

Supplementary Materials

This supplementary file contains Supplementary Table S1, Supplementary Table S2, and Supplementary Table S3. Supplementary Table S1 reports the full search strategies. Supplementary Table S2 provides the complete charting of the 165 included studies. Supplementary Table S3 provides the complete thematic distribution of included studies and domain combinations. The PRISMA-ScR checklist is provided as a separate file.

Supplementary Table S1. Full search strategies

Complete database-specific search strategies and restrictions used in Scopus, PubMed, and Web of Science Core Collection.

Database	Search label	Exact search string	Fields searched	Date range	Language filter	Document-type filter	Records exported	Search date	Notes
Scopus	Scopus V1	TITLE-ABS-KEY((drowning OR "forensic drowning" OR "antemortem drowning") AND (diatom* OR "diatom test") AND (metagenom* OR "DNA-based" OR DNA OR "site inference" OR "18S" OR microarray OR metabarcod* OR "deep learning" OR "artificial intelligence" OR automated OR classification OR quantitative OR "L/D ratio"))	Title, abstract, keywords	2014–2026	English, if available	Article OR Review	96	15 May 2026	First complementary Scopus search; core methodological search.
Scopus	Scopus V2	TITLE-ABS-KEY((drowning OR "death by drowning" OR "forensic drowning" OR "antemortem drowning" OR "submersion death*" OR "bodies in water") AND (diatom* OR "diatom test" OR Bacillariophyceae OR phytoplankton OR microalga* OR plankton*) AND (metagenom* OR metabarcod* OR "DNA-based" OR DNA OR PCR OR qPCR OR sequencing OR "18S" OR "16S" OR rbcL OR microarray OR "site inference" OR "drowning site*" OR "drowning medium" OR "artificial intelligence" OR "machine learning" OR "deep learning" OR automated OR automatic OR "image analysis" OR classification OR "L/D ratio" OR quantitative OR "Auto-SEM" OR "scanning electron microscopy" OR standard* OR validation))	Title, abstract, keywords	2014–2026	English, if available	Article OR Review	111	15 May 2026	Second complementary Scopus search; broadened site-inference, microalgal/planktonic, automation, validation, and standardization retrieval.
PubMed	PubMed final	("Drowning"[Mesh] OR drowning[Title/Abstract] OR "forensic drowning"[Title/Abstract] OR "death by drowning"[Title/Abstract] OR "antemortem drowning"[Title/Abstract] OR "submersion death"[Title/Abstract] OR "submersion deaths"[Title/Abstract] OR "body in water"[Title/Abstract] OR "bodies in water"[Title/Abstract]) AND ("Diatoms"[Mesh] OR diatom*[Title/Abstract] OR "diatom test"[Title/Abstract] OR Bacillariophyceae[Title/Abstract] OR phytoplankton[Title/Abstract] OR microalga*[Title/Abstract] OR plankton*[Title/Abstract])	MeSH + Title/Abstract	2014–2026	English, if available	Not applied at export stage; publication type assessed during screening	129	15 May 2026	Broad sensitivity PubMed strategy; article-type filtering was not applied at export stage.
Web of Science Core Collection	Web of Science V3	TS=((drowning OR "forensic drowning" OR "death by drowning" OR "antemortem drowning" OR "submersion death*" OR "body in water" OR "bodies in water") AND (diatom* OR "diatom test" OR Bacillariophyceae OR phytoplankton OR microalga* OR plankton*) AND (forensic OR diagnos* OR postmortem OR autops* OR cadaver* OR death* OR "legal medicine" OR "forensic pathology" OR "drowning medium" OR "drowning site*" OR "site inference" OR validation OR "diatom test"))	Topic	2014–2026	English	Article OR Review Article	151	15 May 2026	Final WoS strategy with forensic/diagnostic context block.

Supplementary Table S2. Complete charting of included studies

The complete charting of the 165 included studies is split into two parts. Rows are ordered by citation number in the revised main manuscript.

Supplementary Table S2a. Methodological and forensic characteristics of included studies

Study-level analytical and forensic characteristics. Citation numbers correspond to the main manuscript reference list.

Citation no.	First author et al. (year)	Sample type	Organism / marker	Analytical method	Forensic target	Thematic domain(s)	Relevance
4	Tambuzzi et al. (2024)	lung tissue; bone marrow; bone; blood / heart blood; animal model; rat model	Diatoms; Algae; Silicon / siliceous material	Artificial intelligence	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification	B;C;D	High
5	Ludes et al. (2025)	lung tissue; blood / heart blood; water samples; rat model; human cases	Diatoms; Algae	Light microscopy; SEM; MD-VF-Auto SEM; Auto-SEM; Microwave digestion; Digestion; Vacuum filtration; Filtration	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Contamination / false-positive interpretation	B;C;D	High
6	Tyr et al. (2025)	lung tissue; liver; kidney; bone marrow; bone; blood / heart blood	Diatoms; Plankton; Algae	Light microscopy	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Contamination / false-positive interpretation	C;D	High
7	Zhou et al. (2020)	lung tissue; blood / heart blood; water samples; rat model	Diatoms; Plankton; Algae	Digestion; Deep learning	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification	B;C;D	High
8	Shen et al. (2019)	lung tissue; liver; kidney; gastric contents; drowning medium / water sample; water samples	Diatoms	Light microscopy; SEM; MD-VF-Auto SEM; Auto-SEM; Microwave digestion; Digestion; Vacuum filtration; Filtration	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Contamination / false-positive interpretation	A;B;C;D	High
9	Dahiya et al. (2024)	lung tissue; bone marrow; bone; clothing / fabric; rat model; image dataset	Diatoms; Plankton; Algae	Light microscopy; Digestion	Automated detection/classification; Quantitative standardization/validation; Trace transfer / clothing evidence	C;D	High
10	Al-Najjar et al. (2026)	rat model	Diatoms	Light microscopy; SEM; Metagenomics; Metabarcoding	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Contamination / false-positive interpretation	C;D	High
11	Yu et al. (2014)	lung tissue; liver; kidney; water samples; water bodies; animal model	Diatoms; Plankton; 16S rDNA	Light microscopy; SEM; Microwave digestion; Digestion; PCR; PCR-capillary electrophoresis	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation	A;C;D	High
12	Jiang et al. (2020)	lung tissue; animal model; rat model; human cases	Diatoms; 18S rRNA/rDNA	Light microscopy; SEM; PCR; Microarray; DNA sequencing	Automated detection/classification; Quantitative standardization/validation	A;C;D	High
13	Fang et al. (2019)	lung tissue; water samples; animal model; rat model; rabbit model; human cases	Diatoms; Plankton; Algae; 18S rRNA/rDNA; 16S rDNA	DNA sequencing	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Trace transfer / clothing evidence	A;C;D	High
14	Nakanishi et al. (2024)	water samples; rat model; human cases	Diatoms; Plankton; 18S rRNA/rDNA; 16S rDNA	Light microscopy; DNA sequencing; Metagenomics	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Contamination / false-positive interpretation	A;D	High
15	Zhang et al. (2025)	blood / heart blood; rat model; human cases; cadaver / human remains	Diatoms; Plankton; Aeromonas hydrophila; 16S rDNA; rbcL	PCR; qPCR	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation	A;C	High
16	Yu et al. (2021)	lung tissue; liver; kidney; rat model; human cases	Diatoms; Plankton; Algae; Aeromonas hydrophila; 18S rRNA/rDNA	Light microscopy; SEM; MD-VF-Auto SEM; Auto-SEM; Microwave digestion; Digestion; Vacuum filtration; Filtration; PCR	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation	A;B;C	High
17	Zhou et al. (2019)	lung tissue; blood / heart blood; rat model; human cases; image dataset	Diatoms; Plankton	Light microscopy; SEM; Microwave digestion; Digestion; Deep learning; Machine learning; Artificial intelligence	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Contamination / false-positive interpretation	B;C;D	High
18	Gu et al. (2022)	lung tissue; blood / heart blood; water bodies; rat model; human cases; image dataset	Diatoms; Plankton	Light microscopy; YOLO; Deep learning; Machine learning	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation	B;D	High
19	Yu et al. (2022)	lung tissue; liver; kidney; blood / heart blood; water bodies; rat model	Diatoms; Algae	Light microscopy; SEM; Microwave digestion; Digestion; Vacuum filtration; Filtration; YOLO; Artificial intelligence	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation	B;C;D	High
20	Zhang et al. (2023)	lung tissue; liver; kidney; bone marrow; bone; blood / heart blood	Diatoms; Plankton	Light microscopy; DiatomNet; Deep learning; Artificial intelligence	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Contamination / false-positive interpretation; Trace transfer / clothing evidence	B;C;D	High
21	Zhao et al. (2015)	lung tissue; liver; kidney; bone marrow; bone; water samples	Diatoms	Light microscopy; SEM; MD-VF-Auto SEM; Auto-SEM; Microwave digestion; Digestion; Vacuum filtration; Filtration	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation	B;C;D	High

Citation no.	First author et al. (year)	Sample type	Organism / marker	Analytical method	Forensic target	Thematic domain(s)	Relevance
22	Hu et al. (2026)	lung tissue; liver; kidney; bone marrow; bone; spleen	Diatoms; Plankton; Microbial/bacterial markers	Light microscopy; SEM; MD-VF-Auto SEM; Auto-SEM; Microwave digestion; Digestion; Vacuum filtration; Filtration	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Contamination / false-positive interpretation	A;B;C;D	High
23	Zhu et al. (2022)	lung tissue; rat model; human cases; image dataset	Diatoms	DiatomNet; Deep learning; Artificial intelligence	Automated detection/classification; Quantitative standardization/validation	B;C;D	High
24	Hagen et al. (2025)	lung tissue; liver; kidney; blood / heart blood; drowning medium / water sample; water bodies	Diatoms	Light microscopy; SEM; MD-VF-Auto SEM; Auto-SEM; Vacuum filtration; Filtration; Digestion	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Contamination / false-positive interpretation	A;B;C;D	High
25	Du et al. (2022)	lung tissue; liver; kidney; water samples; rat model; human cases	Diatoms	Light microscopy; SEM; MD-VF-Auto SEM; Auto-SEM; Microwave digestion; Digestion; Vacuum filtration; Filtration	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation	B;C;D	High
26	Zhao et al. (2016)	lung tissue; bone marrow; bone; drowning medium / water sample; rat model; human cases	Diatoms	Light microscopy; SEM; MD-VF-Auto SEM; Auto-SEM; Microwave digestion; Digestion; Vacuum filtration; Filtration	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation	A;B;C;D	High
27	Du et al. (2022)	lung tissue; liver; kidney; bone marrow; bone; blood / heart blood	Diatoms	Light microscopy; SEM; MD-VF-Auto SEM; Auto-SEM; Microwave digestion; Digestion; Vacuum filtration; Filtration	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation	A;B;C;D	High
28	Ren et al. (2021)	lung tissue; liver; kidney; blood / heart blood; water samples; animal model	Diatoms; Algae	Light microscopy; SEM; MD-VF-Auto SEM; Auto-SEM; Microwave digestion; Digestion; Vacuum filtration; Filtration	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Contamination / false-positive interpretation; Postmortem redistribution/alternative matrices	B;C;D	Moderate
30	Seo et al. (2014)	lung tissue; liver; kidney; blood / heart blood; rat model; human cases	Diatoms; Plankton; Algae; Silicon / siliceous material	Light microscopy; Digestion; PCR	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Trace transfer / clothing evidence	A;C;D	Low
31	Pierucci et al. (2016)	lung tissue; blood / heart blood; heart; drowning medium / water sample; rat model; human cases	Diatoms; Plankton; Silicon / siliceous material	Light microscopy; Digestion	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation	A;C	Moderate
32	Piegari et al. (2019)	lung tissue; blood / heart blood; gastric contents; drowning medium / water sample; animal model; rat model	Diatoms	Light microscopy; PCR	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Contamination / false-positive interpretation	A;C;D	Moderate
33	Liu et al. (2019)	lung tissue; liver; kidney; blood / heart blood; heart; spleen	Diatoms; Algae	Microwave digestion; Digestion; Vacuum filtration; Filtration; PCR	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Contamination / false-positive interpretation	A;C;D	Moderate
34	Zhang et al. (2020)	lung tissue; liver; kidney; blood / heart blood; drowning medium / water sample; water samples	Diatoms	Light microscopy; SEM; MD-VF-Auto SEM; Auto-SEM; Microwave digestion; Digestion; Vacuum filtration; Filtration	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Contamination / false-positive interpretation	A;B;C;D	High
35	Zhao et al. (2021)	lung tissue; liver; kidney; blood / heart blood; drowning medium / water sample; water samples	Diatoms	Light microscopy; SEM; MD-VF-Auto SEM; Auto-SEM; Microwave digestion; Digestion	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Contamination / false-positive interpretation	A;B;C;D	High
36	Zhang et al. (2022)	lung tissue; liver; kidney; rat model; human cases	Diatoms; Plankton	Light microscopy; SEM; MD-VF-Auto SEM; Auto-SEM; Microwave digestion; Digestion; Vacuum filtration; Filtration; PCR	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation	A;B;C	High
37	Liu et al. (2022)	liver; rat model; human cases	Diatoms	Light microscopy; SEM; Vacuum filtration; Filtration; Digestion	Automated detection/classification; Quantitative standardization/validation	A;C;D	High
38	Cai et al. (2022)	lung tissue; blood / heart blood; water samples; rat model	Diatoms	PCR; qPCR	Automated detection/classification; Quantitative standardization/validation	A;C	High
39	Tsuneya et al. (2023)	lung tissue; liver; kidney; gastric contents; drowning medium / water sample; animal model	Diatoms; Plankton	Light microscopy; Filtration; Digestion	Automated detection/classification; Quantitative standardization/validation; Contamination / false-positive interpretation	A;C;D	Moderate
40	Tsuneya et al. (2024)	lung tissue; blood / heart blood; drowning medium / water sample; water samples; rat model; human cases	Diatoms	Light microscopy	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Contamination / false-positive interpretation	A;C;D	Moderate
41	Szűcs et al. (2025)	lung tissue; heart; animal model; rat model; human cases; cadaver / human remains	Diatoms; Algae	Light microscopy; PCR	Drowning diagnosis; Automated detection/classification; Postmortem redistribution/alternative matrices	A	Low
42	Tsuneya et al. (2025)	lung tissue; liver; kidney; bone marrow; bone; blood / heart blood	Diatoms	Light microscopy	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Contamination / false-positive interpretation	A;C;D	Moderate
43	Badu et al. (2025)	lung tissue; bone marrow; bone; blood / heart blood; drowning medium / water sample; water samples	Diatoms	Light microscopy; Digestion	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Contamination / false-positive interpretation	A;C;D	Moderate
44	Rutty et al. (2015)	lung tissue; blood / heart blood; rat model; human cases; cadaver / human remains	Diatoms; Plankton; Microbial/bacterial markers	PCR	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation	A	Low
45	Lee et al. (2017)	lung tissue; liver; kidney; bone marrow;	Diatoms; Microbiota;	PCR; DNA sequencing	Drowning diagnosis; Automated detection/classification;	A;C;D	High

