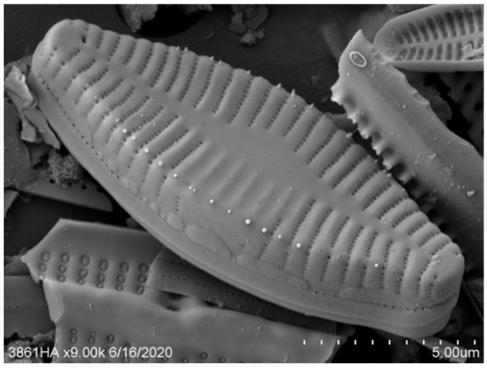
Taxonomic Diatom Workshop
Fragilaria capucina & co: an update



Bart Van de Vijver, Adrienne Mertens,
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Meise Botanic Garden
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LUXEMBOURG INSTITUTE OF SCIENCE AND TECHNOLOGY LIST

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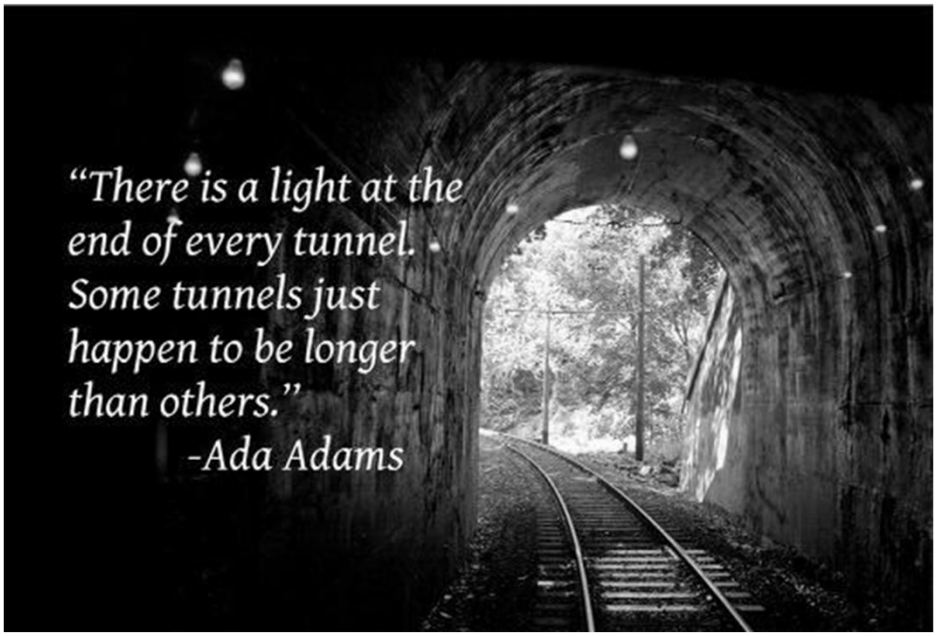
Mike Guiry

Vlaamse Milieu Maatschappij
Meise Botanic Garden
Luxembourg Institute of Science and Technology



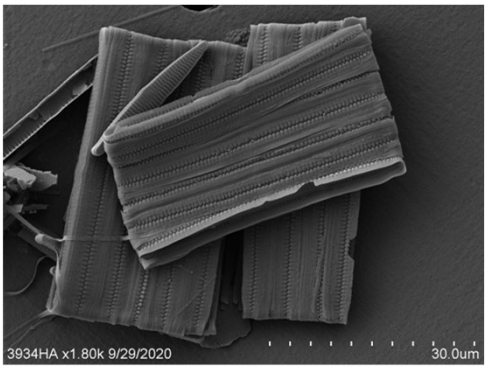
in this workshop

1. the *Fragilaria capucina* group
2. the *Fragilaria rumpens* group
3. the *Fragilaria radians* problem
4. the *Fragilaria vaucheriae* group
5. some minor problems solved

Important features used for *Fragilaria* identification

Colony-forming

aequalis
capucina*
catenarinoi*
fragilarioides*
mesolepta
intermedia*
nevadensis*
pararumpens*
pseudofamiliaris*
rhabdosoma
rumpens*
spinaspeciosa
subconstricta



lemanensis
ostenfeldii

agnesiae **(colonies only in culture)**
joachimii **(colonies only in culture)**

***discussed in this presentation**

Important features used for *Fragilaria* identification

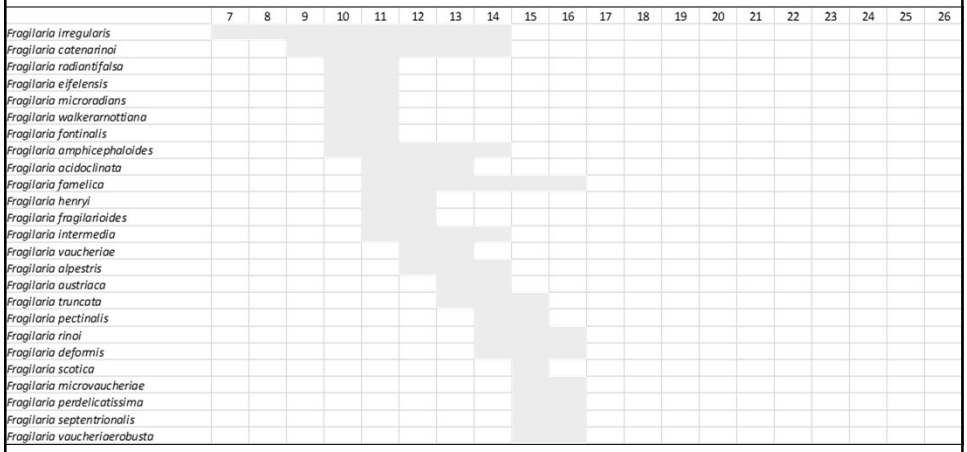
Solitary

acerosa*
acidoclinata
alpestris
amphicephaloides
aquaplus*
austriaca
battarbeeana*
campyla*
crocodylus
deformis*
drouotiana
eifelensis
ennerdalensis*
eutraphenta*
famelica
filiformis
fontinalis
goeyersiana
gloiophila
heatherae
henryi
heudreana*
kellyana*
maoulana*
mertensiae*
microradians
microvaucheriae
misarelensis
nanoides
neglecta*
pectinalis*
perdelicatissima*
radians(*)
radiantifalsa*
recapitellata
rinoi*
sandellii*
septentrionalis
socia
subrecapitellata
tenera
tenera var. nana
tridentina
truncata*
vandekerckhoveana*
vaucheriae*
vaucheriaefalsa*
vaucheriaeraetica*
vaucheriaerobusta*
vandevondeliana
walkerarnottiana

***discussed in this presentation**

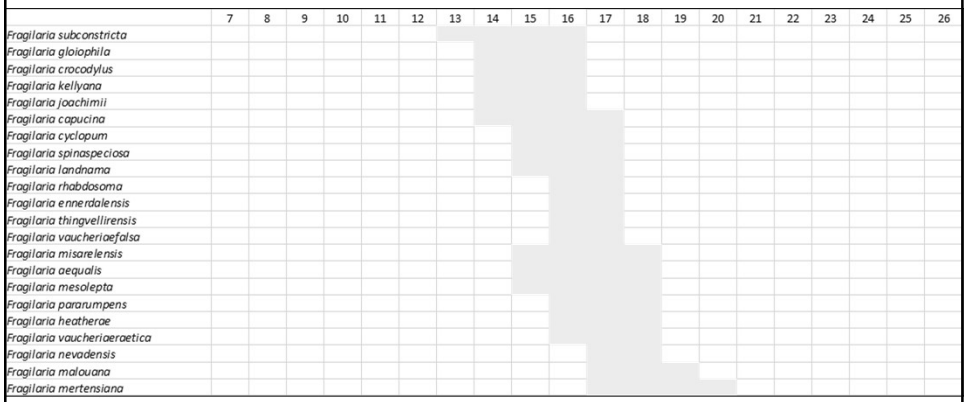
Important features used for identification

Stria density (I)



