Diatom Fingerprinting to Ascertain Death in Drowning Cases

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Abstract

Diatoms are unicellular microorganisms which are commonly found in almost all water bodies. Their silica wall plays important tool in forensic diatomology. Diatom test has been widely applied to detect post mortem or antemortem drowning and comparing the diatoms found in biological sample with those found in water sample confirms that death took place, probably in same water medium. However, in skeletonized stage or dismemberment of body parts at different location, diatom of specific kind helps to link the place of drowning. Diatom fingerprinting was thus created studied for 2 years in water bodies of Haryana to differentiate commonly, least commonly found and seasonal diatoms. A total of 111 species and their 55 genera of diatoms were identified. Diatom genera which were commonly found at the all ten sites were Achnanthes, Asterionella, Aulacoseira, Cyclotella, Gomphonema, Navicula, Nitzschia, Synedra and Tabularia. Some of the diatoms were site specific such as, Cymatopleura, Opephora, and Capartogramma and Cyclotella. A new genus of diatom was discovered Eunucymbellarania vandana, which thus make it site specific. Study of seasonal and site specific diatoms at different sites may help in indicating time of drowning along with the location of drowning which would be very helpful for the scientific forensic investigation of drowning cases.

Keywords: Diatom fingerprinting; Haryana; Drowning

Introduction

Every year in India, along with other cause of death “Drowning” plays a major role; it may be Accidental, Suicidal or Homicidal Drowning. Drowning is a type of asphyxial death in which the respiration is inhibited by submersion in a fluid, and it is not necessary whether the fluid is aspirated into the lungs or not.

The diagnosis of drowning for bodies freshly retrieved from water is mainly based on some “drowning signs”, such as the presence of fine froth at the mouth or nostrils, petechial haemorrhages, impression of ribs on lungs, oedemaous lungs and some other histo-pathological findings. For the decomposed corpses and skeletonised body found in water, however, the diagnosis of drowning is rather difficult because those “drowning signs” were destroyed. Here diatom test stands as the only direct screening test for drowning [1].

The principle behind the “diatom test” is when drowning takes place the diatoms present in medium, enter through ruptured capillaries via penetration into the alveolar system, subsequently to blood stream and further distant organs and other body tissues, it is here diatom test seeks as golden standard test in forensic investigation to detect antemortem or postmortem drowning. The utility of the diatom test for drowning using femoral bone marrow was calculated in a series of 29 cases of drowning were analyzed and emphasize for the usefulness of the diatom-test to find the manner of death and stressed on the collaboration between forensic pathologists and specialist- biologists, who could work together to generate the diatomologic map of the water bodies of that region. In this way, some rare types of diatoms can be identified and located, which can be of great help in pinpointing the actual site of drowning [4].

The presence of diatoms can be established and analyzed both quantitatively and qualitatively through a diatom test. This can lead not only to a more direct determination of the cause of death, but also can help to pinpoint the site of a suspected drowning [5].

Continuous monitoring of water bodies for the percentage bloom of diatom flora and its taxonomy is very essential every year. Since due to climate changes there is variability in diatom flora, which serves as an effective tool to diagnose death due to drowning [6]. Many time body get drifted to some other place either due to water current or otherwise. In such cases if a thorough monitoring of diatom flora of a particular body is recorded, it becomes possible to locate site and season of drowning. For this purpose database of most commonly occurring, site specific, and seasonal occurring diatoms was constituted along with the shape and size resulting into the formation of a fingerprinting system for diatoms.

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Materials and Methods

Sampling of water from different water bodies of Haryana

Two liter water sample was collected in a sterilized plastic bottle from ten different water bodies (Table 1) of Haryana (Figure 1) every month for a period of two years (2008-2010). At the time of sampling, temperature, pH and conductivity was measured using pH-conductivity probe (Swastika ltd., India). Site of sample collection was located by landmarks such as tree, stone or simply a flag.

The water sample was brought in the laboratory and was stored in a cool dark place, to it was added 1 ml of 0.2% formalin to restrict further division and growth. Slide was prepared by Lugol’s iodine method given by Witzel and Likens [7] and under Compound microscope attached with camera (Leica DM 2500) at 100x (Oil immersion) slide was observed and there morphological and morphometric studies were done using LAS EZ software provided with the microscope.

Morphological identification

Acquired images of diatoms were identified using identification keys of Hans [2,8-19].

Distribution pattern and variation of different types of diatoms in all the three types of water bodies (canal, lake and pond) was characterized as follows:

- Commonly occurring or Dominating diatoms
- Least occurring or Site specific diatoms
- Seasonal or Rarely occurring diatoms

Commonly occurring (dominating) diatoms, are defined as the diatoms found in large percentage than others, and mostly they were present in all seasons at all the sites. Least occurring diatoms were those which were generally present in all the seasons but there count was less than the dominating ones thus are site specific. Rarely occurring diatoms one those which were observed only in particular season thus also known as seasonal diatom (Plate 1).

