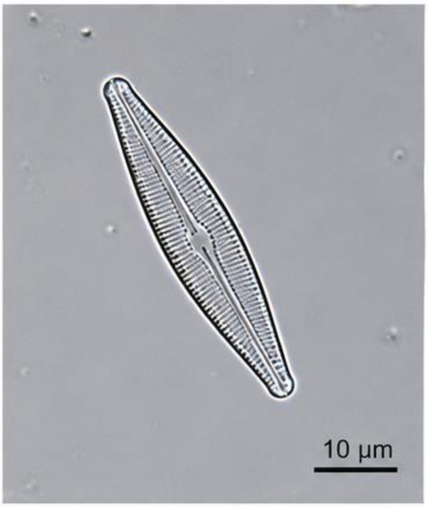
**Table 1. Morphological Characteristics and Taxonomic Classification of Identified Diatom Species**

| Photomicrograph | Genus | Type | Valve Shape | Classification |
|---|---|---|---|---|
|  *Navicula rhynchotella* | *Navicula* | Pennate | Lanceolate (boat-shaped) | **Empire -** Eukaryota<br>**Kingdom -** Chromista<br>**Phylum -** Bacillariophyta<br>**Class -** Bacillariophyceae<br>**Subclass -** Bacillariophycidae<br>**Order -** Naviculales<br>**Family -** Naviculaceae<br>**Genus -** Navicula |
|  *Navicula longicephala* | *Navicula* | Pennate | Lanceolate (boat-shaped) | **Empire -** Eukaryota<br>**Kingdom -** Chromista<br>**Phylum -** Bacillariophyta<br>**Class -** Bacillariophyceae<br>**Subclass -** Bacillariophycidae<br>**Order -** Naviculales<br>**Family -** Naviculaceae<br>**Genus -** Navicula |

| Photomicrograph | Genus | Type | Valve Shape | Classification |
|---|---|---|---|---|
|  *Navicula caterva* | *Navicula* | Pennate | Lanceolate (boat-shaped) | **Empire** - Eukaryota<br>**Kingdom** - Chromista<br>**Phylum** - Bacillariophyta<br>**Class** - Bacillariophyceae<br>**Subclass** - Bacillariophycidae<br>**Order** - Naviculales<br>**Family** - Naviculaceae<br>**Genus** - Navicula |
|  *Navicula galloe* | *Navicula* | Pennate | Lanceolate (boat-shaped) | **Empire** - Eukaryota<br>**Kingdom** - Chromista<br>**Phylum** - Bacillariophyta<br>**Class** - Bacillariophyceae<br>**Subclass** - Bacillariophycidae<br>**Order** - Naviculales<br>**Family** - Naviculaceae<br>**Genus** - Navicula |
|  *Aulacoseira herzogii* | *Aulacoseira* | Centric | Cylindrical, circular in valve view | **Empire** - Eukaryota<br>**Kingdom** - Chromista<br>**Phylum** - Bacillariophyta<br>**Class** - Coscinodiscophyceae<br>**Order** - Aulacoseirales<br>**Family** - Aulacoseiraceae<br>**Genus** - Aulacoseira |

| Photomicrograph | Genus | Type | Valve Shape | Classification |
|---|---|---|---|---|
|  *Neidoipsis hamiltonii* | *Neidiopsis* | Pennate, raphid | Linear to linear-lanceolate, often with rostrate or capitate ends | **Empire** - Eukaryota<br>**Kingdom** - Chromista<br>**Phylum** - Bacillariophyta<br>**Class** - Bacillariophyceae<br>**Subclass** - Bacillariophycidae<br>**Order** - Naviculales<br>**Suborder** - Neidiineae<br>**Family** - Neidiaceae<br>**Genus** - Neidiopsis |
|  *Brebissonia lanceolata* | *Brebissonia* | Pennate | Lanceolate | **Empire** - Eukaryota<br>**Kingdom** - Chromista<br>**Phylum** - Bacillariophyta<br>**Class** - Bacillariophyceae<br>**Subclass** - Bacillariophycidae<br>**Order** - Cymbellales<br>**Family** - Cymbellaceae<br>**Genus** - Brebissonia |
|  *Microfissurata australis* | *Microfissurata* | Pennate | Linear to lanceolate | **Empire** - Eukaryota<br>**Kingdom** - Chromista<br>**Phylum** - Bacillariophyta<br>**Class** - Bacillariophyceae<br>**Subclass** - Bacillariophycidae<br>**Order** - Naviculales<br>**Family** - Naviculales incertae sedis<br>**Genus** - Microfissurata |