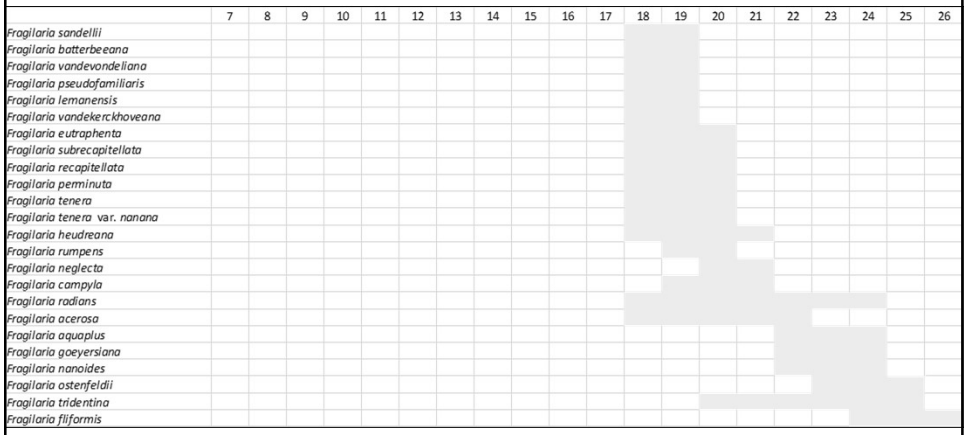
Important features used for identification

Stria density (II)



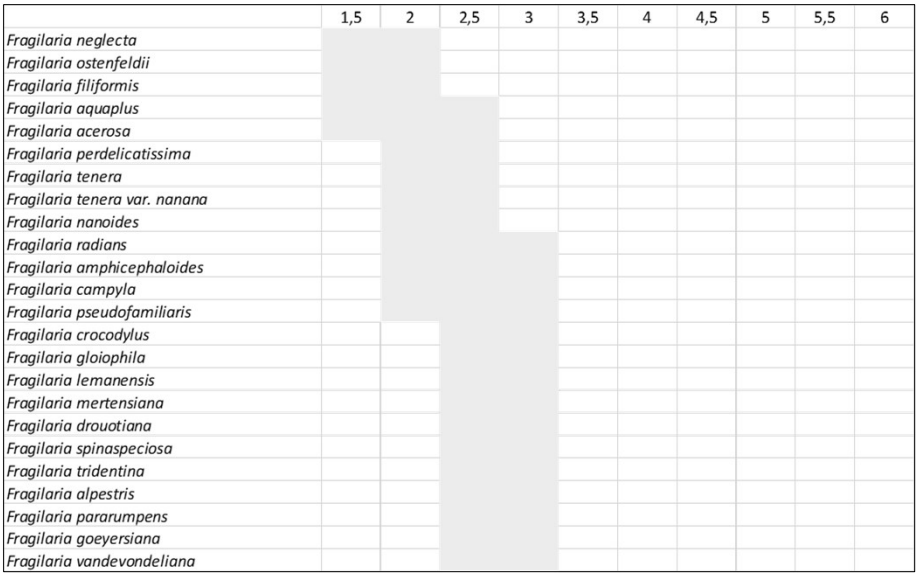
Important features used for identification

Stria density (III)



Important features used for identification

Valve width (I)



Important features used for identification

Valve width (II)

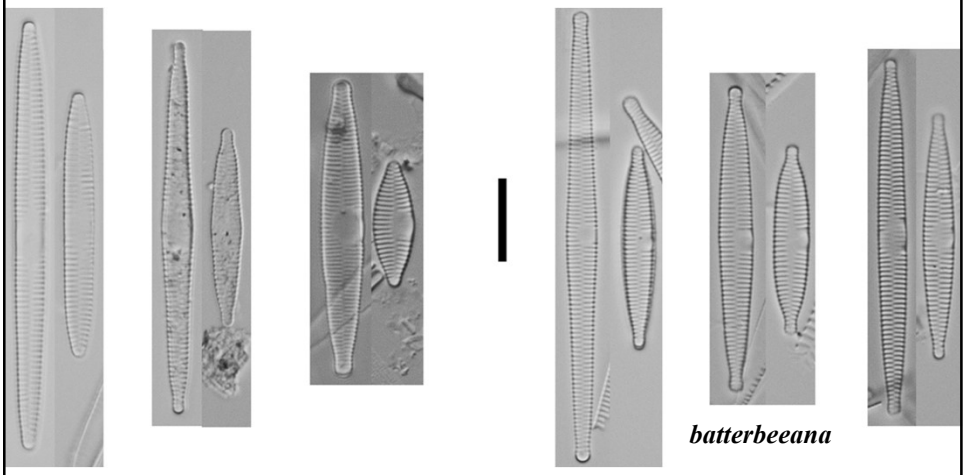
	1,5	2	2,5	3	3,5	4	4,5	5	5,5	6
Fragilaria famelica										
Fragilaria microvaucheriae										
Fragilaria henryi										
Fragilaria austriaca										
Fragilaria perminuta										
Fragilaria vaucheriaeraetica										
Frailaria malouana										
Fragilaria ennerdalensis										
Fragilaria eutraphenta										
Fragilaria heatherae										
Fragilaria capucina										
Fragilaria rhabdosoma										
Fragilaria acidoclinata										
Fragilaria recapitellata										
Fragilaria vaucheriaefalsa										
Fragilaria vandekerckhoveana										
Fragilaria nevadensis										
Fragilaria heudreana										
Fragilaria septentrionalis										
Fragilaria walkerarnottiana										
Fragilaria intermedia										
Fragilaria fragilarioides										
Fragilaria rumpens										
Fragilaria thingvellirensis										
Fragilaria truncata										
Fragilaria scotica										

Important features used for identification

Valve width (III)

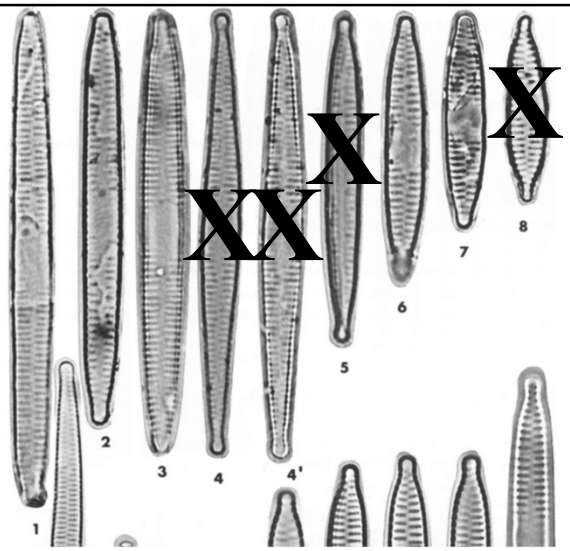
	1,5	2	2,5	3	3,5	4	4,5	5	5,5	6
Fragilaria subrecapitellata										
*Fragilaria mesolepta**										
Fragilaria subconstricta										
Fragilaria aequalis										
Fragilaria vaucheriae										
Fragilaria joachimii										
Fragilaria pectinalis										
Fragilaria batterbeeana										
Fragilaria eifelensis										
Fragilaria catenarinoi										
Fragilaria landnama										
Fragilaria kellyana										
Fragilaria microradians										
Fragilaria vaucheriaerobusta										
Fragilaria fontinalis										
Fragilaria deformis										
Fragilaria misarelensis										
Fragilaria irregularis										
Fragilaria radiantifalsa										
Fragilaria sandellii										
Fragilaria rinoi										

1. The *Fragilaria capucina* group



Fragilaria capucina Desmazières 1825

- **Cells producing ribbon-like colonies**
- **Valves linear**
- **Weakly rostrate apices**
- **Length 28-47 µm, width 3.0-4.0 µm**
- **sternum narrow**
- **Central area rectangular to rhombic**
- **Striae alternate, parallel to slightly radiate near apices, 14-17 in 10 µm**
- **Spines present**