Citation no.	First author et al. (year)	Sample type	Organism / marker	Analytical method	Forensic target	Thematic domain(s)	Relevance
		bone; blood / heart blood	Microbial/bacterial markers; 16S rDNA		Quantitative standardization/validation; Postmortem redistribution/alternative matrices		
46	Kakizaki et al. (2018)	lung tissue; liver; kidney; blood / heart blood; rat model; human cases	Diatoms; Plankton; Microbial/bacterial markers; Aeromonas hydrophila	PCR; DNA sequencing; LAMP assay	Automated detection/classification; Quantitative standardization/validation; Contamination / false-positive interpretation	A;D	High
47	Li et al. (2015)	lung tissue; liver; kidney; animal model; rat model; rabbit model	Diatoms; Algae; 16S rDNA	Light microscopy; SEM; MD-VF-Auto SEM; Auto-SEM; Microwave digestion; Digestion; Vacuum filtration; Filtration; PCR	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation	A;B;C;D	High
48	Uchigasaki et al. (2016)	lung tissue; liver; kidney; blood / heart blood; animal model; rat model	Diatoms; Plankton; 16S rDNA	Digestion; PCR	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Contamination / false-positive interpretation	A;C	Moderate
49	Fucci et al. (2017)	lung tissue; liver; kidney; bone marrow; bone; blood / heart blood	Diatoms; Plankton; Algae	Light microscopy; Digestion; PCR; DNA sequencing; Metagenomics	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation	A;C;D	High
50	Nakanishi et al. (2018)	lung tissue; rat model; human cases	Diatoms; Plankton; Microbial/bacterial markers; Aeromonas hydrophila	Digestion; PCR	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Trace transfer / clothing evidence	A;C	High
51	Yuan et al. (2018)	lung tissue; liver; water samples; human cases	Diatoms; Algae; 16S rDNA	Light microscopy; PCR	Automated detection/classification	A;D	Low
52	Vinayak et al. (2020)	lung tissue; liver; bone marrow; bone; blood / heart blood; spleen	Diatoms; Plankton; Microalgae; Algae; 16S rDNA	SEM; Digestion; PCR; DNA sequencing	Drowning diagnosis; Automated detection/classification	A;C	High
53	Li et al. (2021)	lung tissue; liver; kidney; rat model; human cases; cadaver / human remains	Diatoms; Plankton; Aeromonas hydrophila	Light microscopy; SEM; MD-VF-Auto SEM; Auto-SEM; Microwave digestion; Digestion; Vacuum filtration; Filtration; PCR	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation	A;B;C;D	High
54	Xiao et al. (2021)	lung tissue; liver; kidney; blood / heart blood; water samples; rat model	Diatoms; Plankton; Aeromonas hydrophila; 18S rRNA/rDNA; 16S rDNA	Light microscopy; SEM; MD-VF-Auto SEM; Auto-SEM; Microwave digestion; Digestion; Vacuum filtration; Filtration; PCR	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation	A;B;C;D	High
55	Liu et al. (2021)	water samples; water bodies; animal model; rat model; human cases	Diatoms; Algae; 18S rRNA/rDNA; 16S rDNA; rbcL; Chloroplast markers	Light microscopy; DNA sequencing; Metabarcoding	Automated detection/classification; Quantitative standardization/validation	A;C;D	High
56	Kakizaki et al. (2022)	lung tissue; liver; kidney; bone marrow; bone; blood / heart blood	Diatoms; Microbial/bacterial markers	Digestion	Automated detection/classification; Quantitative standardization/validation; Contamination / false-positive interpretation; Trace transfer / clothing evidence	A;C;D	Moderate
57	Szűcs et al. (2022)	lung tissue; bone marrow; bone; heart; spleen; water bodies	Diatoms; Bacillariophyceae; Algae; Microbial/bacterial markers	Light microscopy; SEM; Digestion; PCR	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Contamination / false-positive interpretation; Postmortem redistribution/alternative matrices	A;C	Moderate
58	Zhou et al. (2023)	lung tissue; liver; bone marrow; bone; blood / heart blood; water samples	Diatoms; Plankton; Silicon / siliceous material	Light microscopy; Filtration; Digestion; PCR; DNA sequencing	Automated detection/classification; Quantitative standardization/validation	A;C;D	High
59	Zhang et al. (2025)	lung tissue; liver; kidney; rat model; human cases	Diatoms; Plankton; 16S rDNA; rbcL	Light microscopy; SEM; MD-VF-Auto SEM; Auto-SEM; Microwave digestion; Digestion; Vacuum filtration; Filtration; PCR	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation	A;B;C;D	High
60	Su et al. (2025)	lung tissue; blood / heart blood; animal model; rat model; mouse model; human cases	Diatoms; Plankton; Microbial/bacterial markers; Aeromonas hydrophila; Microbiota	Light microscopy; SEM; Digestion; PCR; DNA sequencing; Machine learning; Random forest	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Contamination / false-positive interpretation; Postmortem redistribution/alternative matrices	A;B;C;D	High
61	Lin et al. (2014)	lung tissue; bone marrow; bone; blood / heart blood; water samples; rat model	Diatoms	Light microscopy; Digestion	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Contamination / false-positive interpretation	A;C	Moderate
62	Sasidharan et al. (2014)	lung tissue; drowning medium / water sample; water samples; water bodies; rat model; human cases	Diatoms	Not clearly reported	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Contamination / false-positive interpretation	A;C	Moderate
63	Badu et al. (2015)	lung tissue; liver; kidney; blood / heart blood; spleen; drowning medium / water sample	Diatoms	Light microscopy; SEM; Digestion	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Contamination / false-positive interpretation	A;C;D	Moderate
64	Zhuo et al. (2016)	lung tissue; water samples; water bodies; rat model	Diatoms; Algae	Not clearly reported	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation	A;C;D	Moderate
65	Singh et al. (2016)	drowning medium / water sample; water samples; water bodies; rat model; human cases	Diatoms; Bacillariophyceae; Algae; Silicon / siliceous material	Not clearly reported	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Contamination / false-positive interpretation	A;C	Moderate
66	Coelho et al. (2016)	lung tissue; liver; kidney; bone marrow;	Diatoms	Not clearly reported	Drowning-site inference / environmental comparison; Drowning	A;B;C;D	Moderate

Citation no.	First author et al. (year)	Sample type	Organism / marker	Analytical method	Forensic target	Thematic domain(s)	Relevance
		bone; blood / heart blood			diagnosis; Automated detection/classification; Quantitative standardization/validation; Contamination / false-positive interpretation		
67	Rácz et al. (2016)	lung tissue; bone marrow; bone; blood / heart blood; spleen; rat model	Diatoms; Plankton; Algae; Microbial/bacterial markers; 18S rRNA/rDNA	Light microscopy; SEM; PCR	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Postmortem redistribution/alternative matrices	A,C;D	High
68	Kaushik et al. (2017)	lung tissue; liver; kidney; bone marrow; bone; blood / heart blood	Diatoms; Algae; Microbial/bacterial markers	Light microscopy; Digestion	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation	A,C;D	Moderate
69	Idota et al. (2018)	lung tissue; liver; blood / heart blood; heart; water samples; rat model	Diatoms; Plankton; Algae; Microbial/bacterial markers; 16S rDNA	Digestion; PCR	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation	A,C;D	Moderate
70	Kaur et al. (2018)	drowning medium / water sample; water samples; water bodies; rat model	Diatoms; Algae	Light microscopy; Digestion	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation	A,C;D	Moderate
71	Bak et al. (2018)	lung tissue; liver; kidney; bone marrow; bone; blood / heart blood	Diatoms	Light microscopy; SEM; Digestion	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Trace transfer / clothing evidence	A,C;D	Low
72	Zhao et al. (2018)	water samples; water bodies; rat model; human cases	Diatoms; Plankton; 18S rRNA/rDNA; rbcL	Light microscopy; SEM; DNA sequencing	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation	A,C;D	High
73	Hu et al. (2019)	water samples; human cases	Diatoms; 18S rRNA/rDNA	PCR; DNA sequencing	Drowning-site inference / environmental comparison; Automated detection/classification	A	High
74	Li et al. (2019)	rat model; human cases	Diatoms; Plankton; 18S rRNA/rDNA; 16S rDNA; rbcL; Chloroplast markers	Light microscopy	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification	A,C;D	High
75	Voloshynovych et al. (2019)	lung tissue; liver; kidney; bone; heart; spleen	Diatoms; Plankton; Algae; 16S rDNA	Light microscopy; PCR	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation	A,C;D	Low
76	Liu et al. (2020)	lung tissue; liver; kidney; rat model; human cases	Diatoms; 18S rRNA/rDNA; rbcL	Light microscopy; DNA sequencing; Metabarcoding	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification	A,C	High
77	Zhang et al. (2020)	water samples; water bodies; rat model; human cases	Diatoms	Light microscopy; SEM; MD-VF-Auto SEM; Auto-SEM; Microwave digestion; Digestion; Vacuum filtration; Filtration	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation	A,B;C;D	Moderate
78	Zhang et al. (2021)	lung tissue; liver; kidney; bone; blood / heart blood; water samples	Diatoms	Light microscopy; Deep learning; Machine learning; Artificial intelligence; Random forest	Drowning-site inference / environmental comparison; Automated detection/classification; Quantitative standardization/validation	A,B;C	High
79	Bhati et al. (2021)	water bodies; human cases	Diatoms; Algae	Light microscopy	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification	A;D	Low
80	Bhagyalakshmi et al. (2021)	water samples; water bodies; rat model	Diatoms	Light microscopy; SEM; Digestion	Drowning-site inference / environmental comparison; Automated detection/classification; Quantitative standardization/validation; Trace transfer / clothing evidence	A,C;D	Moderate
81	Cai et al. (2022)	Not clearly reported	Diatoms; 18S rRNA/rDNA	PCR; DNA sequencing	Drowning-site inference / environmental comparison; Automated detection/classification	A;D	High
82	Li et al. (2022)	lung tissue; liver; kidney; bone marrow; bone; blood / heart blood	Diatoms	Light microscopy; SEM; MD-VF-Auto SEM; Auto-SEM; Microwave digestion; Digestion; Vacuum filtration; Filtration	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation	A,B;C	High
83	Yu et al. (2022)	rat model; human cases	Diatoms	Not clearly reported	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Postmortem redistribution/alternative matrices	A;D	High
84	Voloshynovych et al. (2022)	kidney; rat model; human cases	Diatoms; Plankton	Light microscopy; PCR	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Trace transfer / clothing evidence	A;D	Moderate
85	Abhishek et al. (2021)	lung tissue; water samples; water bodies; rat model; human cases	Diatoms; Bacillariophyceae; Algae	Light microscopy; Digestion	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Contamination / false-positive interpretation	B;C;D	Moderate
86	Li et al. (2022)	Not clearly reported	Diatoms	Not clearly reported	Drowning-site inference / environmental comparison; Automated detection/classification	A,C;D	Low
87	Kaur et al. (2022)	lung tissue; bone marrow; bone; blood / heart blood; heart; drowning medium / water sample	Diatoms	Light microscopy; SEM; Digestion	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation	A,C;D	Moderate
88	Wu et al. (2022)	water samples	Diatoms	Light microscopy; SEM; Digestion	Drowning-site inference / environmental comparison; Automated	A,C;D	Moderate

