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A Review on Significance of Diatoms in Drowning Cases

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***Abstract*: The review paper "A review on significance of diatoms in drowning cases" delves at the critical function that diatoms play in forensic investigations, particularly when it comes to deaths caused by drowning. Determining the cause of death and making a diagnosis of drowning, a type of asphyxia brought on by immersion in water or another fluid, can be difficult. Diatoms, photosynthesising algae with skeletons made of silica, have become an important source of evidence for drowning deaths. The report emphasises the value of diatoms as supporting evidence that can be used to distinguish between post-mortem submersion and ante-mortem drowning. Effective extraction strategies for diatom recovery from tissue samples are addressed, including the novel Lefort aqua regia approach and acid digestion procedures. The identification of the drowning site depends critically on the qualitative and quantitative examination of diatoms in organ samples and their comparison with those from the drowning medium. It is emphasised that the diatom test is a vital instrument in forensic science that makes it possible to distinguish drowning victims from other causes of death. Diatoms are quite useful in situations of advanced breakdown because they are resistant to putrefaction. The analysis also discusses prospective applications for the future, including the employment of cutting-edge technologies to detect diatoms in forensic cases. The research concludes by highlighting the crucial function that diatoms play in forensic investigations of drowning cases. Specifically, diatom samples are carefully analysed and compared to confirm drowning deaths and pinpoint the drowning site.**

***Keywords*: Ante-mortem, Asphyxia, Diatoms, Drowning, Post-mortem, Putrefaction, Submersion.**

1. Introduction

One kind of asphyxia-related death is drowning. In this case, breathing is reserved by immersion in water or a liquid; aspirating the fluid into the lungs is not required. Drowning deaths are hard to diagnose and are frequently determined by ruling out all other possible causes of death [1]. When determining the cause of death, diatoms discovered inside the corpse of a drowning victim might be used as supporting evidence. It is possible to determine if the drowning occurred post-mortem or ante-mortem. There is now only one direct screening test for drowning, the diatom test.

The diatom test has been regarded as a crucial diagnostic and confirmatory technique for drowning deaths ever since diatoms were found in the lungs of a drowning victim.

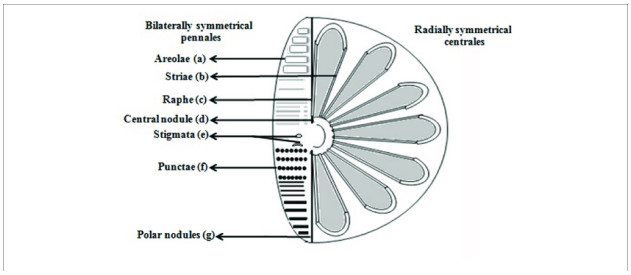

Fig. 1. Intricate image of Diatom

Diatoms: Diatoms are photosynthesising algae that can be found in practically any type of environment, including freshwater, marine waters, soil, and really anywhere that is moist. They have a siliceous skeletal fragment [1].

They could have a tube-like form, be simple or branching, and be covered with a gelatinous membrane. A frustule, consisting of two valves connected by a girdle, a connective zone, encloses every diatom. Their bones, which are made of silica, do not easily deteriorate and are occasionally discernible even in severely decayed remains. Diatoms are often not found in the body naturally. A strong case can be made for drowning as the cause of death if laboratory testing reveals diatoms in the body that are the same species as those discovered in the water from whence the body was recovered.

According to a study involving drowning victims, diatoms are present in the medium because the victims' breathing in the water caused the diatoms to enter the bloodstream and alveolar system, which in turn caused the diatoms to enter other organs and parts of the body, including the kidneys, brain, bone marrow, and lungs. The soft tissues, such as the liver and lungs, and the hard bones, such as the sternum and femur, of drowning victims are typically sent to the laboratories for diatom detection.

The origin of the diatoms detected in bone marrow is known, thus matching diatoms from both the drowned body's tissue and the hypothesised aqueous medium is necessary for the diatom test to be successful [1]. This test would be very important in the identification of drowning cases.