Fragilaria capucina

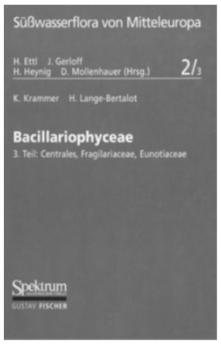
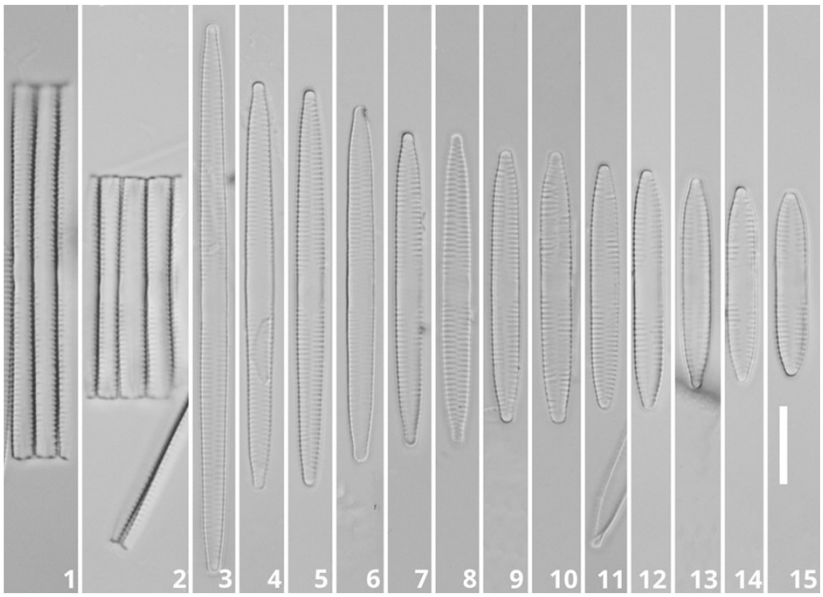


Fig. 1–8: **Fragilaria capucina** Desmazières **var. capucina** (S. 121)

Fig. 1–8: Typenmaterial, Plantes cryptogames des France, Fasc. 10 no. 453 von 1825 (vgl. Fig. 109: 6 = *Synedra vaucheriae* var. *septentrionalis* u. a.)

Type material

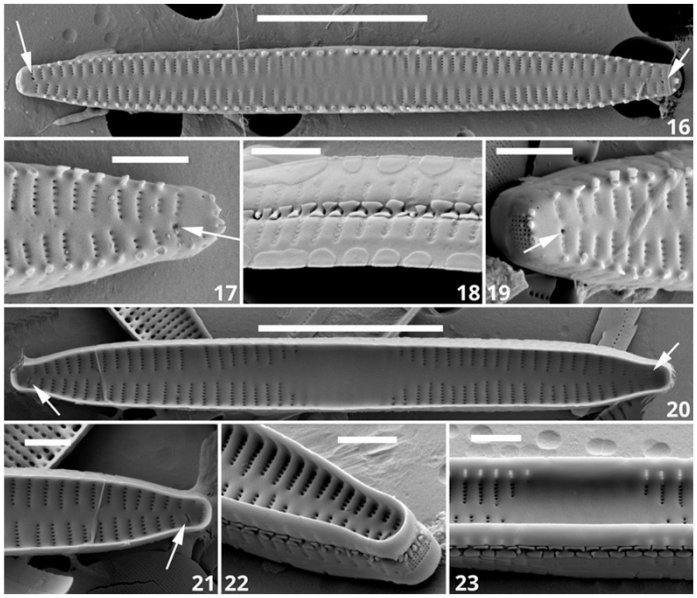
Fragilaria capucina



Fragilaria **Desmazières - Exsiccata set (Fasc. 10, no. 453)**

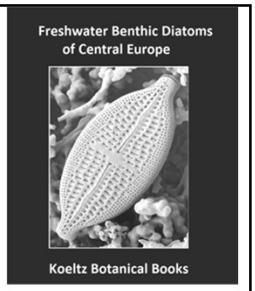
Van de Vijver et al. (2021)

Type material ***Fragilaria capucina***



Fragilaria **Desmazières - Exsiccata set (Fasc. 10, no. 453)** **Van de Vijver et al. (2021)**

Fragilaria capucina



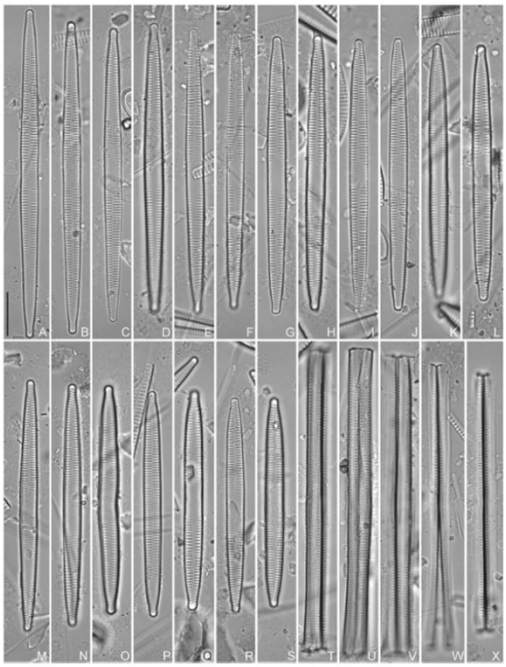
Lange-Bertalot et al. 2017, p. 276, plate 10, figs 8-9

Figs 8, 9: ***Fragilaria capucina*** Desmazières

Fresh material: Cells form band-like colonies (linking spines are present). Outline: Girdle view: Frustules linear-rectangular. Valve: Linear. Ends: Subrostrate. [SEM feature: Two small rimoportulae, one at each pole.]

Dimensions: Length 25 to c. 75 µm, width 3.5-4.5 µm. Striae: c. 12-17/10 µm, often weakened or interrupted in the centre of the valve by a rectangular to rhombic Central area. Puncta pattern not resolvable.

Other European populations **Luxembourg**



Plant Ecology and Evolution 152 (2): 327–339, 2019
https://doi.org/10.5091/plecevo.2019.1619

REGULAR PAPER

On the identity of the rare *Fragilaria subconstricta* (Fragilariaceae), with *Fragilaria* species forming ribbon-like colonies shortly reconsidered

David Heudre[1,*], Carlos E. Wetzel[2], Laura Moreau[1], Bart Van de Vijver[3,4] & Luc Ector[1]

Fragilaria capucina ???

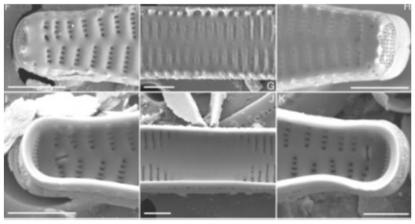


Figure 4 – *Fragilaria capucina* LM valve (A–S) and girdle (T–X) views (material from Grouf stream, Helfent, Luxembourg)

(Heudre et al. 2019b)

Ecology

Fragilaria capucina

<u>Delgado et al. (2015)</u>

oligo- to mesotrophic
weakly acidic to alkaline water
low to medium electrolyte content

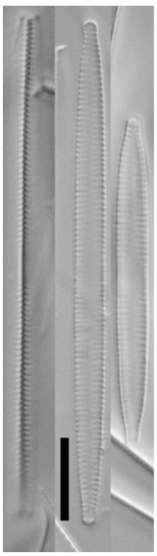
<u>Lange-Bertalot et al. (2017)</u>

ecological amplitude not well defined

<u>Van de Vijver et al. (2021)</u>

Type sample dominated by taxa such as *Melosira varians*, *Gomphonema parvulum*, *Planothidium frequentissimum*, *P. lanceolatum* and *Navicula cryptotenella*. Less frequent taxa include *Nitzschia amphibia*, *N. supralitorea*, *Surirella terricola*, *Achnanthidium jackii*, *A. microcephalum* and *Encyonema silesiacum*.

Probably a rare species !