Citation no.	First author et al. (year)	Sample type	Organism / marker	Analytical method	Forensic target	Thematic domain(s)	Relevance
89	Chakraborty et al. (2022)	water samples; water bodies; rat model; human cases	Diatoms	Light microscopy; Digestion	detection/classification; Quantitative standardization/validation Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation	A,C;D	Moderate
90	Sharma et al. (2022)	water samples; water bodies; rat model; image dataset	Diatoms	Light microscopy; SEM; Digestion	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Trace transfer / clothing evidence	A,C;D	Moderate
91	Zhu et al. (2022)	lung tissue; rat model; human cases	Diatoms	YOLO; Deep learning; Artificial intelligence	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation	A,B;C;D	High
92	Liu et al. (2022)	lung tissue; rat model; human cases	Diatoms; rbcL	PCR; Artificial intelligence	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification; Postmortem redistribution/alternative matrices	A,B;D	High
93	Zehra et al. (2023)	lung tissue; bone marrow; bone; blood / heart blood; spleen; water samples	Diatoms; Bacillariophyceae; Plankton; Algae	Light microscopy; Filtration	Drowning-site inference / environmental comparison; Automated detection/classification; Quantitative standardization/validation; Contamination / false-positive interpretation; Trace transfer / clothing evidence	A,C;D	Moderate
94	Su et al. (2023)	lung tissue; liver; kidney; bone marrow; bone; blood / heart blood	Diatoms; Plankton; Algae; Microbial/bacterial markers; 16S rDNA; Silicon / siliceous material	DNA sequencing; Deep learning; Random forest	Drowning-site inference / environmental comparison; Automated detection/classification	A,B;C;D	High
95	Bhardwaj et al. (2023)	lung tissue; bone marrow; bone; blood / heart blood; water samples; water bodies	Diatoms; Bacillariophyceae; Microalgae; Algae; Microbial/bacterial markers	Not clearly reported	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation	A,C;D	Low
96	Tournois et al. (2024)	lung tissue; liver; kidney; bone marrow; bone; blood / heart blood	Diatoms; Algae	Light microscopy; SEM; Digestion	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Trace transfer / clothing evidence	A,B;C;D	Moderate
97	Ma et al. (2025)	lung tissue; liver; kidney; bone marrow; bone; blood / heart blood	Diatoms; Algae; rbcL	Light microscopy; SEM; PCR	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Postmortem redistribution/alternative matrices	A,C;D	High
98	Nurdin et al. (2025)	rat model	Diatoms; Bacillariophyceae; Microalgae; Algae	Light microscopy	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation	A,C;D	Low
99	Su et al. (2025)	lung tissue; water samples; animal model; rat model; rabbit model; mouse model	Diatoms; Plankton; Microbial/bacterial markers; 16S rDNA	DNA sequencing; Machine learning	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Postmortem redistribution/alternative matrices	A,B;D	High
100	Rana et al. (2026)	water samples; water bodies; rat model; human cases	Diatoms	Light microscopy; SEM; Digestion	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Trace transfer / clothing evidence	A,C;D	Moderate
101	Zhang et al. (2026)	lung tissue; water samples; water bodies; rat model; human cases	Diatoms; Plankton; Algae; Microbial/bacterial markers; Microbiota	Light microscopy; SEM; DNA sequencing; Machine learning; Random forest	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation	A,B;C;D	High
102	Ju et al. (2026)	lung tissue; rat model; cadaver / human remains	Diatoms; Bacillariophyceae; Plankton; Algae; Microbial/bacterial markers	Light microscopy; SEM; DNA sequencing; Metabarcoding; Artificial intelligence	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Contamination / false-positive interpretation	A,B;C;D	High
103	Wang et al. (2015)	water samples; rat model; human cases	Diatoms	Light microscopy; SEM; Microwave digestion; Digestion; Filtration	Automated detection/classification; Quantitative standardization/validation	B;C;D	High
104	Zhao et al. (2015)	kidney; blood / heart blood; water samples; water bodies; rat model; human cases	Diatoms	Light microscopy; SEM	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation	B;C;D	Moderate
105	Zhao et al. (2017)	lung tissue; liver; kidney; bone marrow; bone; blood / heart blood	Diatoms	Light microscopy; SEM; MD-VF-Auto SEM; Auto-SEM; Microwave digestion; Digestion; Vacuum filtration; Filtration	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation	B;C;D	High
106	Zhou et al. (2020)	lung tissue; rat model; human cases; cadaver / human remains	Diatoms	Digestion; Deep learning; Artificial intelligence	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Contamination / false-positive interpretation	B;C	High
107	Yu et al. (2021)	lung tissue; liver; kidney; blood / heart blood; water bodies; rat model	Diatoms	Light microscopy; SEM; MD-VF-Auto SEM; Auto-SEM; Microwave digestion; Digestion; Vacuum filtration; Filtration	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Contamination / false-positive interpretation	B;C;D	High
108	Deng et al. (2021)	lung tissue; bone marrow; bone; blood / heart blood; rat model; human cases	Diatoms	Light microscopy; Artificial intelligence	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Contamination / false-positive interpretation	B;C;D	High
109	Chen et al. (2022)	lung tissue; liver; kidney; rat model; human	Diatoms	Light microscopy; SEM; YOLO; Deep learning; Artificial	Drowning diagnosis; Automated detection/classification;	B;C	High

Citation no.	First author et al. (year)	Sample type	Organism / marker	Analytical method	Forensic target	Thematic domain(s)	Relevance
		cases; image dataset		intelligence	Quantitative standardization/validation		
110	Yu et al. (2022)	lung tissue; liver; kidney; rat model; human cases; image dataset	Diatoms	Light microscopy; SEM; Artificial intelligence	Drowning diagnosis; Automated detection/classification	B;C;D	High
111	Yu et al. (2023)	lung tissue; rat model; human cases; cadaver / human remains; image dataset	Diatoms	Digestion; Artificial intelligence	Drowning-site inference / environmental comparison; Automated detection/classification; Quantitative standardization/validation	B;C;D	High
112	Hagen et al. (2023)	lung tissue; liver; kidney; bone marrow; bone; blood / heart blood	Diatoms; Algae	Light microscopy; SEM; MD-VF-Auto SEM; Auto-SEM; Microwave digestion; Digestion; Filtration	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Contamination / false-positive interpretation	B;C;D	High
113	Wu et al. (2024)	lung tissue; liver; kidney; water samples; rat model; human cases	Diatoms	Light microscopy; SEM; MD-VF-Auto SEM; Auto-SEM; Microwave digestion; Digestion; Vacuum filtration; Filtration	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Contamination / false-positive interpretation	B;C;D	High
114	Deng et al. (2024)	lung tissue; liver; kidney; bone marrow; bone; blood / heart blood	Diatoms	Light microscopy; SEM; Deep learning; Machine learning; Artificial intelligence	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation	B;C;D	High
115	Du et al. (2024)	lung tissue; liver; kidney; blood / heart blood; gastric contents; animal model	Diatoms	Light microscopy; SEM; MD-VF-Auto SEM; Auto-SEM; Microwave digestion; Digestion	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Contamination / false-positive interpretation	B;C;D	High
116	Deng et al. (2025)	liver; kidney; bone marrow; bone; rat model	Diatoms	Deep learning; Machine learning	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation	B;C;D	High
117	Xu et al. (2016)	liver; kidney; water samples; rat model; human cases	Diatoms; Plankton; Algae	Light microscopy; SEM; Microwave digestion; Digestion; Filtration	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Contamination / false-positive interpretation	C	High
118	Kakizaki et al. (2019)	lung tissue; liver; kidney; blood / heart blood; animal model; rat model	Diatoms	Digestion	Automated detection/classification; Quantitative standardization/validation	C	Low
119	Tsuneya et al. (2021)	lung tissue; water samples; animal model; rat model; human cases	Diatoms	Digestion	Automated detection/classification; Quantitative standardization/validation; Postmortem redistribution/alternative matrices	C;D	Moderate
120	Marezza et al. (2021)	lung tissue; liver; kidney; blood / heart blood; heart; spleen	Diatoms; Microalgae; Algae	Microwave digestion; Digestion	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation	C;D	Moderate
121	Tsuneya et al. (2022)	lung tissue; water samples; rat model; human cases	Diatoms	Light microscopy; Digestion	Automated detection/classification; Quantitative standardization/validation	C;D	Moderate
122	Tsuneya et al. (2023)	lung tissue; water samples; rat model; human cases; cadaver / human remains	Diatoms	Digestion	Automated detection/classification; Quantitative standardization/validation	C;D	Moderate
123	Guo et al. (2024)	lung tissue; water samples; rat model	Diatoms	Digestion	Automated detection/classification	C;D	Low
124	Zhao et al. (2019)	lung tissue; animal model; rat model; rabbit model	Diatoms	Light microscopy; SEM; Microwave digestion; Digestion; Vacuum filtration; Filtration	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation	C	High
125	Kalashnikov et al. (2025)	lung tissue; blood / heart blood; rat model	Diatoms	SEM	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation	C;D	Moderate
126	Pal et al. (2014)	bone; blood / heart blood; water samples; animal model; rat model; human cases	Diatoms	Light microscopy; SEM; Digestion	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation	C	Moderate
127	Myskowiak et al. (2017)	blood / heart blood; rat model; human cases; cadaver / human remains	Diatoms	SEM	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Contamination / false-positive interpretation	C	Moderate
128	More et al. (2018)	water samples; rat model	Diatoms; Algae	SEM	Drowning diagnosis; Automated detection/classification; Postmortem redistribution/alternative matrices	C	Low
129	Marella et al. (2019)	rat model; cadaver / human remains	Diatoms	SEM	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation	C;D	Moderate
130	Wang et al. (2020)	lung tissue; liver; kidney; heart; spleen; water samples	Diatoms	SEM	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation	C;D	Low
131	Khurshid et al. (2021)	bone; blood / heart blood; water samples; rat model; cadaver / human remains	Diatoms	Not clearly reported	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Contamination / false-positive interpretation	C;D	Moderate
132	Dervisevic et al. (2024)	lung tissue; kidney; blood / heart blood; rat model; human cases	Diatoms; Plankton; Algae	Light microscopy	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation	C;D	Moderate
133	Lee et al. (2026)	bone; rat model; human cases	Diatoms	SEM	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation	C;D	Moderate
134	Carlie et al. (2014)	bone; animal model; rat model; human cases	Diatoms; Algae	Not clearly reported	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Trace transfer / clothing evidence	C	Low