Results and Discussion

Diatoms are sensitive to changes in pH, conductivity, temperature, and thus variation in the water quality enables them to function as environmental, ecological and forensic indicators. For two consecutive years study of Diatoms from different water bodies of Haryana from ten water bodies (Table 1) was done and a total 111 diatom taxa were studied [6]. The most commonly found diatom at all the ten sites were Achnanthes, Asterionella, Aulacoseira, Cyclotella, Gymnophona, Navicula, Nitzschia, Synedra and Tabularia.

Canal sites (H1, H2 and H6)

The commonly occurring diatoms at the canal water bodies were Asterionella, Cocconeis, Cymbella, Navicula. Site specific diatom at H1 was Cymatopleura, Opephora, and Capartogramma at H2 Catenula, Didymosphenia, Stenopterobia and at H6 it was Denticula, Luticola, and Staurosira. Seasonal diatom at H1 was Opephora, at H2 was Catenula, and at H6 it was Luticola.

Lake sites (H4, H5 and H9)

The commonly occurring diatoms at lake water bodies were Asterionella, Cyclotella, and Cymbella where as the site specific at H4 was Brachysira and Thalassiosira, at H5 it was Licmophora and Rhopalodia, and at H9 it was Denticula and Reimeria. Seasonal diatom at H4 was Actinocyclus, at H5 was Eunocymbellaronia [6] and at H9 it was Epithemia.

Pond sites (H3, H7, H8 and H10)

The commonly occurring diatom genera at pondwater bodies were Cyclotella, Navicula and Fragilariaceae. Site specific at H3 were Coccosiscus, Diploneis, and Eunotia, at H7 Rhopalodia at H8 it was Cyclotella and at H10 it was Coccosiscus. Seasonal diatom at H3 was Eunotia, at H7 was Eunocymbellaronia [6] at H8 was Coccosiscus and at H10 the seasonal diatom was Gymnophona. Figure 2 shows few commonly occurring diatoms, Figure 3 shows some least occurring, and Figure 4 shows some seasonal diatoms). Diatom fingerprinting (Plate 1) of different diatom taxa at different water body would thus help in generating a database to link scene of actual drowning and thus would be of great aid in criminal justice delivery system.

Table 1: Selected water stations for sampling from Haryana (India).