F. capucina
L 28-47 µm
W 3-4 µm
S 14-17 in 10 µm

Can be confused with

***Fragilaria capucina* has**

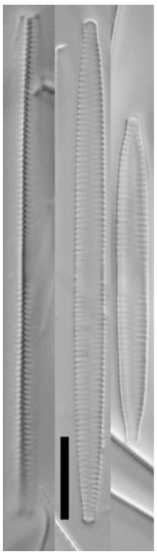
lower stria density

more linear valves

more elongate, less sturdy valves

two rimoportulae

F. rumpens
L 20-80 µm
W 3.0-3.5 µm
S 19-20 in 10 µm



F. capucina
L 28-47 µm
W 3-4 µm
S 14-17 in 10 µm

Can be confused with

***Fragilaria capucina* has**

lower stria density

linear valves
no inflated central area

more elongate, less sturdy valves

two rimoportulae

F. nevadensis
L 20-50 µm
W ca. 4 µm
S 17-18 in 10 µm

Can be confused with

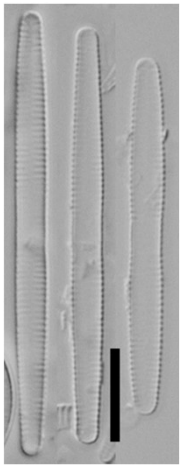
F. capucina
L 28-47 µm
W 3-4 µm
S 14-17 in 10 µm

***Fragilaria capucina* has**

slightly narrower valves

more protracted apices

no central constriction



F. aequalis
L 20-60 µm
W 3.5-4.5 µm
S 15-18 in 10 µm

Can be confused with

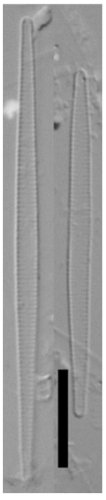
F. capucina
L 28-47 µm
W 3-4 µm
S 14-17 in 10 µm

***Fragilaria capucina* has**

broader valves

lower stria density

colonies!



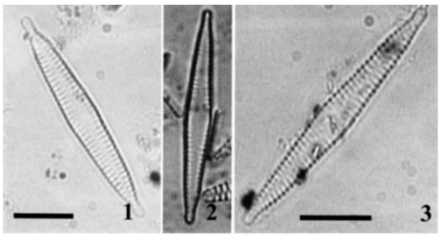
"F. gracilis"
L 20-60 µm
W 2-3 µm
S 19-24 in 10 µm

Fragilaria nevadensis Linares-Cuesta & Sánchez-Castillo 2007

- **Cells producing ribbon-like colonies up to 8 cells**
- **Valves lanceolate with swollen central part**
- **Apices subcapitate**
- **Length 20-50 µm, width ca. 4.0 (3.0-5.0) µm**
- **sternum narrow**
- **Central area large hyaline zone spanning entire valve width**
- **Striae alternate, parallel near central area gradually becoming weakly radiate towards apices, 17-18 in 10 µm**
- **Spines present, spatulate, linking**

Original description

Fragilaria nevadensis



Diatom Research (2007), Volume 22 (1), 127–134

FRAGILARIA NEVADENSIS SP. NOV., A NEW DIATOM TAXON FROM A HIGH MOUNTAIN LAKE IN THE SIERRA NEVADA (GRANADA, SPAIN)

J. Eduardo Linares-Cuesta & Pedro M. Sánchez-Castillo*

***Fragilaria nevadensis* Linares-Cuesta & Sánchez-Castillo sp. nov.** (Figs 1–9)

Diagnosis: Cellulae in catenas 2–8 cellularum conjucta vel solitariae. Valvae lanceolatae, cum margine undulato et apicibus subcapitatis. Latitudo 3,5–5 µm et longitudo 30–50 µm. Area axialis angusta et linearis, area centralis ellipticae generaliter intermissa (usque ad margines) et semper dilatata. Striae parallelae alternantes utrimque, 14–18 in 10 µm, indistincte punctata.

Holotypus: Fig. 1. Slide 3013, Diatom Phycoteca of Granada University Herbarium (GDA).

Isotypus: Slide 3014, Diatom Phycoteca of Granada University Herbarium (GDA).

Type locus: Laguna Segunda, Siete lagunas Valley, Granada, Spain.

Description: Cells arranged in chains, 2–8, sometimes isolated. Valves lanceolate with swollen central part and subcapitate apices. Swollen central part with elliptic central area usually extending to the margins of the valve. Axial sternum narrow. Striae alternate, parallel, not punctate, 14–18 in 10 µm. Dimensions: 3.5–5 µm wide and 30–50 µm long. (Figs 1–3).

Laguna Segunda, Siete lagunas Valley, Granada, Spain

(Linares-Cuesta & Sanchez-Castillo 2007)

Original description

Fragilaria nevadensis

Diatom Research (2007), Volume 22 (1), 127–134

FRAGILARIA NEVADENSIS SP. NOV., A NEW DIATOM TAXON FROM A HIGH MOUNTAIN LAKE IN THE SIERRA NEVADA (GRANADA, SPAIN)

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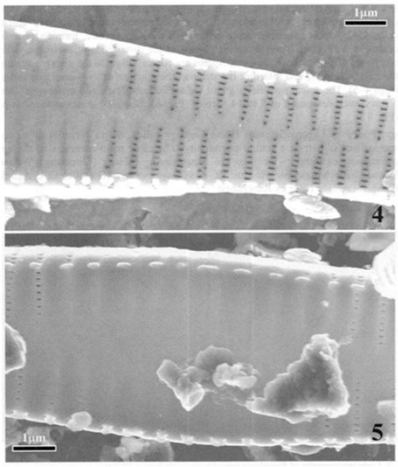
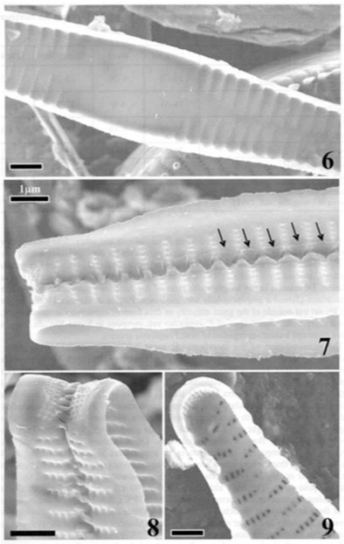




Laguna Segunda, Siete lagunas Valley, Granada, Spain

(Linares-Cuesta & Sanchez-Castillo 2007)

Type population

Fragilaria nevadensis

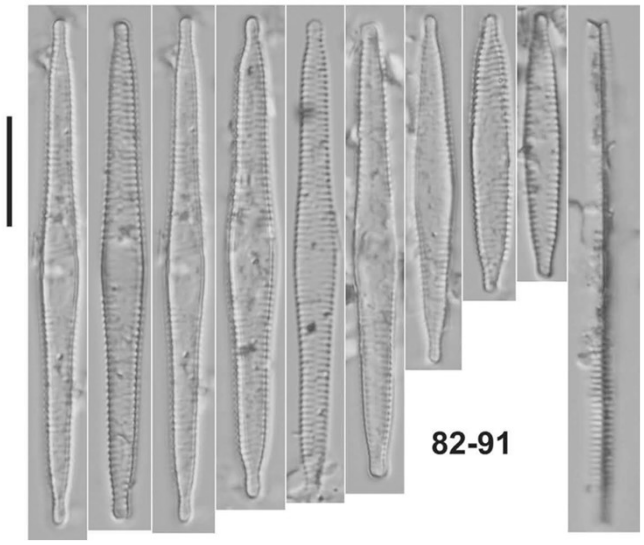
PHYCOLOGIA
2019, VOL. 58, NO. 2, 128–144
https://doi.org/10.1080/00318884.2018.1524245

International Phycological Society

Taylor & Francis

Morphology and ecology of *Fragilaria misarelensis sp. nov.* (Bacillariophyta), a new diatom species from southwest of Europe

Maria Helena Novais, Salomé F.P. Almeida, Saúl Blanco, and Cristina Delgado

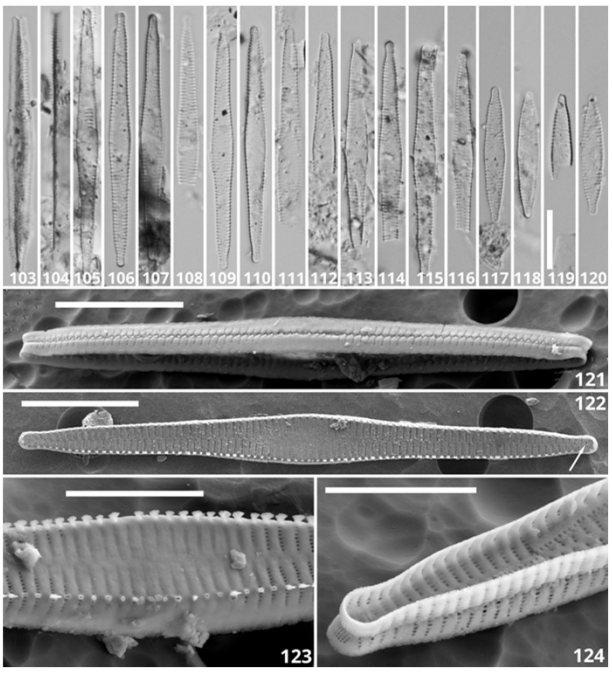


Laguna Segunda, Siete Lagunas Valley, Spain

(Novais et al. 2019)