Citation no.	First author et al. (year)	Sample type	Organism / marker	Analytical method	Forensic target	Thematic domain(s)	Relevance
135	Sitthiwong et al. (2014)	lung tissue; liver; kidney; blood / heart blood; gastric contents; rat model	Diatoms; Algae	Light microscopy; Digestion	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Trace transfer / clothing evidence	C;D	Moderate
136	Rubio et al. (2014)	lung tissue; liver; bone marrow; bone; blood / heart blood; heart	Diatoms	Light microscopy; SEM	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Postmortem redistribution/alternative matrices	C;D	Low
137	Jakhar et al. (2015)	lung tissue; liver; kidney; bone marrow; bone; blood / heart blood	Diatoms; Bacillariophyceae; Algae	Light microscopy; SEM; Digestion	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation	C;D	Low
138	Pal et al. (2017)	lung tissue; kidney; bone marrow; bone; blood / heart blood; heart	Diatoms; Plankton	Digestion	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation	C;D	Moderate
139	Andrade et al. (2022)	lung tissue; bone marrow; bone; blood / heart blood; rat model; human cases	Diatoms; Algae	Light microscopy; SEM	Drowning diagnosis; Automated detection/classification; Trace transfer / clothing evidence	C;D	Low
140	Wang et al. (2015)	kidney; water samples; animal model; rat model; rabbit model	Diatoms	Light microscopy; SEM; Microwave digestion; Digestion; Vacuum filtration; Filtration	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Contamination / false-positive interpretation; Trace transfer / clothing evidence	C	Moderate
141	Fucci et al. (2015)	lung tissue; liver; kidney; bone marrow; bone; blood / heart blood	Diatoms; Plankton	Digestion	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Trace transfer / clothing evidence	C;D	Moderate
142	Kakizaki et al. (2015)	lung tissue; liver; kidney; bone marrow; bone; blood / heart blood	Diatoms	Digestion	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Contamination / false-positive interpretation	C	Moderate
143	Zhao et al. (2016)	lung tissue; liver; kidney; bone marrow; bone; blood / heart blood	Diatoms	Light microscopy; SEM; Microwave digestion; Digestion; Vacuum filtration; Filtration	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation	C;D	Moderate
144	Niu et al. (2018)	lung tissue; liver; kidney; bone marrow; bone; spleen	Diatoms	Light microscopy; SEM; Microwave digestion; Digestion; Vacuum filtration; Filtration	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation	C;D	Moderate
145	Besta et al. (2025)	lung tissue; liver; kidney; bone marrow; bone; heart	Diatoms	Light microscopy; Microwave digestion; Digestion; Vacuum filtration; Filtration	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Contamination / false-positive interpretation	C;D	Moderate
146	Saini et al. (2016)	lung tissue; bone marrow; bone; water samples; water bodies; rat model	Diatoms; Plankton; Algae	Light microscopy; SEM	Drowning-site inference / environmental comparison; Automated detection/classification	C	Low
147	Saini et al. (2017)	water samples; water bodies; rat model	Diatoms	Light microscopy; SEM; Digestion	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Trace transfer / clothing evidence	C;D	Moderate
148	Carballeira et al. (2018)	lung tissue; kidney; bone marrow; bone; spleen; water samples	Diatoms; Plankton	Light microscopy; Digestion	Drowning-site inference / environmental comparison; Automated detection/classification; Quantitative standardization/validation; Trace transfer / clothing evidence	C;D	Moderate
149	Thakar et al. (2018)	lung tissue; liver; kidney; bone marrow; bone; blood / heart blood	Diatoms; Bacillariophyceae; Plankton	Light microscopy; Digestion	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Contamination / false-positive interpretation	C;D	Moderate
150	Zalat et al. (2023)	lung tissue; liver; kidney; bone marrow; bone; blood / heart blood	Diatoms; Plankton	Light microscopy; Digestion	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Trace transfer / clothing evidence	C;D	Moderate
151	Bogusz et al. (2023)	lung tissue; kidney; bone marrow; bone; blood / heart blood; rat model	Diatoms	SEM	Drowning-site inference / environmental comparison; Automated detection/classification; Quantitative standardization/validation	C;D	Moderate
152	Rubini et al. (2018)	bone marrow; bone; animal model; rat model; human cases	Diatoms	Light microscopy	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation	C;D	Low
153	Magni et al. (2020)	water bodies; clothing / fabric; animal model; rat model; human cases	Diatoms; Algae	Light microscopy; SEM; Digestion	Drowning-site inference / environmental comparison; Automated detection/classification; Quantitative standardization/validation; Trace transfer / clothing evidence; Postmortem redistribution/alternative matrices	C;D	Moderate
154	Kihara et al. (2021)	lung tissue; liver; kidney; bone marrow; bone; blood / heart blood	Diatoms	Not clearly reported	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Contamination / false-positive interpretation	C;D	Moderate
155	Sonoda et al. (2022)	lung tissue; liver; kidney; bone marrow; bone; blood / heart blood	Diatoms	Digestion	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Contamination / false-positive interpretation	C;D	Moderate
156	Tambuzzi et al. (2022)	lung tissue; liver; kidney; bone marrow; bone; vitreous humor	Diatoms	Light microscopy; SEM; Digestion	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation	C;D	Moderate
157	Marshall et al. (2023)	lung tissue; bone marrow; bone; blood / heart	Diatoms; Bacillariophyceae; Algae	Light microscopy; SEM; Digestion	Drowning-site inference / environmental comparison; Drowning	C;D	Moderate

Citation no.	First author et al. (year)	Sample type	Organism / marker	Analytical method	Forensic target	Thematic domain(s)	Relevance
		blood; water samples; water bodies			diagnosis; Automated detection/classification; Quantitative standardization/validation; Contamination / false-positive interpretation		
158	Marshall et al. (2023)	lung tissue; bone marrow; bone; rat model; porcine model	Diatoms; Bacillariophyceae; Algae	Light microscopy; SEM	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Contamination / false-positive interpretation	C;D	Moderate
159	Bogusz et al. (2024)	lung tissue; kidney; bone marrow; bone; blood / heart blood; heart	Diatoms; Plankton	Light microscopy; SEM	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Contamination / false-positive interpretation	C;D	Moderate
160	Dervišević et al. (2024)	lung tissue; bone; animal model; rat model; human cases	Diatoms; Algae	Light microscopy	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation	C;D	Moderate
161	Tambuzzi et al. (2024)	lung tissue; liver; kidney; bone marrow; bone; blood / heart blood	Diatoms	Not clearly reported	Automated detection/classification; Quantitative standardization/validation; Contamination / false-positive interpretation	C;D	Moderate
162	Kihara et al. (2026)	lung tissue; liver; kidney; bone marrow; bone; blood / heart blood	Diatoms	Light microscopy	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Contamination / false-positive interpretation	C;D	Moderate
163	Lunetta et al. (2025)	lung tissue; liver; bone; water samples; rat model	Diatoms	Light microscopy; Digestion	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Contamination / false-positive interpretation	C;D	Moderate
164	Muccino et al. (2015)	rat model; cadaver / human remains	Diatoms	Not clearly reported	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification	D	Low
165	DU et al. (2022)	lung tissue; liver; kidney; gastric contents; water samples; rat model	Diatoms	Not clearly reported	Automated detection/classification; Quantitative standardization/validation	D	Low
166	Torres-Portugal et al. (2026)	water samples; rat model	Diatoms; Algae	Light microscopy	Drowning-site inference / environmental comparison; Automated detection/classification; Quantitative standardization/validation; Trace transfer / clothing evidence	D	Low
167	Ishikawa et al. (2019)	water samples; animal model; rat model; human cases; cadaver / human remains	Diatoms; Silicon / siliceous material	Light microscopy; SEM	Drowning-site inference / environmental comparison; Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation; Postmortem redistribution/alternative matrices	C	Low
168	Poulain et al. (2023)	lung tissue; blood / heart blood; heart; rat model	Diatoms; Algae	SEM	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation	C	Moderate
169	Handlos et al. (2025)	blood / heart blood; water bodies; rat model	Diatoms	Not clearly reported	Drowning diagnosis; Automated detection/classification; Quantitative standardization/validation	D	Moderate

Supplementary Table S2b. Main findings, reported advantages, and reported limitations of included studies

Condensed study-level synthesis information.

Citation no.	First author et al. (year)	Main findings	Reported advantages	Reported limitations
4	Tambuzzi et al. (2024)	Background: diatoms are unicellular algae that have been used for more than a century for forensic purposes to diagnose drowning, with more or less success depending on the historical era. Although many years have passed, scientific research on diatoms has never ceased, which testifies to their enduring allure in forensics.	Potentially improves molecular detection, environmental comparison, or site inference. May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Evidence may be narrative, case-based, or preliminary. Molecular/site-inference methods need external validation and robust environmental reference sampling. AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
5	Ludes et al. (2025)	This article evaluates the criteria for diatom testing in forensic investigations, focusing on drowning cases. Diatoms, unicellular algae found in aquatic environments, are critical to the determination of drowning because water containing diatoms is inhaled during submersion.	Potentially improves molecular detection, environmental comparison, or site inference. May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Evidence may be narrative, case-based, or preliminary. Molecular/site-inference methods need external validation and robust environmental reference sampling. AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
6	Tyr et al. (2025)	The diagnostic use of the diatom test for drowning has been under investigation for more than a century. Despite continuing research, its true usefulness remains controversial and under debate.	May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Evidence may be narrative, case-based, or preliminary. AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
7	Zhou et al. (2020)	In forensic practice, it is difficult to determine whether a dead body in the water resulted from drowning or from disposal after death. Diatom testing is currently an important supporting technique for the determination of death by drowning and of drowning sites, even though it is a time-consuming and laborious task.	Potentially improves molecular detection, environmental comparison, or site inference. May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Evidence may be narrative, case-based, or preliminary. Molecular/site-inference methods need external validation and robust environmental reference sampling. AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
8	Shen et al. (2019)	Diatom test has been a significant tool for the diagnosis of drowning. The reliability of the diatom test is still in strong dispute in the field of forensic science because of the false-positive results.	May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Evidence may be narrative, case-based, or preliminary. AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
9	Dahiya et al. (2024)	Background: Forensic diatomology is a rapidly progressing domain that involves the examination of microscopic algae known as diatoms for forensic purposes. Diatoms are microscopic, single-celled, eukaryotic algae that exist in diverse aquatic environments such as rivers, lakes, ponds, and oceans.	May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Evidence may be narrative, case-based, or preliminary. AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
10	Al-Najjar et al. (2026)	The study/report addresses Diatom Analysis in Drowning: A Critical Review of Reliability, Contamination, and Medico-Legal Interpretation in the context of forensic drowning or aquatic forensic evidence.	Potentially improves molecular detection, environmental comparison, or site inference. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Evidence may be narrative, case-based, or preliminary. Molecular/site-inference methods need external validation and robust environmental reference sampling. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
11	Yu et al. (2014)	PCR-Capillary electrophoresis technology was used to identify diatoms in lung, liver and kidney, and to assess the effects of these diatom species. From 20 randomly selected experimental rabbits, which were drowned in the same location, the liver, kidney and lung from each rabbit were removed and diatom DNA was extracted from the tissues of these organs and subsequently amplified by specific primers of the diatom SSU gene.	Potentially improves molecular detection, environmental comparison, or site inference. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
12	Jiang et al. (2020)	Diatom test is the most commonly used method to diagnose drowning in forensic laboratories. However, microscopic examination and identification of diatom frustules is time-consuming and requires taxonomic expertise.	Potentially improves molecular detection, environmental comparison, or site inference. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Evidence may be narrative, case-based, or preliminary. Molecular/site-inference methods need external validation and robust environmental reference sampling. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
13	Fang et al. (2019)	The development of DNA barcoding method has given rise to a promising way of studying genetic taxonomy. Our previous study showed that pyrosequencing profile of 18S rDNA V7 hypervariable region can be used for identifying water sources without resolving the exact components of diatom colonies in water samples.	Potentially improves molecular detection, environmental comparison, or site inference. May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
14	Nakanishi et al. (2024)	The diatom test is one of the methods used to diagnose drowning in forensic autopsies. Metagenomic diatom analysis may reveal where a drowning occurred.	Potentially improves molecular detection, environmental comparison, or site inference. May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
15	Zhang et al. (2025)	Objective To investigate the feasibility of diagnosing drowning by detecting plankton DNA in cardiac blood of cadavers recovered from water using real-time quantitative PCR (qPCR) . Methods Cardiac blood samples were collected via precordial puncture from 32 drowned cadavers and 10 non-drowned cadavers.	Potentially improves molecular detection, environmental comparison, or site inference. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
16	Yu et al. (2021)	In the field of drowning research, the method of diatom morphology has been most applied to determine whether the cause of death is drowning. However, the characteristics of complex operation, high level of professional knowledge drive us to propose a new method.	Potentially improves molecular detection, environmental comparison, or site inference. May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
17	Zhou et al. (2019)	Diatom examinations have been widely used to perform drowning diagnosis in forensic practice. However, current methods for recognizing diatoms, which use light or electron microscopy, are time-consuming and laborious and often result in false positive or negative decisions.	Potentially improves molecular detection, environmental comparison, or site inference. May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Evidence may be narrative, case-based, or preliminary. Molecular/site-inference methods need external validation and robust environmental reference sampling. AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
18	Gu et al. (2022)	The detected result of diatoms is an important indicator in forensic drowning examination, and most of the current deep learning methods have achieved greater success in detecting diatoms with simple or no backgrounds. However, diatom images captured by the high-definition electron scanning microscopy in modern forensic science contain complex backgrounds and hamper the accurate diatom detection, resulting in the omission detection of the smal...	May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
19	Yu et al. (2022)	The diatom test is a forensic technique that can provide supportive evidence in the diagnosis of	Potentially improves molecular detection, environmental comparison, or site inference. May	Evidence may be narrative, case-based, or preliminary. Molecular/site-inference methods need external