| Photomicrograph | Genus | Type | Valve Shape | Classification |
|---|---|---|---|---|
|   *Cymbella affinis* | *Cymbella* | Pennate | Dorsiventral, semi-lanceolate | **Empire -** Eukaryota<br>**Kingdom -** Chromista<br>**Phylum -** Bacillariophyta<br>**Class -** Bacillariophyceae<br>**Subclass -** Bacillariophycidae<br>**Order -** Cymbellales<br>**Family -** Cymbellaceae<br>**Genus -** Cymbella |
|   *Cymbella mexicana var. kamtschatica* | *Cymbella* | Pennate | Dorsiventral, semi-lanceolate | **Empire -** Eukaryota<br>**Kingdom -** Chromista<br>**Phylum -** Bacillariophyta<br>**Class -** Bacillariophyceae<br>**Subclass -** Bacillariophycidae<br>**Order -** Cymbellales<br>**Family -** Cymbellaceae<br>**Genus -** Cymbella |
|   *Cymbella affiniformis* | *Cymbella* | Pennate | Dorsiventral, semi-lanceolate | **Empire -** Eukaryota<br>**Kingdom -** Chromista<br>**Phylum -** Bacillariophyta<br>**Class -** Bacillariophyceae<br>**Subclass -** Bacillariophycidae<br>**Order -** Cymbellales<br>**Family -** Cymbellaceae<br>**Genus -** Cymbella |

| Photomicrograph | Genus | Type | Valve Shape | Classification |
|---|---|---|---|---|
|   *Cyclotella atomus* | *Cyclotella* | Centric | Circular | **Empire -** Eukaryota<br>**Kingdom -** Chromista<br>**Phylum -** Bacillariophyta<br>**Class -** Thalassiosirophyceae<br>**Subclass -** Thalassiosirophycidae<br>**Order -** Thalassiosirales<br>**Family -** Thalassiosiraceae<br>**Genus -** Cyclotella |
|   *Encyonema hamsherae* | *Encyonema* | Pennate | Dorsiventral, slightly curved | **Empire -** Eukaryota<br>**Kingdom -** Chromista<br>**Phylum -** Bacillariophyta<br>**Class -** Bacillariophyceae<br>**Subclass -** Bacillariophycidae<br>**Order -** Cymbellales<br>**Family -** Encyonemataceae<br>**Genus -** Encyonema |
|   *Kobayasiella jaagi* | *Kobayasiella* | Pennate | Linear-lanceolate | **Empire -** Eukaryota<br>**Kingdom -** Chromista<br>**Phylum -** Bacillariophyta<br>**Class -** Bacillariophyceae<br>**Subclass -** Bacillariophycidae<br>**Order -** Naviculales<br>**Family -** Naviculales incertae sedis<br>**Genus -** Kobayasiella |

| Photomicrograph | Genus | Type | Valve Shape | Classification |
|---|---|---|---|---|
| <br>*Amphipleura pellucida* | *Amphipleura* | Pennate (Raphid) | Very narrow linear-lanceolate | **Empire -** Eukaryota<br>**Kingdom -** Chromista<br>**Phylum -** Bacillariophyta<br>**Class -** Bacillariophyceae<br>**Subclass -** Bacillariophycidae<br>**Order -** Mastogloiales<br>**Family -** Amphipleuraceae<br>**Genus -** Amphipleura |

**IV. RESULTS**

Microscopic examination of the five water samples collected during the summer (June) sampling revealed the presence of nine freshwater diatom genera, belonging predominantly to the pennate diatoms, along with one centric genus. The genera identified were Navicula, Fragilaria, Cymbella, Encyonema, Amphipleura, Microfissurata, Brebissonia, Neidiopsis and Aulacoseira. Eight of the nine genera recorded were pennate diatoms; Aulacoseira was the only centric diatom encountered, occurring as chain-forming cylindrical cells typical of standing or slow-moving water.