Type population

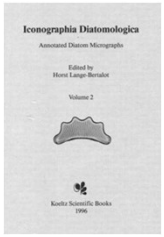
Fragilaria nevadensis

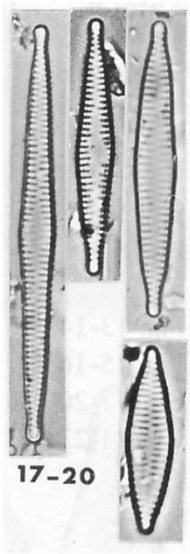


Laguna Segunda, Siete Lagunas Valley, Spain **(Van de Vijver et al. 2021)**

Other European populations

Fragilaria nevadensis





Lange-Bertalot & Metzeltin 1996: plate 7, Figs 17-20

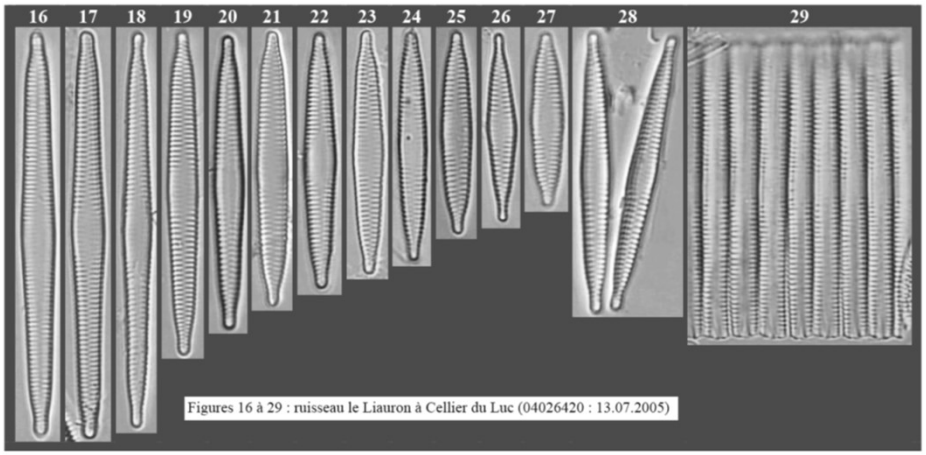
identified as *F. capucina* ssp. *rumpens* !!!!

Fig. 17-20. *Fragilaria capucina* ssp. *rumpens* (Kütz.) Lange-Bertalot

Other European populations

Fragilaria nevadensis

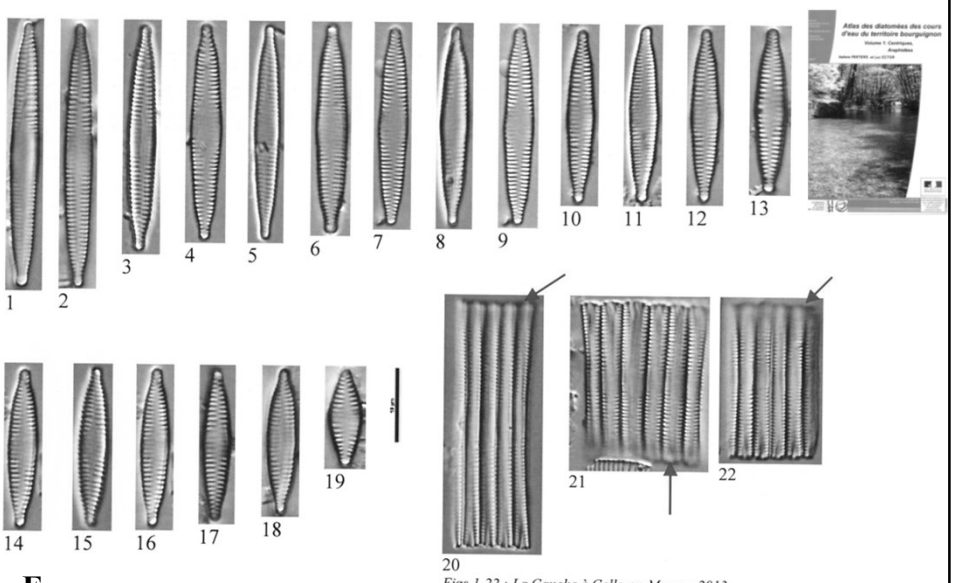
France



(Bey & Ector 2013)

Other European populations

Fragilaria nevadensis



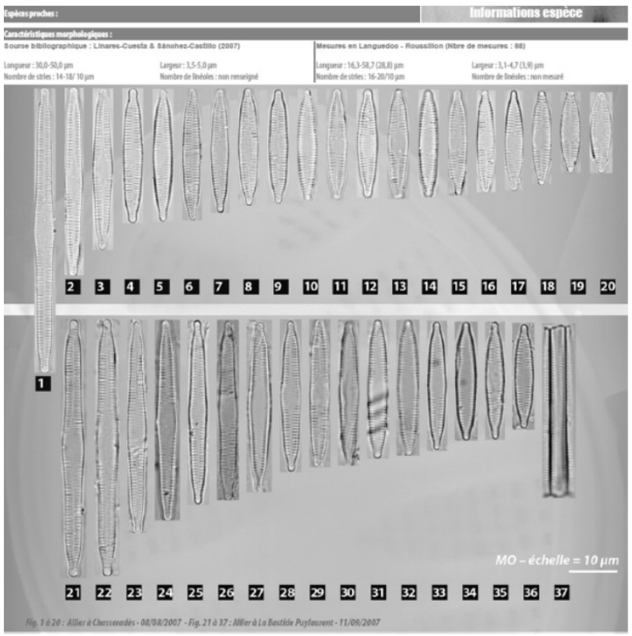
Figs 1-22 : La Canche à Celle-en-Morvan 2013

France

(Peeters & Ector 2017)

Other European populations

Fragilaria nevadensis

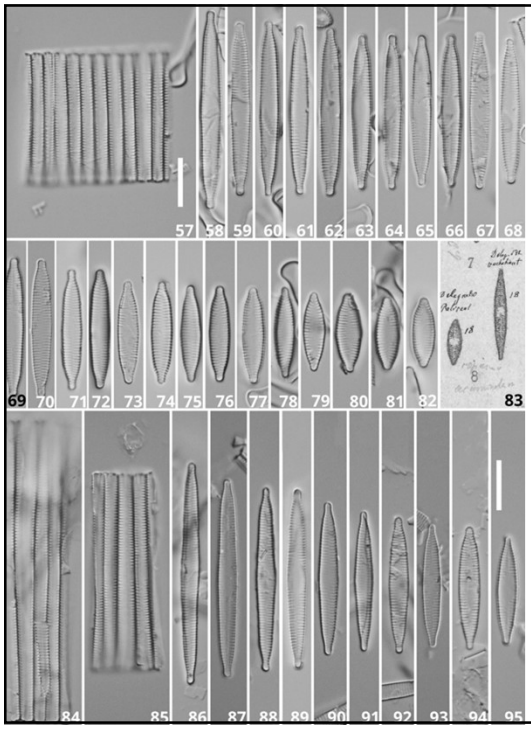


France

(Asconit, Atlas des diatomées de la région Languedoc Roussillon - DREAL Languedoc Roussillon)

Other European populations

Fragilaria nevadensis



Belgium

(Van de Vijver et al. 2021)

Ecology

Fragilaria nevadensis

Van de Vijver et al. (2021)

The type material of *Fragilaria nevadensis* is dominated by *Staurosira venter*, *Fragilariforma virescens*, *Odontidium mesodon*, *Meridion constrictum* and *Nitzschia hantzschiana*.