Citation no.	First author et al. (year)	Main findings	Reported advantages	Reported limitations
		drowning but requires the laborious observation and counting of diatoms using a microscopy with too much effort, and therefore it is promising to introduce artificial intelligence (AI) to make the test process automatic. In this article, we propose an artificial intelligence solution based on the YOLOv5 framework for the automatic detection and rec...	reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	validation and robust environmental reference sampling. AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
20	Zhang et al. (2023)	Background and Objective: Diatom testing is supportive for drowning diagnosis in forensic medicine. How-ever, it is very time-consuming and labor-intensive for technicians to identify microscopically a handful of diatoms in sample smears, especially under complex observable backgrounds.	May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
21	Zhao et al. (2015)	The cause of death for the decomposed corpses recovered from water is still a difficult issue in current forensic practice. In this article, we present two cases of bodies recovered from water with no positive findings to indicate the cause of their death.	Potentially improves molecular detection, environmental comparison, or site inference. May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Evidence may be narrative, case-based, or preliminary. Molecular/site-inference methods need external validation and robust environmental reference sampling. AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
22	Hu et al. (2026)	The diatom test has been a classical test for drowning diagnosis for over a century. While it is often regarded in literature as a reliable method—even a golden standard—its validity remains a subject of ongoing controversy.	Potentially improves molecular detection, environmental comparison, or site inference. May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
23	Zhu et al. (2022)	Objective: To select four algorithms with relatively balanced complexity and accuracy among deep learning image classification algorithms for automatic diatom recognition, and to explore the most suitable classification algorithm for diatom recognition to provide data reference for automatic diatom testing research in forensic medicine. Methods: The "diatom" and "background" small sample size data set (20 000 images) of digestive fluid smear o...	May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
24	Hagen et al. (2025)	The diagnosis of drowning represents a considerable challenge in forensic practice. Typically, it is made by excluding other potential causes of death while concurrently identifying key signs of drowning.	May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
25	Du et al. (2022)	Objective: To retrospectively analyze diatom test cases of corpses in water and discuss the value of quantitative analysis of diatoms in the diagnosis of drowning. Methods: A total of 490 cases of water-related death were collected.	May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
26	Zhao et al. (2016)	The presence of diatoms in the lung tissues, internal organs and bone marrow is considered as the supportive evidence in the diagnosis of death by drowning. Generally, the diatoms detected in the lung tissues are regarded as insignificant since these diatoms can be detected in the lung tissues of the postmortem immersion bodies.	May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Evidence may be narrative, case-based, or preliminary. AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
27	Du et al. (2022)	Diatom test has been widely used in the diagnosis of drowning and inferring the drowning site. One of the issues is whether the concordance of the diatom types and patterns between the drowning victim's organs and media should be considered an essential requirement for the diagnosis of drowning.	Potentially improves molecular detection, environmental comparison, or site inference. May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
28	Ren et al. (2021)	Objective: A diagnosis of drowning remains one of the most challenging issues in forensic science, especially for decomposed bodies. Diatom analysis is considered as an encouraging method for diagnosing drowning.	May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
30	Seo et al. (2014)	In order to devise a better forensic test for diatoms, the DNA binding ability of the diatom frustule constructing by silica, in the presence of chaotropic ions were utilized. It was proved that the diatoms were able to be captured via λ DNA using silica-coated magnetic beads (Mag beads), followed by isolation and purification from the Mag beads as a solid phase by substituting the chaotropic agent with ultrapure water.	Potentially improves molecular detection, environmental comparison, or site inference. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
31	Pierucci et al. (2016)	The aim of this paper was to evaluate silicon (Si) concentration in human whole ventricular blood as a further potential chemical marker in the diagnosis of drowning. We employed an acidic digestion for the extraction of soluble Si, and an alkaline digestion for the determination of total Si, including particulate matter, both arising from drowning medium.	Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
32	Piegari et al. (2019)	The detection of diatoms into the organs is considered an important “biological marker” for the diagnosis of drowning in human pathology, but it still has a high possibility for false positive results. The aims of this study were: (1) to evaluate the contribution of pathological examination in drowning cases and (2) to investigate the differences in the number and location of diatoms between animals who died in drowning and non-drowning condit...	Potentially improves molecular detection, environmental comparison, or site inference. Clarifies medico-legal interpretation or reliability of drowning evidence.	Evidence may be narrative, case-based, or preliminary. Molecular/site-inference methods need external validation and robust environmental reference sampling. Findings should be interpreted as supportive rather than standalone proof.
33	Liu et al. (2019)	Post-mortem diagnosis of drowning is a real challenge, especially in a decomposed body. The diatom test is considered a reliable scientific assessment in several countries including China.	Potentially improves molecular detection, environmental comparison, or site inference. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
34	Zhang et al. (2020)	Forensic diatom test has been considered as a significant tool for diagnosis of drowning. Most of the studies in this field discussed the methodology of extracting, enriching and detecting diatoms from different tissues and drowning media.	May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
35	Zhao et al. (2021)	Diatoms detected in human organs have been considered as supportive evidence for the diagnosis of drowning. During drowning, the vast majority of diatoms are retained in lung tissues, and only few are transported to distant organs via the bloodstream.	May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Evidence may be narrative, case-based, or preliminary. AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
36	Zhang et al. (2022)	Objective: To compare the application effect of microwave digestion - vacuum filtration - automated scanning electron microscopy (MD-VF-Auto SEM) method and plankton gene multiplex PCR system in the diagnosis of drowning. Methods: Lung, liver and kidney tissue of 10 non-drowning cases and 50 drowning cases were prepared for further MD-VF-Auto SEM method analysis and plankton gene multiplex PCR system analysis.	Potentially improves molecular detection, environmental comparison, or site inference. May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.

Citation no.	First author et al. (year)	Main findings	Reported advantages	Reported limitations
37	Liu et al. (2022)	Objective: To study the effects of temperature and time for diatoms digestion and find out suitable digestive temperature and time. Methods: Eighty pieces of liver tissues were collected, each piece of tissue was 2 g, and 2 mL Pearl River water was added to each piece of tissue.	May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
38	Cai et al. (2022)	Objective: To examine the effect of improving diatom DNA extraction by glass bead - vortex oscillation method. Methods: The DNeasy PowerSoil Pro kit was used as control, two plant DNA extraction kits with different principles (New Plant genomic DNA extraction kit and Plant DNA Isolation kit) and one whole blood DNA extraction kit (whole blood genomic DNA extraction kit) were selected to extract diatom DNA from lung tissue and water sample of t...	Potentially improves molecular detection, environmental comparison, or site inference. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
39	Tsuneysa et al. (2023)	A male in his late adolescence fell into the sea and was found 50 min later with cardiopulmonary arrest. He was revived approximately 260 min after he drowned.	Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Evidence may be narrative, case-based, or preliminary. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
40	Tsuneysa et al. (2024)	The source of diatoms detected in non-drowned bodies have been attributed to postmortem invasion, contamination during autopsy or diatom testing, or “natural load.” However, sand aspiration has not been reported as a source. Herein, we report an autopsy case in which diatoms were detected in a non-drowned human who had aspirated mud.	Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Evidence may be narrative, case-based, or preliminary. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
41	Szűcs et al. (2025)	Drowning is one of the leading causes of unintentional injury deaths. To deepen the comprehension of drowning epidemiology in our retrospective study, we analyzed 263 drowning cases across 12 distinct counties of Hungary in a six-year period.	Potentially improves molecular detection, environmental comparison, or site inference. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
42	Tsuneysa et al. (2025)	Introduction Diatoms inhaled with a drowning medium are thought to reach closed organs, including the kidney and liver, through circulation; however, this is uncertain. Thus, to assess this doubt, we evaluated the relationship between resuscitation or decomposition and diatom concentration in closed organs (kidney and liver) (Cc).	Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Evidence may be narrative, case-based, or preliminary. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
43	Badu et al. (2025)	Advanced putrefaction causes extensive loss of soft tissue, rendering it difficult to use the diatom test as a reliable diagnostic tool for drowning investigations. A positive diatom test in carrion insect larvae may provide significant assistance in overcoming the challenge of decomposition.	Potentially improves molecular detection, environmental comparison, or site inference. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Evidence may be narrative, case-based, or preliminary. Molecular/site-inference methods need external validation and robust environmental reference sampling. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
44	Rutty et al. (2015)	Bodies found immersed in water can pose difficulties to the investigating authorities. Pathologists may be assisted with the diagnosis by the use of tests such as the analysis for diatoms or the levels of strontium in the blood, although there is a recognised level of uncertainty associated with these tests.	Potentially improves molecular detection, environmental comparison, or site inference. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Evidence may be narrative, case-based, or preliminary. Molecular/site-inference methods need external validation and robust environmental reference sampling. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
45	Lee et al. (2017)	Pathological diagnosis of drowning remains a challenge for forensic science, because of a lack of pathognomonic findings. We analyzed microbiota and surfactant protein in the lungs for a novel diagnosis of drowning.	Potentially improves molecular detection, environmental comparison, or site inference. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
46	Kakizaki et al. (2018)	We developed a novel molecular tool for assisting the diagnosis of death by drowning and evaluated its validity in forensic practical cases. Two novel sets of loop-mediated isothermal amplification (LAMP) primers were designed to detect either representative freshwater (Aeromonas) or marine (Vibrio, Photobacterium, Listonella) bacterioplankton (aquatic bacteria) in one tube using the LAMP technique.	Potentially improves molecular detection, environmental comparison, or site inference. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
47	Li et al. (2015)	OBJECTIVE: To establish a method for amplifying specific 16S rDNA fragment of algae related with drowning and test its value in drowning diagnosis; METHODS: Thirty-five rabbits were randomly divided into 3 the drowning group (n=15), postmortem water immersion group (n=15, subjected to air embolism before seawater immersion), and control group(n=5, with air embolism only). Twenty samples of the liver tissues from human corpses found in water w...	Potentially improves molecular detection, environmental comparison, or site inference. May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
48	Uchigasaki et al. (2016)	The detection of plankton DNA is one of the important methods for the diagnosis of drowning from postmortem tissues. This study investigated the quantities of picoplankton (Cyanobacteria) DNA in the lung, liver, kidney tissues and blood of drowned and non-drowned rabbits, and the sensitivity of detection of picoplankton DNA by polymerase chain reaction (PCR) detect for the diagnosis of death from drowning.	Potentially improves molecular detection, environmental comparison, or site inference. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
49	Fucci et al. (2017)	In this preliminary study, a digestive method used in forensic context to extract diatoms has been applied in organs taken from ten wildlife animals belonging three species of mammals (a deer, a roe and five otters) and one species of birds (two magpies). Only four carcasses were recovered from aquatic environments (bath trough for animals, bathtub irrigation, river) and only in three cases out of ten that the cause of death was ruled out as d...	Potentially improves molecular detection, environmental comparison, or site inference. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Evidence may be narrative, case-based, or preliminary. Molecular/site-inference methods need external validation and robust environmental reference sampling. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
50	Nakanishi et al. (2018)	For diagnosing death due to drowning, the method of acid digestion of diatoms is widely used to detect plankton in the organs of the corpse. However, the method is limited by its being complex, hazardous, time-consuming, and insufficiently sensitive.	Potentially improves molecular detection, environmental comparison, or site inference. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
51	Yuan et al. (2018)	Objective: To identify the drop off location of victims in drowning cases, and confirm whether it is a fatal drowning or the victim is thrown into the water after death by detecting part of 5.8S sequence and second internal transcribed spacer (ITS2) (5.8S+ITS2) of diatom rDNA in water and organs. Methods: Two cases identified by diatom examination, which received by Nanjing Municipal Public Security Bureau Forensic Center, were taken as the re...	Potentially improves molecular detection, environmental comparison, or site inference. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
52	Vinayak et al. (2020)	Diatoms are unicellular microalgae with cell wall made up of rigid silica found in all open water bodies. They thus resist degradation and hence are important tool to diagnose cause of death in drowned bodies.	Potentially improves molecular detection, environmental comparison, or site inference. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
53	Li et al. (2021)	Objective: To construct a polymerase chain reaction-capillary electrophoresis (PCR-CE) detection method using ChlB gene and NIES gene, investigate the method's specificity and sensitivity, and	Potentially improves molecular detection, environmental comparison, or site inference. May reduce manual workload and observer-dependent classification. Supports more	Molecular/site-inference methods need external validation and robust environmental reference sampling. AI workflows depend on annotated datasets and external validation. Comparability may be affected by