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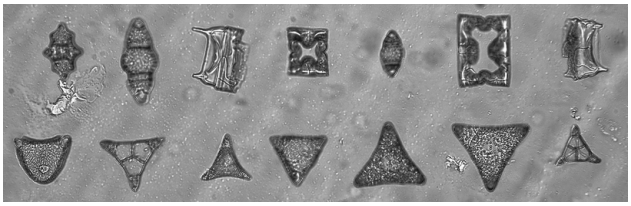

Fig. 2. Diatoms of different shapes

2. Literature Review

A Synopsis of Diatom Test's History - Hofmann was the first to find diatoms in lung fluid [2]. Incze [3] showed that diatoms might reach the bloodstream through the lungs and successfully identified diatoms in parenchymal organs and blood. Tamasaka discovered diatoms in bone marrow [4].

Porawski [5] developed a method for the diatom test for direct screening drowning deaths after demonstrating the presence of diatoms in bone marrow, lung, liver, spleen, kidney, and brain tissue. The presence of diatoms can be verified and analysed both qualitatively and quantitatively. Pollanen's acid digestion of the tissues enhanced the extraction process [6]. Bone marrow diatoms matched the drowning medium in 90% of drowning cases. One of the main complaints of the diatom test to date, according to Pollanen [7], has been its sensitivity.

"Increasing the sensitivity of the test could significantly improve the medico-legal utility of the diatom test for drowning." Diatoms are diversified remnants that can be identified with great taxonomic precision, according to Cameron [8]. These elements enable the use of diatoms in forensic geosciences for a variety of purposes. According to Horton's [9] research, the diatom test is a useful forensic science method for identifying drowning deaths.

Extraction Techniques - Acid Digestion Method: This globally recognised technique is used to extract diatoms. It produces good outcomes and is simple to execute.

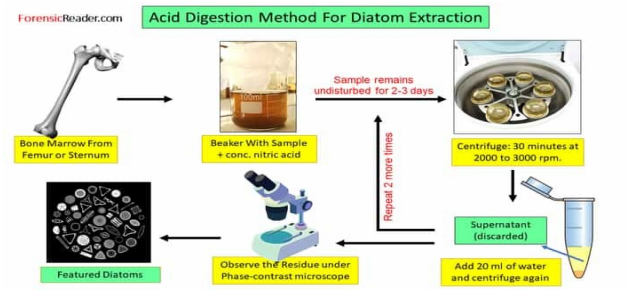

Fig. 3. Acid digestion method for diatom extraction

1) Nitric Acid Method

i. The person who is thought to be drowning provides samples. During the procedure, care should be taken to ensure that the sample is not contaminated with foreign diatoms.

ii. For example, intact femurs are taken out after autopsy and cleaned in distilled water. A clean band saw is used to cut femurs lengthwise. A clean spatula is then used to retrieve around 50g of bone marrow, which is then placed into a boiling flask.

iii. After adding about 50 mL of strong nitric acid to the flask, the marrow-acid suspension is cooked on a hot plate for about 48 hours while being monitored closely by a fume hood.

iv. After cooling and centrifuging the suspension—sometimes twice—the sediment is inspected under a microscope. The acid-resistant material that was produced is then placed onto sterile microscope slides, and the supernatant is disposed of.

When someone drowns, a stunning collection of the most fragile and exquisite diatom skeletons is visible. When conditions are right, it is even possible to identify the drowning site since the diatoms in fresh and salt water differ, and the seaweed varies from location to location along the coast.

2) Sulphuric Acid Method

i. The benefit of this is that there won't be any intense foaming. Make sure that all calcareous components have been eliminated before proceeding, as gypsum crystals would develop and render the sample completely unusable.

ii. After the sample has fully settled, throw away the supernatant.

iii. Add sulphuric acid concentration until the volume doubles that of the initial sample.

iv. Put in some potassium dichromate. Unlike the H_2O_2 approach, no strong reaction happens, hence no extra caution is required. Merely incorporate sufficient dichromate to achieve a saturated solution.

v. Allow to stand for a minimum of 24 hours, or accelerate the reaction by 60 degrees in a water bath. Nevertheless, it can take a few hours for the sample to become clean. Sediments should be greyish in appearance, with no remnants of plants, etc.

vi. Allow to settle fully, then discard supernatant and rinse multiple times following the above instructions. Compared to the H_2O_2 procedure, the sulphuric acid method appears to remove "dirt" resistant a little better since the oxidation reaction is not as sudden as with peroxide. But once more, patience—rather than the chemistry—is the key.