Probably more widespread than we currently know!

Can be confused with

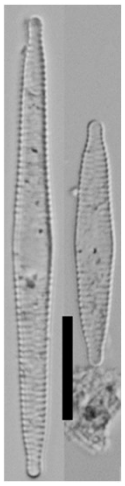
***Fragilaria nevadensis* has**

lower stria density

typical inflated central area

shorter colonies

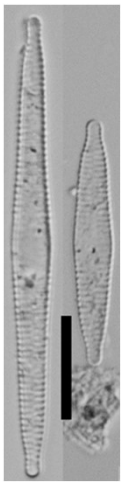
well protracted apices



F. nevadensis
L 20-50 µm
W ca. 4 µm
S 17-18 in 10 µm

F. rumpens
L 20-80 µm
W 3.0-3.5 µm
S 19-20 in 10 µm

Can be confused with



F. nevadensis
L 20-50 µm
W ca. 4 µm
S 17-18 in 10 µm

***Fragilaria nevadensis* has**

higher stria density

typical inflated central area

one rimoportulae

F. capucina
L 28-47 µm
W 3-4 µm
S 14-17 in 10 µm

Can be confused with

F. nevadensis
L 20-50 µm
W ca. 4 µm
S 17-18 in 10 µm

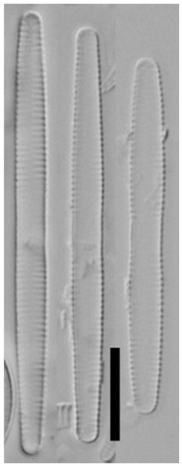
***Fragilaria nevadensis* has**

lanceolate valve outline

more protracted apices

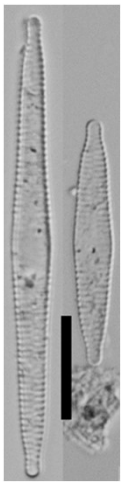
inflated central area

no central constriction



F. aequalis
L 20-60 µm
W 3.5-4.5 µm
S 15-18 in 10 µm

Can be confused with



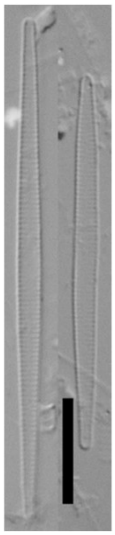
***Fragilaria nevadensis* has**

lanceolate valve outline

broader valves
inflated central area

lower stria density

colonies!



F. nevadensis
L 20-50 µm
W ca. 4 µm
S 17-18 in 10 µm

"F. gracilis"
L 20-60 µm
W 2-3 µm
S 19-24 in 10 µm

Fragilaria sandellii **Van de Vijver & Jarlman in Van de Vijver et al. 2012**

- **Cells solitary or in groups of 2**
- **Valves elliptic-lanceolate to lanceolate in longer valves**
- **Apices slightly protracted, subrostrate to acutely rounded**
- **Length 11-70 µm, width 4.5-6.0 µm**
- **Sternum very narrow, maximum 1/10 of the total valve width, linear**
- **Central area large unilateral hyaline zone**
- **Striae weakly radiate throughout valve, 18–19 in 10 µm.**
- **Short, marginal, very thin, acute spines present at valve face/mantle junction, non-linking**

Original description

Fragilaria sandellii

Nova Hedwigia, Beiheft 141, 237–254
Stuttgart, März 2012

Article

New and interesting diatom species (Bacillariophyceae) from Swedish rivers

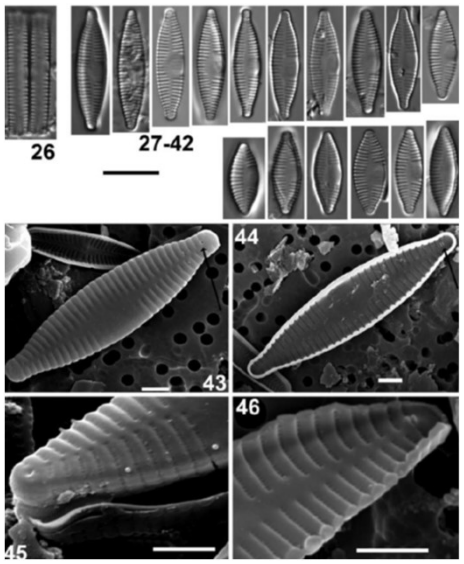
Bart Van de Vijver[1,*], Amelie Jarlman[2], Myriam de Haan[1] and Luc Ector[3]

***Fragilaria sandellii* Van de Vijver & Jarlman sp. nov.** (Figs 26–46)

DIAGNOSIS: Frustulae solitariae, numquam formantes colonias. Valvae lanceolatae in specimini-bus maioribus ad ellipticae-lanceolatae in valvis minoribus, numquam lineares-lanceolatae vel lineares, marginibus clare convexis, apicibusque protractis, rostratis. Longitudo 11.5–22.0 µm, latitudo 4.5–6.0 µm. Area axialis angusta, linearis, recta, leviter dilatans ad aream centralem. Area centralis formans fasciam asymmetricam latam, marginata unilateraliter striis abbreviatis. Striae transapicales leviter radiatae ad paene parallelae omnino, alternantes, 16–18 in 10 µm, uniseriatae. Areolae rotundae, non discernendae in microscopio photonico. Spinae marginales adsunt. Rimoportula una per valvam visibilis.

DISTRIBUTION: So far only found in Viskansbäcken, a small river in central Sweden west of Sundsvall. Due to confusion with other species belonging to the (former) *Fragilaria capucina* Desmazières complex such as *F. capitellata* (Grunow in Van Heurck) J. B. Petersen, *F. perminuta* (Grunow) Lange-Bertalot, *F. rumpens* (Kützing) G. W. F. Carlson and *F. vaucheriae* (Kützing) J. B. Petersen, the exact distribution in Sweden and the rest of Europe is unknown. Krammer & Lange-Bertalot (2004) found similar valves in Lake Baikal (Siberia) although it is not clear whether both populations are conspecific.

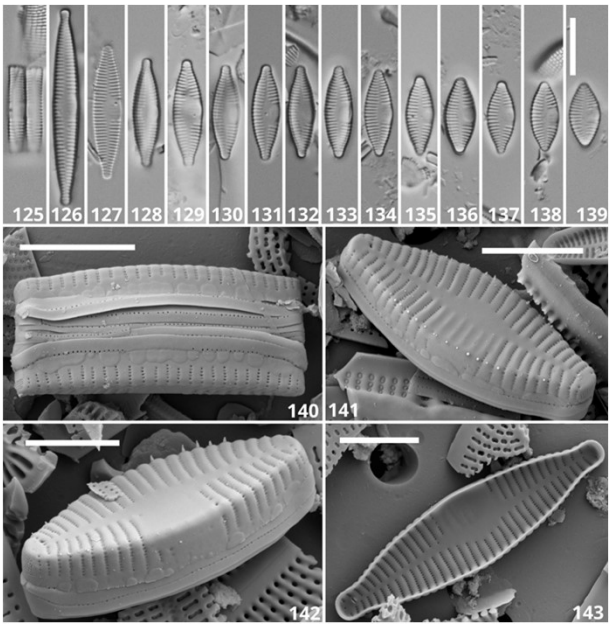
ECOLOGY AND ASSOCIATED FLORA: Viskansbäcken is a small (mean width 2 m), slightly alkaline (pH = 7.4) river with a low specific conductance value (57 µS/cm), slightly elevated Tot-N (367 µg/l) and low Tot-P (7.9 µg/l) values. The diatom flora is dominated by species belonging to the *Achnanthidium minutissimum* complex, *Cocconeis placentula* Ehrenberg s.l. and *Fragilaria rumpens*.