Citation no.	First author et al. (year)	Main findings	Reported advantages	Reported limitations
		to evaluate its application value in drowning diagnosis. Methods: The specific primers ChlB and NIES were designed for the conserved sequence of chlorophyte ChlB gene and cyanophyte NIES gene in GenBank to construct PCR-CE detection method; 50 species of...	standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
54	Xiao et al. (2021)	In recent years, the DNA detection of drowning-related diatoms, cyanobacteria, and aeromonas has gradually attracted interest from forensic scientists. In this study, we described the validation and application of a novel multiplex PCR system.	Potentially improves molecular detection, environmental comparison, or site inference. May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
55	Liu et al. (2021)	Considering a quite high proportion of sequences deposited in GenBank were mislabeled, the most urgent task for DNA barcoding of diatoms is to create standard sequences using correctly identified specimens, ideally type specimens. The presence of diatoms in victim's internal organs has been regarded as a gold biological evidence of drowning. The idea becomes true at the advent of DNA metabarcoding.	Potentially improves molecular detection, environmental comparison, or site inference. May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
56	Kakizaki et al. (2022)	Low rates of diatom positivity in the closed organs of drowning victims present challenges for diatom testing. High positivity rates in closed organs of non-drowning victims also raise an important issue.	Potentially improves molecular detection, environmental comparison, or site inference. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Evidence may be narrative, case-based, or preliminary. Molecular/site-inference methods need external validation and robust environmental reference sampling. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
57	Szűcs et al. (2022)	A diagnosis of drowning is not always possible based on the traditional autopsy findings. The most widely used ancillary methods are based on the detection of diatoms and other waterborne organisms in the organs of the systemic circulation by light microscope or polymerase chain reaction (PCR).	Potentially improves molecular detection, environmental comparison, or site inference. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
58	Zhou et al. (2023)	Diatom testing is an essential auxiliary means in forensic practice to determine whether the corpse drowned in water and to infer the drowning location. Diatom testing is also an important research content in the field of the environment and plankton.	Potentially improves molecular detection, environmental comparison, or site inference. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
59	Zhang et al. (2025)	Objective To compare the application effects of plankton multiplex polymerase chain reaction – capillary electrophoresis (PCR – CE), SYBR Green I real-time quantitative PCR (qPCR) and microwave digestion–vacuum filtration–automated scanning electron microscopy (MD–VF–Auto SEM) in the diagnosis of drowning. Methods Lung, liver and kidney tissues from 212 drowned corpses and 30 non-drowned corpses were examined respectively by the three drowning-...	Potentially improves molecular detection, environmental comparison, or site inference. May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
60	Su et al. (2025)	Background: Drowning diagnosis has long been a critical issue in forensic research, influenced by various factors such as the environment and decomposition time. While traditional methods such as diatom analysis have limitations in decomposed remains, microbial community profiling offers a promising alternative.	Potentially improves molecular detection, environmental comparison, or site inference. May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
61	Lin et al. (2014)	We report on the presence, distribution and numbers of diatoms within specific organs as a result of drowning in fresh, treated and seawater. Specimens of sphenoid sinus fluid and lung tissue from 100 cases of suspected drowning and 20 cases where death was by natural causes, to act as a control, were examined for the presence of diatoms.	Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
62	Sasidharan et al. (2014)	Diatom investigation has invited a lot of criticisms and controversies in the diagnosis of drowning. Distribution of diatoms widely varies between different water bodies depending on the various parameters of a water body.	Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
63	Badu et al. (2015)	A diagnosis of drowning is a challenge in legal medicine, as there is generally a lack of pathognomonic findings indicative of drowning. Diatom analysis has been considered very supportive for a diagnosis of drowning, although the test is still controversial for some investigators.	Potentially improves molecular detection, environmental comparison, or site inference. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
64	Zhuo et al. (2016)	Diatom test (forensic diatomology) is commonly considered as the 'gold standard' in the diagnosis of drowning in forensic practices. The diatomology contributes significantly not only in determining the mode of death but also in determining the site of drowning because of various distribution characterizations of diatoms in different water bodies or different seasons.	Potentially improves molecular detection, environmental comparison, or site inference. May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Evidence may be narrative, case-based, or preliminary. Molecular/site-inference methods need external validation and robust environmental reference sampling. AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
65	Singh et al. (2016)	In the present study, diatomological composition of main drowning sites of the three Rivers of Mizoram state in the Northeast India has been studied. The aim is to establish a database of diatoms to help in the diagnosis of suspected drowning cases occurring in this region.	Potentially improves molecular detection, environmental comparison, or site inference. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Evidence may be narrative, case-based, or preliminary. Molecular/site-inference methods need external validation and robust environmental reference sampling. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
66	Coelho et al. (2016)	The role of the investigation of diatoms' presence in organs and body fluids of an individual found dead in a liquid medium and the relevant contribution to the forensic diagnosis of drowning remain controversial. Furthermore, the absence of an exact and well-defined method for diatoms' analysis makes its study a challenging task. Considering this medico-legal problem and the absence of forensic studies on this subject in Portugal, this work ai...	Potentially improves molecular detection, environmental comparison, or site inference. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Evidence may be narrative, case-based, or preliminary. Molecular/site-inference methods need external validation and robust environmental reference sampling. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
67	Rácz et al. (2016)	Proper diagnosis in drowning victims is often difficult due to the lack of signs specific to drowning. The diatom test is a widely used procedure for the diagnosis.	Potentially improves molecular detection, environmental comparison, or site inference. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Evidence may be narrative, case-based, or preliminary. Molecular/site-inference methods need external validation and robust environmental reference sampling. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
68	Kaushik et al. (2017)	Background: The most frequent use of diatoms in forensic science is the diagnosis of death due to drowning. The basic principle of diatom test in drowning is based on the inference that diatoms are present in medium where drowning took place and the inhaled water enters the alveolar spaces of lungs and penetrates from the alveoli into the blood circulation, thus microscopic unicellular algae called diatoms get transported to different organs o...	Potentially improves molecular detection, environmental comparison, or site inference. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Evidence may be narrative, case-based, or preliminary. Molecular/site-inference methods need external validation and robust environmental reference sampling. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
69	Idota et al. (2018)	When a body is discovered in water, it is difficult to conclude whether the cause of death was	Potentially improves molecular detection, environmental comparison, or site inference. May	Molecular/site-inference methods need external validation and robust environmental reference sampling.

Citation no.	First author et al. (year)	Main findings	Reported advantages	Reported limitations
		drowning, even today. Although diatom testing by the digestive method is classical, we hypothesized that aquatic bacteria, as well as diatoms, might be detected in drowned bodies, and conducted temperature gradient gel electrophoresis (TGGE)-targeting 16S rDNA.	reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
70	Kaur et al. (2018)	Renuka lake is one of the famous tourist and religious destination in the Sirmaur district of Himachal Pradesh. Number of tourist come to visit this lake every year and in recent past many cases of drowning have been reported.	Potentially improves molecular detection, environmental comparison, or site inference. May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
71	Bak et al. (2018)	The study addresses the utility of diatoms in deciding whether a woman whose body was found in a river had died as a result of drowning. Several hours after the woman had been reported missing, a rescue dog led the police to a concrete water tank close to her workplace.	Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Evidence may be narrative, case-based, or preliminary. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
72	Zhao et al. (2018)	Diatom examination has always been used for the diagnosis of drowning in forensic practice. However, traditional examination of the microscopic features of diatom frustules is time-consuming and requires taxonomic expertise.	Potentially improves molecular detection, environmental comparison, or site inference. May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
73	Hu et al. (2019)	Objective To detect the diatom population diversity in Dianchi by constructing a 18S rDNA clone library. Methods DNA from diatoms in 6 water samples of Dianchi was amplified with diatom 18S rDNA specific primer.The 18S rDNA clone library was constructed, and clones were randomly selected for sequence.	Potentially improves molecular detection, environmental comparison, or site inference. May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
74	Li et al. (2019)	In forensic science, the determination of diatoms bears several goals, for example to estimate the post mortem interval (PMI), to determine the cause of death of a corpse found in water as well as to further locate the suspected drowning site. However, to identify diatoms using morphological method beyond the genus level is difficult and requires expert knowledge.	Potentially improves molecular detection, environmental comparison, or site inference. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
75	Voloshynovych et al. (2019)	Forensic medical diagnostics of drowning now is a difficult issue to resolve. Determination of diatom plankton with light microscopy is one of the supplementary methods for diagnostics of drowning.	Potentially improves molecular detection, environmental comparison, or site inference. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
76	Liu et al. (2020)	In the field of criminal investigations, in the event that a body is found in water, the ability to differentiate whether the cause of death was drowning or the body was murdered then dumped into water elsewhere is difficult but important for case detection. Detecting diatoms in human organs can be used to effectively identify if the cause of death was drowning.	Potentially improves molecular detection, environmental comparison, or site inference. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Evidence may be narrative, case-based, or preliminary. Molecular/site-inference methods need external validation and robust environmental reference sampling. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
77	Zhang et al. (2020)	The diagnosis of drowning is one of the most difficult in forensic medicine. Forensic diatomology has been proposed to be useful in solving the diagnosis of drowning and considered to be a reliable indicator of the site of drowning.	Potentially improves molecular detection, environmental comparison, or site inference. May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
78	Zhang et al. (2021)	Seasonal or monthly databases of the diatom populations in specific bodies of water are needed to infer the drowning site of a drowned body. However, existing diatom testing methods are laborious, time-consuming, and costly and usually require specific expertise.	Potentially improves molecular detection, environmental comparison, or site inference. May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
79	Bhati et al. (2021)	Diatoms are unicellular, photosynthesizing algae found in fresh and marine waters as well as in moist soil. This research aims to identify different diatoms present in different water bodies in Delhi region.	Potentially improves molecular detection, environmental comparison, or site inference. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. Findings should be interpreted as supportive rather than standalone proof.
80	Bhagyalakshmi et al. (2021)	CONTEXT: In forensic analysis diatoms plays an important role. Their structure and morphology is widely used to identify the location.	Potentially improves molecular detection, environmental comparison, or site inference. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
81	Cai et al. (2022)	The study/report addresses Application Progress of High-Throughput Sequencing Technology in Forensic Diatom Detection in the context of forensic drowning or aquatic forensic evidence.	Potentially improves molecular detection, environmental comparison, or site inference. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Evidence may be narrative, case-based, or preliminary. Molecular/site-inference methods need external validation and robust environmental reference sampling. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
82	Li et al. (2022)	Diatoms detected in the organs of corpses are considered reliable indicators for the diagnosis of drowning. However, this remains a disputed area regarding the consistency of diatom types and patterns in the organs and drowning medium.	Potentially improves molecular detection, environmental comparison, or site inference. May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Evidence may be narrative, case-based, or preliminary. Molecular/site-inference methods need external validation and robust environmental reference sampling. AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
83	Yu et al. (2022)	Objective: To explore the research hotspots and development trends of the field of forensic drowning from 1991 to 2020 by bibliometrics methods. Methods: Based on Web of Science, CNKI database, Wanfang Data knowledge service platform, python 3.9.2, CiteSpace 5.8.R3, Gephi 0.9.2, etc.	Potentially improves molecular detection, environmental comparison, or site inference. May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
84	Voloshynovych et al. (2022)	The article describes the current possibilities of forensic medicine in the diagnosis of death by drowning, as well as reflects the different views of the authors and the evolution of approaches to this issue. Despite the constant interest of scientists in the topic of drowning and extensive research on this issue, there are still many white spots.	Potentially improves molecular detection, environmental comparison, or site inference. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Evidence may be narrative, case-based, or preliminary. Molecular/site-inference methods need external validation and robust environmental reference sampling. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
85	Abhishek et al. (2021)	Diatoms are eukaryotic, unicellular algae that belong to a Bacillariophyceae family and it exists in water. Diatom is important in determining whether or not a person died as a result of drowning.	Potentially improves molecular detection, environmental comparison, or site inference. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
86	Li et al. (2022)	The study/report addresses Change Rule of Diatom in Zhangweixin River in Dezhou in the context of forensic drowning or aquatic forensic evidence.	Potentially improves molecular detection, environmental comparison, or site inference. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.

Citation no.	First author et al. (year)	Main findings	Reported advantages	Reported limitations
87	Kaur et al. (2022)	Diatom test is widely used for ascertaining the place of drowning as well as the manner of drowning i.e. ante or post mortem drowning.	Potentially improves molecular detection, environmental comparison, or site inference. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
88	Wu et al. (2022)	The study/report addresses Distribution of Diatoms in the Navigable Sections of Beijing-Hangzhou Grand Canal in the context of forensic drowning or aquatic forensic evidence.	Potentially improves molecular detection, environmental comparison, or site inference. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
89	Chakraborty et al. (2022)	Background: The 'Diatom test' is a reliable method which helps to determine the cause of death due to drowning based on quantitative and qualitative analysis of diatoms in human body and reference water sample. Positivity of this test is considered as an indicator of antemortem drowning.	Potentially improves molecular detection, environmental comparison, or site inference. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Evidence may be narrative, case-based, or preliminary. Molecular/site-inference methods need external validation and robust environmental reference sampling. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
90	Sharma et al. (2022)	Diatoms are regarded as valuable evidence to correlate the cause of death. In the present study, 17 water samples were collected from different sites of Gomti river ghats of Lucknow and Jaunpur district.	Potentially improves molecular detection, environmental comparison, or site inference. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
91	Zhu et al. (2022)	Diatom test is the main laboratory test method in the diagnosis of drowning in forensic medicine. It plays an important role in differentiating the antemortem drowning from the postmortem drowning and inferring drowning site.	Potentially improves molecular detection, environmental comparison, or site inference. May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Evidence may be narrative, case-based, or preliminary. Molecular/site-inference methods need external validation and robust environmental reference sampling. AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
92	Liu et al. (2022)	Drowning is the death caused by asphyxiation due to fluid blocking the airway. In the practice of forensic medicine, it is the key to determine whether the corpse was drowned or entered the water after death.	Potentially improves molecular detection, environmental comparison, or site inference. May reduce manual workload and observer-dependent classification. Clarifies medico-legal interpretation or reliability of drowning evidence.	Evidence may be narrative, case-based, or preliminary. Molecular/site-inference methods need external validation and robust environmental reference sampling. AI workflows depend on annotated datasets and external validation. Findings should be interpreted as supportive rather than standalone proof.
93	Zehra et al. (2023)	Introduction Drowning and recovery of human corpses from water bodies is a common phenomenon worldwide. The season-dependent and site specific phytoplankton in the water get aspirated into the human body through the lungs in the process of drowning.	Potentially improves molecular detection, environmental comparison, or site inference. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
94	Su et al. (2023)	Diagnosing the drowning site is a major challenge in forensic practice, particularly when corpses are recovered from flowing rivers. Recently, forensic experts have focused on aquatic microorganisms, including bacteria, which can enter the bloodstream during drowning and may proliferate in corpses.	Potentially improves molecular detection, environmental comparison, or site inference. May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Evidence may be narrative, case-based, or preliminary. Molecular/site-inference methods need external validation and robust environmental reference sampling. AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
95	Bhardwaj et al. (2023)	In forensic pathology, solving the crime mystery of death due to drowning still remains a challenging issue. The amalgamation of autopsy findings and comparative study of diatoms recovered from the victim's body organs and suspected drowning site help to decipher the cause of death due to drowning or post-mortem immersion.	Potentially improves molecular detection, environmental comparison, or site inference. Clarifies medico-legal interpretation or reliability of drowning evidence.	Evidence may be narrative, case-based, or preliminary. Molecular/site-inference methods need external validation and robust environmental reference sampling. Findings should be interpreted as supportive rather than standalone proof.
96	Tournois et al. (2024)	The diagnosis of drowning is one of the most difficult tasks in forensic medicine. The diatom test is a complementary analysis method that may help the forensic pathologist in the diagnosis of drowning and the localization of the drowning site.	Potentially improves molecular detection, environmental comparison, or site inference. May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
97	Ma et al. (2025)	Diatom taxonomy is integral to drowning site inference, aiding in event reconstruction and the differentiation between accidental, suicidal and homicidal drownings. Traditional methods, however, are labor-intensive, require significant expertise and depend on expensive instruments such as scanning electron microscopy (SEM) at high magnifications.	Potentially improves molecular detection, environmental comparison, or site inference. May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
98	Nuridin et al. (2025)	The study/report addresses Diatom Colonization on Cowhide Substrate in Batang Kuranji River, Padang City, for Forensic Drowning Diagnosis in the context of forensic drowning or aquatic forensic evidence.	Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
99	Su et al. (2025)	Drowning incidents present significant challenges for forensic investigators in determining the exact site of occurrence. Traditional forensic methods often rely on physical evidence and circumstantial clues, but the emerging field of forensic microbiology offers a promising avenue for enhancing precision and reliability in site inference.	Potentially improves molecular detection, environmental comparison, or site inference. May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
100	Rana et al. (2026)	Determining antemortem drowning in medico-legal casework remains a persistent forensic challenge, particularly in bodies exhibiting advanced putrefactive changes, where conventional morphological indicators are no longer discernible. Forensic diatomology provides a critical microtrace-evidence framework for substantiating drowning and enabling immersion-site attribution through ecological fingerprinting of diatom assemblages.	Potentially improves molecular detection, environmental comparison, or site inference. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
101	Zhang et al. (2026)	Accurate inference of drowning sites remains a critical challenge in forensic investigations, particularly for corpses recovered from dynamic aquatic environments. Conventional methods, such as diatom testing, are limited by the absence or scarcity of diatoms in certain water bodies, labor-intensive morphological identification, and challenges in distinguishing morphologically similar species.	Potentially improves molecular detection, environmental comparison, or site inference. May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
102	Ju et al. (2026)	Aquatic microbial communities-particularly phytoplankton and diatoms-have emerged as precise and reliable bioindicators for forensic site identification. This review offers a comprehensive synthesis of advancements in traditional microscopy, molecular techniques (such as environmental DNA and metabarcoding), artificial intelligence (AI)-driven analysis, presenting an integrative framework for the field of forensic hydroecology.	Potentially improves molecular detection, environmental comparison, or site inference. May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Evidence may be narrative, case-based, or preliminary. Molecular/site-inference methods need external validation and robust environmental reference sampling. AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
103	Wang et al. (2015)	OBJECTIVE: To compare the efficacy of three methods for forensic diatom test, namely strong acid digestion-centrifuge enrichment-light microscopy (SD-CE-LM), microwave digestion-membrane filtration-automated scanning electron microscopy (MD-ME-SEM), and microwave digestion-membrane filtration-light microscopy (MD-MF-LM); METHODS: Sixty samples were randomly divided into 3 groups for diatom test using three methods, and the sample preparation ...	May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.