Navicula was the most abundant and widely distributed genus, recorded at the majority of sampling sites and indicating broad ecological tolerance. Fragilaria and Aulacoseira were moderately abundant. The remaining genera - Cymbella, Encyonema, Amphipleura, Microfissurata, Brebissonia and Neidiopsis - occurred in comparatively low abundance and showed restricted, site-specific distributions. The coexistence of benthic (e.g. Cymbella, Encyonema) and planktonic (e.g. Aulacoseira) forms indicated considerable ecological heterogeneity across the five water bodies despite their shared location within a coal-mining landscape.

| Site | Genera Identified |
|---|---|
| Sarwari Pond (Sirki Khurd) | *Navicula, Aulacoseira, Fragilaria* |
| Rati Nagar Pond (Sirki Khurd) | *Navicula, Neidiopsis* |
| Shiv Mandir Pond (Gevra) | *Navicula, Cymbella* |
| Azad Chowk / Jhawar Pond | *Amphipleura, Cyclotella, Encyonema, Kobayasiella* |
| Basawat Pond (Beltikri) | *Microfissurata* |

**Table 2: Site-wise distribution of diatom genera identified in the Gevra water bodies**

| Diatom Genus | Morphological Type | Relative Occurrence |
|---|---|---|
| *Navicula* | Pennate (raphid) | High |
| *Fragilaria* | Pennate (araphid) | Moderate-High |
| *Cymbella* | Pennate (raphid) | Moderate |
| *Aulacoseira* | Centric | Moderate |
| *Encyonema* | Pennate (raphid) | Low-Moderate |
| *Amphipleura* | Pennate (raphid) | Low |
| *Microfissurata* | Pennate (raphid) | Low |
| *Brebissonia* | Pennate (raphid) | Low |
| *Neidiopsis* | Pennate (raphid) | Low |

## V. DISCUSSION

### 5.1 Dominance of Certain Genera

The dominance of Navicula across the sampled water bodies is consistent with its known ecological adaptability and broad tolerance of variation in pH, nutrient concentration and water quality, and mirrors its reported dominance in other freshwater surveys of Chhattisgarh. Fragilaria and Aulacoseira, both associated with nutrient-rich or standing-water conditions respectively, were also comparatively abundant, suggesting the presence of stable aquatic habitats capable of supporting both attached and planktonic diatom communities alongside the mine-influenced hydrology of the region.

### 5.2 Site-Specific Distribution

Diatom assemblages varied appreciably among the five sampling sites (Table 2). While Navicula was recorded across most sites, genera such as Microfissurata (Basawat Pond only) and the Amphipleura-Cyclotella-Encyonema-Kobayasiella assemblage (Azad Chowk only) showed clearly restricted, site-specific occurrence. This pattern is consistent with differences in nutrient availability, sediment type, water depth, flow and the degree of mine-related influence among the five ponds, and supports the central premise of diatomological mapping: that each water body carries a distinguishable diatom profile.

### 5.3 Environmental Interpretation: Influence of Mining Activity

The Gevra mining complex does not present a single, uniform water chemistry; rather, it forms a mosaic of neutral-to-alkaline settling ponds, acidic seepage pools associated with pyrite oxidation, and locally fresher groundwater-breach inflows. This heterogeneity plausibly explains why genera with contrasting ecological preferences were recovered within a short distance of one another. Motile Navicula species are well suited to the high-turbidity, silt- and coal-dust-laden runoff typical of settling basins; Cymbella and Brebissonia, which anchor to substrates using mucilaginous stalks, are favored by the elevated calcium and water hardness associated with weathering of overburden; and the more acid-tolerant or low-conductivity-associated taxa recorded at Azad Chowk and Beltikri (e.g. Kobayasiella-type and Encyonema/Neidiopsis-type occurrences) are consistent with locally acidic drainage or fresher groundwater inflow points. Table 4 summarises this interpretation as a working hypothesis linking water condition to the dominant genera observed; it should be treated as indicative rather than confirmed, since it is based on general diatom ecology and the documented physico-chemical character of Korba coal-mine waters rather than on physico-chemical measurements taken alongside the present diatom samples.