(Van de Vijver et al. 2012)

Type population

Fragilaria sandellii

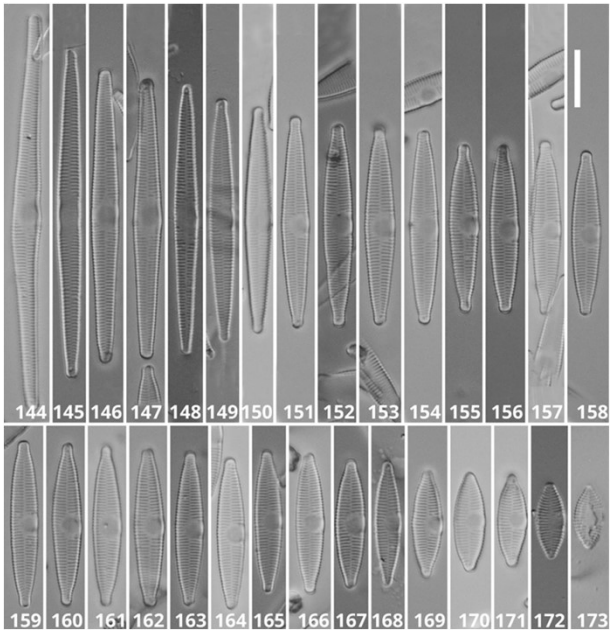


Viskansbäken, central Sweden, 25.IX.2004

(Van de Vijver et al. 2021)

Other European populations

Fragilaria sandellii



H.L. Smith Diatomacearum Species Typicae, slide no. 572 (century 6, 1880), Jonkoping (= Jönköping), Sweden.

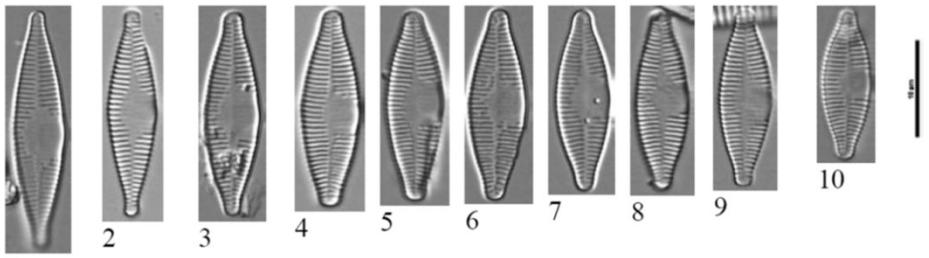
(Van de Vijver et al. 2021)

Other European populations

Fragilaria sandellii

France

FSDL - *Fragilaria sandellii*



Figs 1-10 : La Cure à Marigny-l'Eglise 2011

(Peeters & Ector 2017)

Other European populations

Fragilaria sandellii

France

Fragilaria **sp. 1**
(taxon proche de *F. sandellii*)

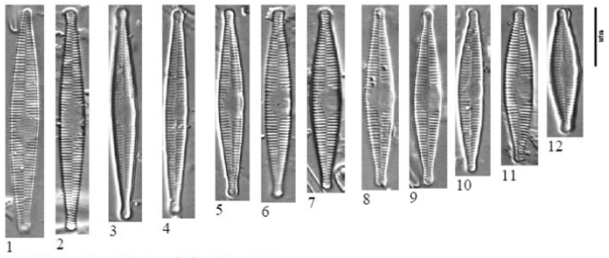
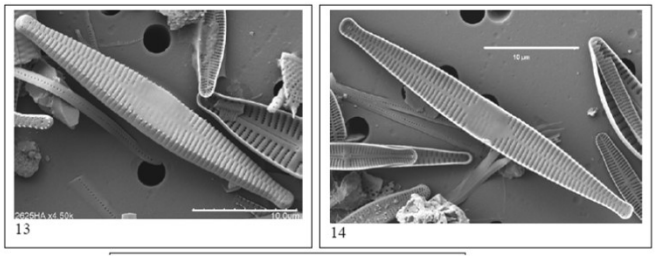


Fig 1-15 : La Cure à Montsauche les Settons 2002



(Peeters & Ector 2017)

Ecology

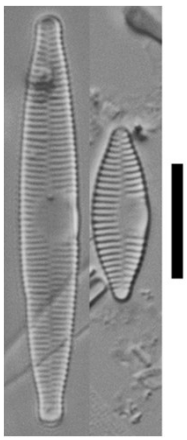
Fragilaria sandellii

<u>Van de Vijver et al. (2012, 2021)</u>

slightly alkaline (pH =7.4)
low conductivity (<60 µS/cm)
slightly elevated Tot-N (367 µg/l) and low Tot-P (7.9 µg/l) values

The type material of the *Fragilaria sandellii* is dominated by *Cocconeis placentula* s.l., *Fragilaria* cf. *rumpens*, *Gomphonema parvulum*, *Fragilaria vaucheriae* and *F. pararumpens*, *Achnanthidium microcephalum* with *F. sandellii* only playing a very minor role in this sample. Less frequent taxa include *Reimeria sinuata*, *Hannaea arcus* and *Achnanthidium catenatum*.

Can be confused with



Fragilaria sandellii **has**

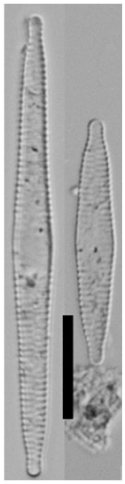
larger valve width

no colonies!

more elliptic-lanceolate valve outline

clear unilateral central area

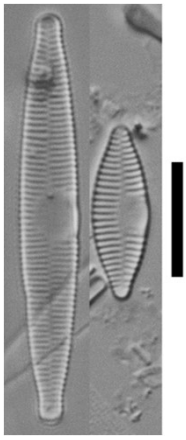
no central inflation



F. sandellii
L 11-70 µm
W 4.5-6.0 µm
S 18-19 in 10 µm

F. nevadensis
L 20-50 µm
W ca. 4 µm
S 17-18 in 10 µm

Can be confused with



Fragilaria sandellii **has**

larger valve width

no colonies!

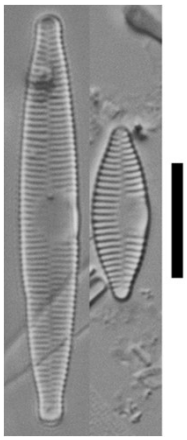
more elliptic-lanceolate valve outline

clear unilateral central area

F. sandellii
L 11-70 µm
W 4.5-6.0 µm
S 18-19 in 10 µm

F. rumpens
L 20-80 µm
W 3.0-3.5 µm
S 19-20 in 10 µm

Can be confused with



F. sandellii
L 11-70 µm
W 4.5-6.0 µm
S 18-19 in 10 µm

***Fragilaria sandellii* has**

larger valve width

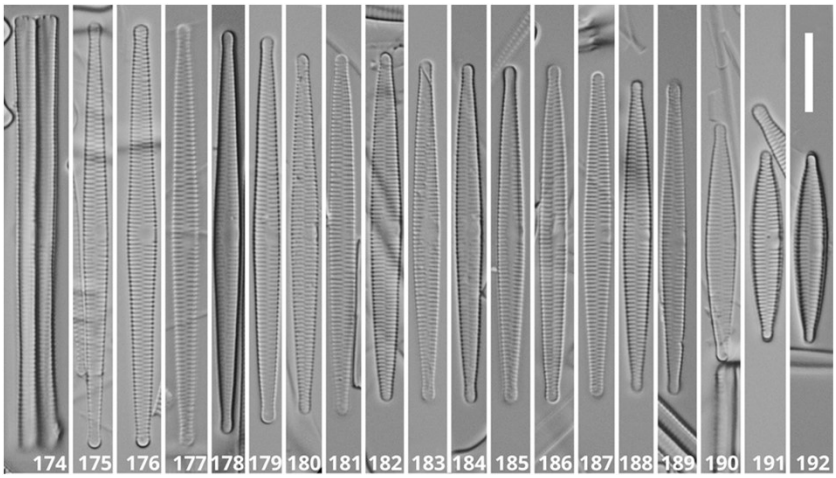
no colonies!

more elliptic-lanceolate valve outline

clear unilateral central area

F. capucina
L 28-47 µm
W 3-4 µm
S 14-17 in 10 µm

Fragilaria malouana Van de Vijver et al.