Citation no.	First author et al. (year)	Main findings	Reported advantages	Reported limitations
104	Zhao et al. (2015)	The diatom test is the most reliable approach that provides scientific support for diagnosis of drowning. However, there are limitations, which, made forensic scientists stop using the test, such as the fact that it is time-consuming and lack of domain knowledge of the diatom identification.	May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
105	Zhao et al. (2017)	The value of diatom test for the diagnosis of drowning remains controversial. The conventional forensic diatom test with low sensitivity is not a useful tool to provide accurate information about diatom in the tissues and organs.	May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Evidence may be narrative, case-based, or preliminary. AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
106	Zhou et al. (2020)	: : , , , , 10, , , , (receiver operator characteristic, ROC) (area under the curve, AUC) 98.22%, 92.45%, , , , .	Potentially improves molecular detection, environmental comparison, or site inference. May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
107	Yu et al. (2021)	Forensic diatom test has been widely accepted as a way of providing supportive evidences in the diagnosis of drowning. The current workflow is primarily based on the observation of diatoms by forensic pathologists under a microscopy, and this process can be very time-consuming.	Potentially improves molecular detection, environmental comparison, or site inference. May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Evidence may be narrative, case-based, or preliminary. Molecular/site-inference methods need external validation and robust environmental reference sampling. AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
108	Deng et al. (2021)	Diatom test is one of the commonly used diagnostic methods for drowning in forensic pathology, which provides supportive evidence for drowning. However, in forensic practice, it is time-consuming and laborious for forensic experts to classify and count diatoms, whereas artificial intelligence (AI) is superior to human experts in processing data and carrying out classification tasks.	May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
109	Chen et al. (2022)	Objective: To construct a YOLOv3-based model for diatom identification in scanning electron microscope images, explore the application performance in practical cases and discuss the advantages of this model. Methods: A total of 25 000 scanning electron microscopy images were collected at 1 500× as an initial image set, and input into the YOLOv3 network to train the identification model after experts' annotation and image processing.	May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
110	Yu et al. (2022)	Objective: To explore the application values of diatom artificial intelligence (AI) search system in the diagnosis of drowning. Methods: The liver and kidney tissues of 12 drowned corpses were taken and were performed with the diatom test, the view images were obtained by scanning electron microscopy (SEM).	May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
111	Yu et al. (2023)	[Objective] Artificial intelligence(AI)full smear automated diatom detection technology can perform forensic pathology drowning diatom detection more quickly and efficiently than human experts.However,this technique was only used in conjunction with the strong acid digestion method,which has a low extraction rate of diatoms. In this study, we propose to use the more efficient proteinase K tissue digestion method(hereinafter referred to as enzy...	Potentially improves molecular detection, environmental comparison, or site inference. May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
112	Hagen et al. (2023)	If a dead body is discovered in water, it nearly always raises the question about the cause of death, often associated with the persistent problem to differentiate between a drowning incident and post-mortem immersion. In numerous cases, a reliable confirmation of death by drowning is often only possible by a combination of diagnoses obtained from autopsy and additional investigations.	May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
113	Wu et al. (2024)	Diatom testing is considered a useful method for providing supportive evidence for the diagnosis of drowning in forensic pathology. However, various factors remain controversial for recognizing diatoms, such as being time-consuming and laborious and influencing the consistency of the results.	May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
114	Deng et al. (2024)	Detection and classification of diatoms has been considered as the most effective method for the drowning diagnosis in forensic practice. However, challenges (such as limited samples, complex background interference, and detecting multiple objects) remain during detection and classification.	Potentially improves molecular detection, environmental comparison, or site inference. May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
115	Du et al. (2024)	The diatom test has been used by forensic pathologist as standard for drowning, but the occurrence of false-positive results (presence of diatoms found in the tissues of subjects who died from causes other than drowning) draws criticism regarding the specificity of the test. Diatoms within food or water can be ingested through the gastrointestinal tract.	May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
116	Deng et al. (2025)	In the field of forensic science, diatom testis widely utilized to determine the cause and location of death for bodies found in water. Diatom detection plays an important role in the diatom test.	Potentially improves molecular detection, environmental comparison, or site inference. May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
117	Xu et al. (2016)	Diatoms are significant symbols for diagnosis of reasons for drowning. The conventional acidity digestion complied with centrifugation extraction has been controversial for its low efficiency.	May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
118	Kakizaki et al. (2019)	Diatom analysis is very effective for positive diagnosis of water inhalation in drowning. However, conventional strong acid diatom testing is laborious and potentially dangerous.	Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
119	Tsuneya et al. (2021)	Objective: To determine the efficacy of using sodium hypochlorite (NaClO, Purelox) as a simple and rapid alternative digestion method for the diatom test through a quantitative comparison with the conventional method that uses fuming nitric acid (HNO3).Materials and methods: In experiment 1, using 30 water samples, the NaClO and HNO3 methods were compared using paired t-test. In experiments 2 and 3, we included blank human lung plus 13 water s...	Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
120	Marezza et al. (2021)	The best method of diatom identification in animal and human tissues is still an important discussion topic, in terms of effectiveness and reliability. In this technical note, authors propose a new method of extraction of diatoms using heated hydrogen peroxide from animal and human	Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.

Citation no.	First author et al. (year)	Main findings	Reported advantages	Reported limitations
		tissue samples.		
121	Tsuneya et al. (2022)	Background: The diatom test method using sodium hypochlorite (NaClO) was equivalent to the conventional method in water samples. However, the method using NaClO was inferior to the conventional method in lung samples, in which ethanol was used and the reaction with NaClO was longer compared with the method in water samples.	Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
122	Tsuneya et al. (2023)	Objective: To study the quantitative effect of ethanol on the diatom test for water and lung samples. Materials and methods: In experiment 1, we tested 20 water samples taken from natural water areas.	Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
123	Guo et al. (2024)	The study/report addresses Application of Protease-Hydrogen Peroxide Digestion Method in Forensic Diatom Examination in the context of forensic drowning or aquatic forensic evidence.	Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
124	Zhao et al. (2019)	∴ ∴ ∴ ∴ ∴ ∴ (ratio of content of diatoms in lung tissue and drowning fluid, CL/CD) ∴ CL/CD (5.82±3.50) (0.47±0.35) ; CL/CD ∴ ∴ ∴ ∴ ∴ CL/CD (P<0.05) ∴ ∴ CL/CD>1.6. CL/CD, ∴	May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
125	Kalashnikov et al. (2025)	BACKGROUND: Determination of the cause of death during forensic autopsy of bodies recovered from water remains a challenging expert task. The diagnostic algorithm relies on a comprehensive assessment of specific morphological features of drowning, general asphyxial manifestations, and laboratory findings.	Potentially improves molecular detection, environmental comparison, or site inference. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
126	Pal et al. (2014)	A teenage boy went to see a wrestling bout in nearby village and disappeared mysteriously. On presumption of death under suspicious circumstances, the parents lodged a complaint and a murder case was registered in police station under section 302, 34 IPC.	Potentially improves molecular detection, environmental comparison, or site inference. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Evidence may be narrative, case-based, or preliminary. Molecular/site-inference methods need external validation and robust environmental reference sampling. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
127	Myskowiak et al. (2017)	Diatoms are a reliable diagnostic tool for drowning. Yet, they are at the origin of controversies due to limits linked to the discovery site, discrepancies in the results induced by the methods used or non-conformities affecting the expression of the results.	Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
128	More et al. (2018)	An experimental case was designed at Ballygunge campus pond (22 degrees 31' N, 88 degrees 21' E) of the University of Calcutta, India for determining the applicability of fresh water diatoms in solving aquatic crime related cases. One volunteer acted as a "Victim" and another as an "Assailant".	Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
129	Marella et al. (2019)	Introduction: The diagnosis of drowning is one of the major challenges in the field of forensic medicine and usually it is a diagnosis of exclusion. Traditionally, the post-mortem diagnosis of drowning is based on the combination in one diagnosis both the alterations, caused by the type of asphyxia, and those due to the thanatological changes, caused by the duration of the corpse in water.	Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Evidence may be narrative, case-based, or preliminary. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
130	Wang et al. (2020)	Rationale: Postmortem forensic imaging technologies provide a noninvasive/minimally invasive approach for imaging of internal organ structures of the human body to detect injuries, diseases, and other morphologic changes. Currently, postmortem forensic imaging methods have been widely used in determination of the cause of death.	Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Evidence may be narrative, case-based, or preliminary. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
131	Khurshid et al. (2021)	Medico-legal investigations should be performed on all unnatural (homicide, suicide, or accident), unexpected, and suspicious deaths to evaluate the possibility of homicide and ascertain the exact cause of death. However, in some scenarios, burial takes place before an autopsy can be conducted.	Potentially improves molecular detection, environmental comparison, or site inference. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Evidence may be narrative, case-based, or preliminary. Molecular/site-inference methods need external validation and robust environmental reference sampling. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
132	Dervisevic et al. (2024)	Background: There is no specified diagnostic procedure that can help in determining the cause of death and the diagnosis of drowning because the pathohistological signs are almost identical and non-specified. Aim: Our study aims to recognize and prove diatom appearance in organs from a forensic aspect in Bosnia and Herzegovina, and to examine which is the more specific method in the diagnosis of drowning, the diatom test or the pathohistologic...	Potentially improves molecular detection, environmental comparison, or site inference. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
133	Lee et al. (2026)	BACKGROUND: Drowning is defined as a process of respiratory impairment caused by submersion in water and is a significant cause of death worldwide. However, postmortem diagnosis of drowning remains a major challenge in forensic pathology, primarily because it relies on the exclusion of all other possible causes based on only a few pathognomonic findings during autopsy, particularly in cases involving decomposition.	Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Evidence may be narrative, case-based, or preliminary. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
134	Carlie et al. (2014)	The discovery of a child's skeleton in a Late Neolithic well in Sweden raises again the issue of watery rituals and human sacrifice in prehistoric societies. Analysis of diatoms from the right humerus and from the surrounding sediment indicated that the child died by drowning and had not simply been disposed of in the well after death.	Clarifies medico-legal interpretation or reliability of drowning evidence.	Findings should be interpreted as supportive rather than standalone proof.
135	Sitthiwong et al. (2014)	Forensic diatomology is an important method of gaining supporting evidence in the investigation of drowning cases. In this research, diatom species were detected and identified in the tissues of twelve corpses that were found submerged in water.	Potentially improves molecular detection, environmental comparison, or site inference. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
136	Rubio et al. (2014)	The identification of fatal mechanisms involving drowning represents a difficult task for the forensic pathologists. Here, we analysed macromorphological, histopathological and microbiological findings that influence the lung weight of drowning.	Potentially improves molecular detection, environmental comparison, or site inference. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Evidence may be narrative, case-based, or preliminary. Molecular/site-inference methods need external validation and robust environmental reference sampling. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
137	Jakhar et al. (2015)	In the present report, 38 human drowning case studies from Haryana (India) were examined and solved by using "diatom test" in Forensic Science Laboratory Madhuban, Karnal (Haryana). After medico-legal examination, crime exhibits were sent to the laboratory along with the samples of water from which the dead bodies were recovered.	Potentially improves molecular detection, environmental comparison, or site inference. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.