| Station Code | Water body | Source | Geographical area type | Location |
|--------------|------------|--------|------------------------|----------|
| H-1          | Canal      | Western Eastern Yamuna Canal, Panipat | Plain    | 29°21’41.44”N 76°57’05.58”E |
| H-2          | Canal      | Western Eastern Yamuna Canal, Kamal   | Plain    | 29°37’16.29”N 76°58’56.10”E |
| H-3          | Pond       | Municipal park, Ambala                | Plain    | 30°22’36.78”N 76°46’19.95”E |
| H-4          | Lake       | Bhramsarover Lake, Kurukshestra       | Plain    | 29°57’43.10”N 76°49’40.32”E |
| H-5          | Lake       | Rani Taalab Lake, Jind               | Plain    | 29°18’53.06”N 76°19’03.00”E |
| H-6          | Canal      | Bhakra Canal, Hisar                   | Plain    | 29°07’51.86”N 75°42’33.41”E |
| H-7          | Pond       | Ghaseda village, Mewat                | Foot hills| 28°07’57.26”N 77°03’53.41”E |
| H-8          | Pond       | Baghot village, Mahendergarh          | Foot hills| 28°25’31.72”N 76°15’55.69”E |
| H-9          | Lake       | Tilyar Lake, Rohtak                   | Plain    | 28°52’52.60”N 76°38’16.20”E |
| H-10         | Pond       | Baund village, Bhuiwani              | Plain    | 28°46’44.64”N 76°20’09.59”E |
### Sr. No. | Diatom genera | Station code | Order | Shape | Size (µm) | Length | Width
---|---|---|---|---|---|---|---
1. | 1 Achtnanthes | Pennal Elliptical | | Elliptical | 8-16 | 4-6 |
2. | 2 Actinocyclus | Centrale Circular | | Circular | 36-40 | - |
3. | 3 Amphora | Pennal Elliptical | | Elliptical | 75-80 | 15-20 |
4. | 4 Asterionella | Pennal Elliptical | | Elliptical | 80-300 | 5-8 |
5. | 5 Aulacoseira | Centrale Circular | | Circular | 45-60 | - |
6. | 6 Brachysira | Pennal Elliptical | | Elliptical | 20-48 | 12-20 |
7. | 7 Colonies | Pennal Elliptical | | Elliptical | 22-60 | 10-14 |
8. | 8 Caparitogramma | Pennal Elliptical | | Elliptical | 18-45 | 12-18 |
9. | 9 Catenula | Pennal Elliptical | | Elliptical | 10-15 | 2-5 |
10. | 10 Cratiasia | Pennal Elliptical | | Elliptical | 44-200 | 25-75 |
11. | 11 Cocconeis | Pennal Elliptical | | Elliptical | 35-45 | 16-17 |
12. | 12 Coscosiphocactus | Centrale Circular | | Circular | 36-120 | - |
13. | 13 Cyclorella | Centrale Circular | | Circular | 6-40 | - |
14. | 14 Cymatopleura | Pennal Shoe | | Elliptical | 80-300 | 10-45 |
15. | 15 Cymbella | Pennal Elliptical | | Elliptical | 20-200 | 5-50 |
16. | 16 Dentilia | Pennal Elliptical | | Elliptical | 11-14 | 3-5 |
17. | 17 Diatoma | Pennal Elliptical | | Elliptical | 18-60 | 8-18 |
18. | 18 Didymosphenia | Pennal Elliptical | | Elliptical | 80-150 | 50-60 |
19. | 19 Diploneis | Pennal Elliptical | | Elliptical | 10-40 | 6-10 |
20. | 20 Emphouslys | Pennal Sagmom | | Elliptical | 95-120 | 40-60 |
21. | 21 Epithemia | Pennal Elliptical | | Elliptical | 40-50 | 8-10 |
22. | 22 Encyonema | Pennal Elliptical | | Elliptical | 20-60 | 4-35 |
23. | 23 Eunotia | Pennal Elliptical | | Elliptical | 20-150 | 5-25 |
24. | 24 Eunotia | Pennal Elliptical | | Elliptical | 22-28 | 6-8 |
25. | 25 Fragilana | Pennal Elliptical | | Elliptical | 95-119 | 6-7 |
26. | 26 Frustula | Pennal Elliptical | | Elliptical | 60-85 | 10-18 |
27. | 27 Gomphoneis | Pennal Elliptical | | Elliptical | 20-130 | 12-20 |
28. | 28 Gomphoneis | Pennal Elliptical | | Elliptical | 74-80 | 16-20 |
29. | 2.9 Gyrosigma | Pennal Sagmom | | Elliptical | 150-240 | 26-30 |
30. | 30 Gymnocymbella | Pennal Elliptical | | Elliptical | 18-30 | 5-8 |
31. | 31 Hantzschia | Pennal Elliptical | | Elliptical | 80-120 | 18-22 |
32. | 32 Licmophora | Pennal Elliptical | | Elliptical | 45-60 | 5-7 |
33. | 33 Lucenta | Pennal Elliptical | | Elliptical | 15-20 | 5-10 |
34. | 34 Melosira | Centrale Circular | | Circular | 23-25 | - |
35. | 35 Navicula | Pennal Elliptical | | Elliptical | 10-60 | 5-16 |
36. | 36 Nitzchia | Pennal Elliptical | | Elliptical | 40-50 | 12-20 |
37. | 37 Nitzchia | Pennal Elliptical | | Elliptical | 25-115 | 5-10 |
38. | 38 Opephora | Pennal Elliptical | | Elliptical | 30-35 | 5-7 |
39. | 39 Pinnularia | Pennal Elliptical | | Elliptical | 20-250 | 8-18 |
40. | 40 Placonia | Pennal Elliptical | | Elliptical | 20-30 | 10-12 |
41. | 41 Pseudostaurosira | Pennal Elliptical | | Elliptical | 12-22 | 6-8 |
42. | 42 Reimeta | Pennal Elliptical | | Elliptical | 8-12 | 4-6 |
43. | 43 Rhoicosphera | Pennal Elliptical | | Elliptical | 16-46 | 8-10 |
44. | 44 Rhopalodia | Pennal Elliptical | | Elliptical | 18-150 | 4-8 |
45. | 45 Selphora | Pennal Elliptical | | Elliptical | 18-45 | 4-10 |
46. | 46 Staurosire | Pennal Elliptical | | Elliptical | 40-75 | 14-20 |
47. | 47 Stauroneis | Pennal Elliptical | | Elliptical | 7-22-5 | 5-7 |
48. | 48 Stauroneis | Pennal Sigmoid | | Sigmoid | 80-100 | 8-16 |
49. | 49 Staurosirella | Pennal Elliptical | | Elliptical | 5-10 | 2-5 |
50. | 50 Suaeda | Pennal Elliptical | | Elliptical | 40-70 | 30-40 |
51. | 51 Synedra | Pennal Rod | | Rod | 93-150 | 7-9 |
52. | 52 Tabularia | Pennal Elliptical | | Elliptical | 20-120 | 4-6 |
53. | 53 Tryblionella | Pennal Elliptical | | Elliptical | 18-40 | 5-10 |
54. | 54 Thalassosponia | Pennal Elliptical | | Elliptical | 20-66 | 2-4 |
55. | 55 Thalassosira | Centrale Circular | | Elliptical | 15-20 | - |

**Symbols used:**
- (H1 to H10): Sites of water sample collection.
- Present.
- Absent.
- Restricted (rarely occurring and seasonal).

Plate 1: Diatom fingerprinting.
Figure 1: Geographical Map of Haryana.

Figure 2: Few Commonly occurring diatoms.
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Figure 3: Few Least occurring diatoms.

Figure 4: Few Seasonal diatoms.

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