| Water Condition | Likely Chemical Driver | Genera Associated in this Study |
|---|---|---|
| High silt / coal-dust turbidity | Suspended solids | *Navicula spp.* |
| Alkaline overburden runoff | High Ca2+ / TDS | *Cymbella spp., Brebissonia lanceolata* |
| Industrial/domestic nutrient input | Dissolved phosphorus/nitrogen | *Cyclotella-type forms* |
| Acid mine drainage seepage | Low pH (pyrite oxidation) | *Kobayasiella-type, Fragilaria* |
| Fresh groundwater-breach inflow | Low conductivity | *Encyonema, Neidiopsis hamiltonii* |

**Table 4: Working interpretation of water condition and associated diatom genera in the Gevra mining complex**

### 5.4 Forensic Significance

The identification of distinct diatom assemblages across the five Gevra water bodies is the practical basis for forensic diatomological mapping. Because each aquatic environment surveyed carries a recognisably different diatom profile - ranging from the broadly distributed Navicula to the site-restricted Microfissurata and the Azad Chowk-specific assemblage - a diatom profile recovered from a drowning victim's tissues in this region could, in principle, be compared against this baseline to support both the diagnosis of ante-mortem drowning and the identification of the probable drowning site. The presence of both common genera (Navicula, Fragilaria) and site-specific genera (Amphipleura, Brebissonia, Neidiopsis, Microfissurata) increases the discriminatory value of the resulting reference set for medico-legal comparison, though it should be read alongside autopsy and circumstantial findings rather than as a stand-alone determinant, consistent with current guidance on the evidentiary weight of diatom findings [7].

### 5.5 Comparison with Previous Studies

The predominance of Navicula recorded in this study is consistent with its reported dominance in other freshwater diatom surveys of Chhattisgarh and with its widespread occurrence in the Jaipur water-body study, where it was likewise recorded at every site sampled. The broader finding - that each water body carries a distinguishable diatom assemblage - is consistent with Thakar and Singh's (2010) foundational D-Map study in Punjab and with subsequent autopsy-based work demonstrating close correspondence between diatoms recovered from drowning victims and those of the recovery-site water [12]. The present results extend this body of work specifically to a coal-mining-influenced landscape, for which no prior diatomological reference existed.

## VI. CONCLUSION

The present study documented the diatom flora of five freshwater bodies in the Gevra region of Korba district, Chhattisgarh, during the summer season, identifying nine genera - Navicula, Fragilaria, Cymbella, Encyonema, Amphipleura, Microfissurata, Brebissonia, Neidiopsis and Aulacoseira - dominated by pennate forms with Aulacoseira as the sole centric genus. Navicula was the most abundant and widely distributed genus, while several genera showed restricted, site-specific occurrence, demonstrating that individual water bodies within the Gevra mining landscape can be differentiated on the basis of their characteristic diatom assemblage. These findings establish a preliminary diatomological database for Gevra and support the broader concept of diatomological mapping as a tool for drowning-site identification and medico-legal casework in this region. Given that the present survey was limited to a single (summer) season and five sites, seasonal resampling, physico-chemical characterisation of each water body, a larger number of sampling stations, and confirmatory identification by scanning electron microscopy or molecular methods are recommended to strengthen and extend this baseline into a fully validated regional forensic reference database for Chhattisgarh.


## ACKNOWLEDGMENT

I am profoundly grateful to my dissertation guide **Dr. P.K. Soni (SO),** Regional Forensic Science Laboratory (RFSL), **Bilaspur,** for granting me the opportunity to carry out this research work at the laboratory for his invaluable guidance, constant encouragement, constructive suggestions, and unwavering support throughout the course of this study. I am sincerely grateful to the **Laboratory Technicians of the Regional Forensic Science Laboratory (RFSL), Bilaspur**, for their technical assistance, support in laboratory procedures, and prompt cooperation throughout the study. Their assistance was invaluable in the successful completion of the experimental work. I am grateful to all those who directly or indirectly contributed to this research by extending their support and cooperation whenever required.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