Citation no.	First author et al. (year)	Main findings	Reported advantages	Reported limitations
138	Pal et al. (2017)	Background: Diatoms found inside the body of a drowned victim may serve as corroborative evidence in the diagnosis of cause of death. Diatom has proved to be the only golden standard for diagnosis and confirmation of drowning deaths whether the drowning was ante-mortem or post-mortem.Methods: The study was based on the cases of death due to drowning received from three districts of Northern Range of Himachal Pradesh, India during the period of...	Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
139	Andrade et al. (2022)	Coastal archaeological communities were exposed to numerous risks associated with living in their liminal environment. Many of the problems faced by these populations have been recorded and interpreted through their skeletal remains, but death by drowning in saltwater is not easy to recognise and as such is invariably either ignored, inferred, or discounted as a possible cause of death.	Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
140	Wang et al. (2015)	Presence of diatoms in tissues has been considered as a significant sign of drowning. However, there are limitations in the present extraction methods.	Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Evidence may be narrative, case-based, or preliminary. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
141	Fucci et al. (2015)	In this study, we compare digestive methods used in a forensic context to extract diatoms (37 % hydrochloric acid) to a method recently described in Italian protocols for analysis of benthic diatoms for ecological assessment of surface water (hydrogen peroxide digestion). The two digestive methods were performed using 5 g of brain, lung, liver, kidney, and bone marrow taken from the bodies of 10 drowning victims recovered from three different ...	Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
142	Kakizaki et al. (2015)	Conventional acid digestion of tissues for analyzing diatoms obtained from suspected drowning cases is time-consuming, laborious and potentially dangerous. We propose a new protocol for solubilizing lung tissue using only Qiagen Proteinase K, Qiagen Buffer ATL, and 5N hydrochloric acid that can accelerate and simplify diatom extraction from suspected drowning cases.	Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
143	Zhao et al. (2016)	Diagnosis of drowning remains a difficult issue in current forensic sciences. A large number of diatoms were lost by removing the supernatant after centrifugation in the conventional forensic diatom test.	Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
144	Niu et al. (2018)	Diagnosis of drowning remains challenging in forensic science. The diatom test is the 'gold standard' in analysing drowning victims.	Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
145	Besta et al. (2025)	Five simple methods for diatom drowning analysis, including three newly developed ones, were compared for diatom yield and species composition consistency. Saponification of fats using sodium hydroxide solution significantly improved the yield of the extraction step, as well as the use of filtration instead of centrifugation.	Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
146	Saini et al. (2016)	Diatoms are unicellular algae found in almost all water bodies. Over 10,000 different species of diatomshave been reported.	Potentially improves molecular detection, environmental comparison, or site inference. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
147	Saini et al. (2017)	Verdict on tracing exact place of drowning is a part of medico-legal investigation. This question often stands when circumstances remain unclear about true drowning place.	Potentially improves molecular detection, environmental comparison, or site inference. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
148	Carballeira et al. (2018)	The diatom test is considered a useful aid in determining the site of death from drowning. Nevertheless, there is disagreement within the scientific community concerning its reliability, and its findings have been challenged and sometimes overturned in courts of law.	Potentially improves molecular detection, environmental comparison, or site inference. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
149	Thakar et al. (2018)	Background: In forensic investigations of death cases in which the body has been recovered from a water body, there is an urgent need to prove whether the death is due to drowning or not. Moreover, another important issue arises, whether a person was alive at the time of drowning (anti-mortem drowning) or he was thrown dead into the water body (post-mortem drowning) To answer these questions, phytoplankton species of forensic importance from t...	Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
150	Zalat et al. (2023)	In forensic studies of death issues, the body of victims have been found in the water, and by using the diatom test, it could be determined whether the cause of death is related to drowning or not. One more critical problem occurs, when the victim was killed and thrown into the water, was he/she alive at the time of drowning?	Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
151	Bogusz et al. (2023)	Diatoms (Bacillariophyta) are unicellular photosynthetic organisms commonly occurring in aquatic habitats on Earth. Their autecology makes them almost perfect indicators of environmental conditions and so have high potential for use in forensics.	Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
152	Rubini et al. (2018)	Fishing activities are considered one of the most relevant threats for cetaceans and sea turtles conservation since these animals are sometimes found dead entangled in fishing gears. Currently, postmortem diagnosis is based mainly on the presence of nets and lines on the body and the related marks and injuries evident at gross examination.	Clarifies medico-legal interpretation or reliability of drowning evidence.	Findings should be interpreted as supportive rather than standalone proof.
153	Magni et al. (2020)	Crime scene investigation protocols and procedures are well established when concerning terrestrial environments, but are limited when associated with aquatic environments.In aquatic contexts, the soil, sediments and microscopic algae (e.g. diatoms) may all be used as sources of trace evidence for criminal investigations.	Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
154	Kihara et al. (2021)	Background: In forensic medicine, the diatom test is used to diagnose drowning. Drowning and postmortem immersion can be distinguished by calculating the ratio of diatom concentration in the lungs and drowning water (L/W ratio).	Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
155	Sonoda et al. (2022)	The number of diatoms detected in the kidneys and liver varies considerably when comparing various reports, but the reason remains unclear. We previously showed that the reuse of Kjeldahl flasks is susceptible to generating false positives; false-positive results were observed in 17 of 60	Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.

Citation no.	First author et al. (year)	Main findings	Reported advantages	Reported limitations
		tested flasks, and a maximum of 290 diatoms were detected.		
156	Tambuzzi et al. (2022)	The search for diatoms is the test that most of all may contribute to the forensic diagnosis of drowning. Diatoms can be extracted through different methods, which are all complex and long.	Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Evidence may be narrative, case-based, or preliminary. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
157	Marshall et al. (2023)	Diatoms show potential as trace evidence indicators, particularly as evidence of drowning. Often, the diatom test to diagnose drowning is done on soft tissue or bone marrow from a recently deceased individual.	Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
158	Marshall et al. (2023)	The presence of diatom algae in bone marrow has been used as forensic evidence of drowning for several decades; however, these studies are based on known or suspected recent drowning events. This study addresses the potential for diatoms to enter the bone marrow of skeletal remains, that is, de-fleshed long bones post-mortem.	Potentially improves molecular detection, environmental comparison, or site inference. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
159	Bogusz et al. (2024)	Diatoms (Bacillariophyta), being single-celled photosynthetic organisms, are widely distributed in aquatic ecosystems around the globe. Their exoskeletons are resistant to most environmental factors as well as chemical reagents in laboratory settings.	Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
160	Dervišević et al. (2024)	Introduction: Diatom tests are rarely used during autopsy to confirm drowning as the cause of death (COD) because of limitations of the current literature involving these techniques. Instead, experts rely on physical examination by the pathologist.	Potentially improves molecular detection, environmental comparison, or site inference. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
161	Tambuzzi et al. (2024)	To date, synovial fluid has not been the subject of targeted analysis as a possible substrate to search for the presence of diatoms in the forensic context of drowning. However, its unique characteristics of production and isolation from the external environment could make it suitable for this purpose, similar to what has already been demonstrated in the literature for vitreous humor.	Clarifies medico-legal interpretation or reliability of drowning evidence.	Findings should be interpreted as supportive rather than standalone proof.
162	Kihara et al. (2026)	Diatom testing is conducted in forensic medicine primarily to support the diagnosis of drowning. In our previous study, a large number of diatoms, potentially originating from methomyl, were detected in the lungs of a cat found dead under circumstances suggestive of methomyl poisoning, but not involving drowning or submersion.	Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
163	Lunetta et al. (2025)	We describe here a previously unreported source of diatom contamination that may prove relevant in routine diatom analysis in suspected drowning cases. Glass microscope slides utilized in the process, during their manufacture, undergo a washing process, after which, diatomaceous earth (kieselguhr, fossil diatoms) is added to avoid producing stuck slides during the last rinse.	Potentially improves molecular detection, environmental comparison, or site inference. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
164	Muccino et al. (2015)	A cadaver in water sets a relevant issue for the forensic pathologist, concerning the differential diagnosis between homicide, suicide, accidental event, and natural death in water. In the present study, the drowning suicides in a non-coastal territory are analyzed, discussing the main diagnostic difficulties, the preventive intervention, and the strategies for outlining the profile of a "mean victim" that is at risk of committing suicide by d...	Potentially improves molecular detection, environmental comparison, or site inference. May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Molecular/site-inference methods need external validation and robust environmental reference sampling. AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
165	DU et al. (2022)	The study/report addresses Pathway of Diatoms Enter Experimental Rabbits through the Lymphatic System of the Digestive Tract in the context of forensic drowning or aquatic forensic evidence.	Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
166	Torres-Portugal et al. (2026)	Diatoms are an integral part of aquatic ecosystems and have proved valuable in forensic investigation in providing evidence in drowning cases or in assisting geolocation. This preliminary study investigated the seasonal composition of diatom community in three aquatic systems in northern Portugal with regard to different hydrodynamic and anthropogenic pressures.	Potentially improves molecular detection, environmental comparison, or site inference. Clarifies medico-legal interpretation or reliability of drowning evidence.	Evidence may be narrative, case-based, or preliminary. Molecular/site-inference methods need external validation and robust environmental reference sampling. Findings should be interpreted as supportive rather than standalone proof.
167	Ishikawa et al. (2019)	The present investigation was performed with the objective of developing a method to estimate how long a corpse had been immersed in water after death (the time since death). Accurate determination of the time elapsed since death may lead to identification of the place of drowning, and therefore, serves not only as a piece of information useful for determination of the cause of death but also leads to prompt identification of the body.	Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
168	Poulain et al. (2023)	Drowning is the leading cause of death by accident of everyday life in people under 25 years of age. Xenobiotics are frequently involved in drowning cases but their influence on the diagnosis of fatal drowning has not been studied so far.	Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Evidence may be narrative, case-based, or preliminary. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.
169	Handlos et al. (2025)	Drowning is a common cause of death encountered in forensic practice, typically with clearly defined circumstances and mechanisms. However, in rare cases, the dynamics of death may be atypical and require a multidisciplinary evaluation.	May reduce manual workload and observer-dependent classification. Supports more standardized, quantitative, or reproducible workflows. Clarifies medico-legal interpretation or reliability of drowning evidence.	Evidence may be narrative, case-based, or preliminary. AI workflows depend on annotated datasets and external validation. Comparability may be affected by sampling, digestion, filtration, and counting heterogeneity. Findings should be interpreted as supportive rather than standalone proof.

Supplementary Table S3. Complete thematic distribution of included studies and domain combinations

Complete non-mutually exclusive thematic distribution of the 165 included studies across thematic domains and domain combinations. Individual studies could contribute to more than one domain; therefore, percentages do not sum to 100%.

Domain / combination	Label	n	%	Interpretation note
A	Molecular / metagenomic / DNA-based / site inference	83	50.3	Non-mutually exclusive domain assignment; a study may contribute to multiple domains.
B	Automation / image analysis / AI-assisted detection or classification	51	30.9	Non-mutually exclusive domain assignment; a study may contribute to multiple domains.
C	Quantitative / standardized indicators beyond simple presence/absence	148	89.7	Non-mutually exclusive domain assignment; a study may contribute to multiple domains.
D	Medico-legal interpretation / validation / contamination / reliability	133	80.6	Non-mutually exclusive domain assignment; a study may contribute to multiple domains.
E	Unclear / other	0	0.0	No study remained unclear after re-audit.
Complete domain combinations				
C;D	Quantitative/standardized indicators + medico-legal interpretation/validation	40	24.2	
A;C;D	Molecular/site-inference + quantitative/standardized + medico-legal interpretation	37	22.4	
B;C;D	Automation/image analysis/AI + quantitative/standardized + medico-legal interpretation	23	13.9	
A;B;C;D	All four thematic domains	19	11.5	
C	Quantitative/standardized indicators only	12	7.3	
A;C	Molecular/site-inference + quantitative/standardized	11	6.7	
A;D	Molecular/site-inference + medico-legal interpretation/validation	7	4.2	
D	Medico-legal interpretation/validation only	4	2.4	
A;B;C	Molecular/site-inference + automation/image analysis/AI + quantitative/standardized	4	2.4	
A	Molecular/site-inference only	3	1.8	
B;C	Automation/image analysis/AI + quantitative/standardized	2	1.2	
A;B;D	Molecular/site-inference + automation/image analysis/AI + medico-legal interpretation/validation	2	1.2	
B;D	Automation/image analysis/AI + medico-legal interpretation/validation	1	0.6	