The diatom test is especially useful where decomposition is advanced because diatoms resist putrefaction. Dead bodies submerged in water or victims of dry drowning do not test positive for diatoms. The control water samples are always required for comparison in diatom analysis. Standard diatom samples are suitable for comparison purposes and can be kept on slides for preservation.

There are drawbacks to acid digesting techniques since the acid treatment can destroy the diatoms' structural integrity.

However, Huipin Wang et al.'s recently devised Lefort aqua regia (3:1 nitric acid to hydrochloric acid) approach [10] provides an advantage over traditional acid digestion for the recovery of diatoms from tissue samples. Traditional tissue acid digestion techniques for diatom analysis are tedious, time-consuming, and possibly hazardous.

Diatom Test's Qualitative and Quantitative Aspects: Strong proof that the drowning victim's death was caused by water aspiration is provided by qualitative and quantitative analysis

of diatoms in organ samples and water. Numerous investigations carried out globally have demonstrated that the diatom test's validity is contingent upon the configuration and quantity of valves extracted from tissue samples [10]. Numerous global researches have demonstrated that the drowning site may be verified by comparing the species of diatoms found in organ samples with the drowning media. The distribution of diatoms in the body, both quantitatively and qualitatively, is caused by a number of variables.

The significance of the Diatom Test and its role in Forensic Science: We can determine if drowning was the cause of death or not with the use of the diatom test. After committing a crime, criminals will occasionally toss the bodies into the sea to simulate drowning [11]. Diatom tests are more useful when decomposition is advanced and post-mortem drowning symptoms have decreased since diatoms can withstand putrefaction [13]. Research on drowning deaths revealed that only the diatom test, which compares the presence of diatoms in an organ sample with a reference water sample, can determine if a body is ante-mortem drowned in skeletonised or advanced stages of decomposition [12]. From a historical angle, the investigation of drowning deaths necessitated a test that was easily applied, specific, and sensitive. The diatom test has come to be the most significant test used in forensic labs to identify drowning victims [14].

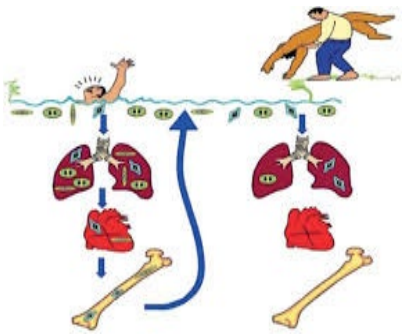

Fig. 4. Ante-mortem and post-mortem drowning

3. Discussion

Distinguishing a death by immersion from a death by submersion is the primary objective in this field. Diatoms may be detected in the body by laboratory testing. Diatoms are tiny algae that can be found in freshwater and saltwater. Their skeletons, which are made of silica, do not easily deteriorate and are occasionally found in severely decayed remains. If the individual is dead when they enter the water, there won't be any circulation, which prevents diatoms from entering the body and from travelling to different organs. When a body is found in the water, there is typically skepticism as to whether the drowning was post-mortem or ante-mortem, meaning the body may have drowned earlier or after death.

The existence of diatoms in bodily tissues is highly relevant evidence in these medical-legal cases. Forensic labs must successfully determine the drowning site in drowning-related mortality cases by establishing a correlation between the diatoms retrieved from bone marrow and liver/lungs samples and the samples collected from drowning medium.

It's crucial to keep in mind that a complete investigation is always necessary and that drowning is not automatically ruled out just because there are no diatoms present. Once more, the data could pinpoint the death scene and implicate a specific location of submersion if particular types of diatoms retrieved from the marrow match those identified at the probable drowning site. This could lead to additional forensic evidence. Diatoms can also support the conclusions drawn from investigative data when determining the cause of an accident.

4. Conclusion and Summary

Diatoms can be analyzed qualitatively and quantitatively by measuring the number of species and detecting diatoms in the samples. The interpretation of study results should be considered in relation to police investigations and post-mortem reports. Even though on rare occasions the diatoms may have also recovered from the internal organs of non-drowning bodies, the diatom test is still important. Diatoms differ in their morphology and taxonomy within a given habitat, making it feasible to identify the place of the drowning. To determine the place of drowning in drowning deaths, water from the suspected drowning site should be investigated and compared with the organ sample. In the near future, diatoms can be detected using cutting-edge technologies including Automatic Diatom Identification and Classification (ADIAC), Fluorimetry, Nuclear Magnetic Resonance (NMR), and Molecular Biological Techniques.

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