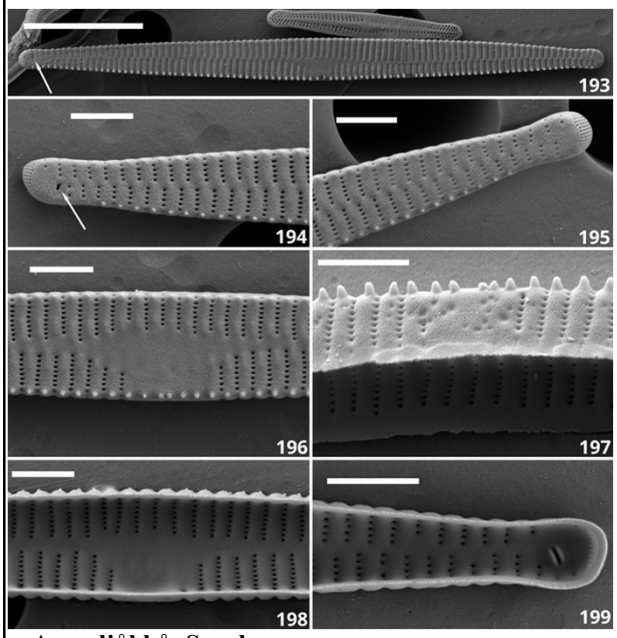


Cells solitary or in pairs
No colonies observed
Valves linear to very narrowly linear-lanceolate
Length 25–60 µm, width 3–4 µm
Striae parallel to weakly radiate, 17–19 in 10 µm

Apmeljåkkå, Sweden

(Van de Vijver et al. 2021)

Fragilaria malouana



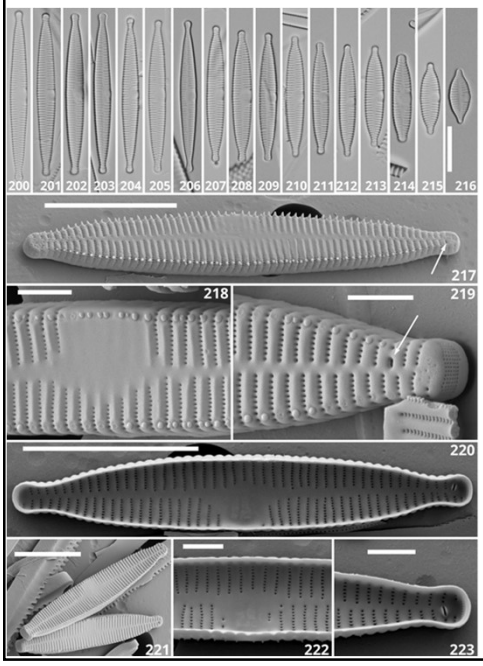
Apmeljåkkå, Sweden

Continuous series of small, acute spines running from apex to apex

alkaline pH (8.0)
low conductivity (88 µS/cm)
low nutrient (NH4-N 5 µg/l, NO2+3-N 25 µg/l) and phosphate (PO4-P 1 µg/l) levels.

(Van de Vijver et al. 2021)

Fragilaria batterbeeana Van de Vijver et al.



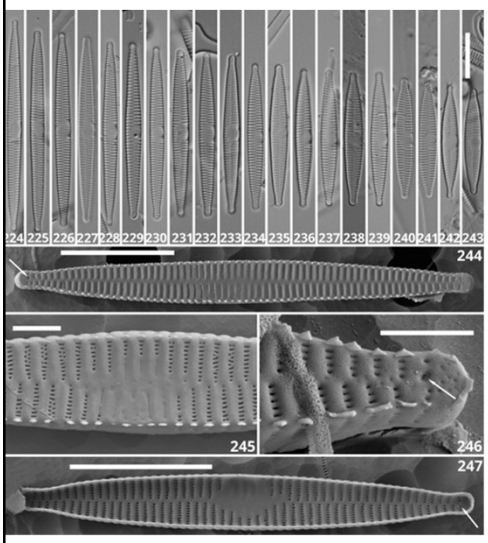
Cells solitary or in pairs, no colonies
Valves lanceolate with weakly to clearly convex margins
Apices protracted, rostrate, subcapitate to even capitate
Length 12–38 µm, width 3.5–5.0 µm
Striae parallel to very weakly radiate, 18–19 in 10 µm
Continuous series of thick, conical marginal spines

pH: 7.7
conductivity: 124 µS/cm
very high levels of nitrate-N (3.34 mg/L)

UK, River Don, Towie, Aberdeenshire

(Van de Vijver et al. 2021)

Fragilaria ennerdalensis Van de Vijver et al.



Cells solitary or in pairs, no colonies
Valves linear to very narrowly linear-lanceolate
Apices protracted, subrostrate
Length 22–48 µm, width 3–4 µm
Striae parallel becoming weakly radiate near apices, 17–18 in 10 µm
Continuous series of small, shark tooth-shaped marginal spines

pH: 7.1
conductivity: 45 µS/cm
very low levels of nitrate-N and phosphate
Very clean water quality

UK, River Ehen, Ennerdale, Cumbria

(Van de Vijver et al. 2021)

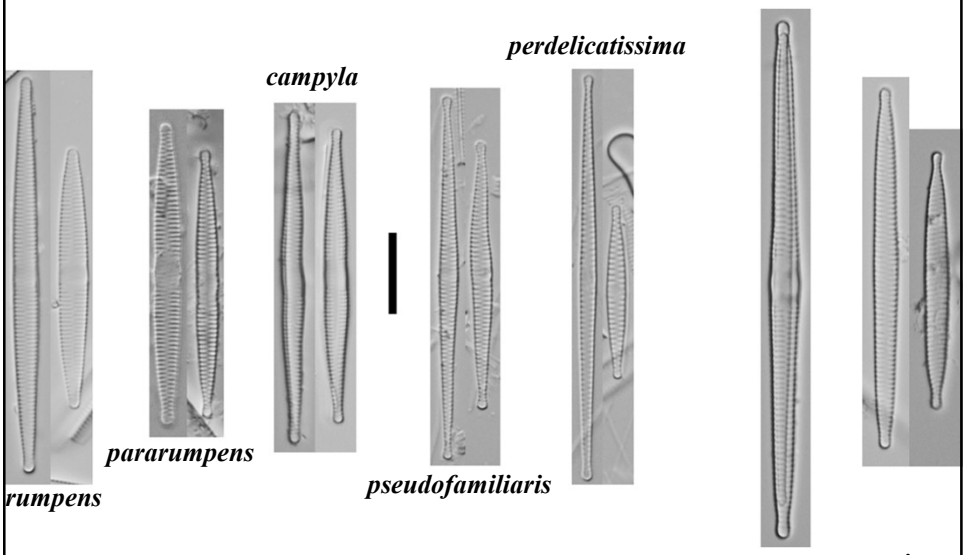
Comparison table for the *Fragilaria capucina* group

Table 2. Comparison table of all *Fragilaria* taxa discussed in this paper

	Fragilaria capucina	*Fragilaria nevadensis*	*Fragilaria sandellii*	*Fragilaria malouana*	*Fragilaria battarbeeana*	*Fragilaria ennerdalensis*
eference	Desmazières (1830)	Linares-Cuesta & Sánchez-Castillo (2007)	Van de Vijver et al. (2012)	Van de Vijver et al. (2021)	Van de Vijver et al. (2021)	Van de Vijver et al. (2021)
Figures	1-23	103-124	125-143	174-199	200-223	224-247
olonies	ribbon-shaped	ribbon-shaped	none	none	none	none
ength (µm)	24-70	20-50	11-24	25-60	12-38	22-48
idth (µm)	3.5-4	ca. 4	4.5-6	3-4	3.5-5	3-4
alve outline	linear, never narrowly lanceolate, with almost parallel margins	Valves lanceolate, with clearly convex, always undulating margins	elliptic-lanceolate to lanceolate in longer valves with distinctly convex margins	linear to very narrowly linear-lanceolate, with almost parallel to weakly convex margins	lanceolate, with weakly to, in smaller valves clearly, convex margins	linear to very narrowly linear-lanceolate, with almost parallel to, in smaller valves, weakly convex margins
pices	Apices cuneately protracted, longer specimens weakly rostrate, short valves never protracted	protracted, rostrate	slightly protracted, subrostrate to acutely rounded	slightly protracted, rostrate to acutely rounded apices	protracted, rostrate	protracted, subrostrate
central area	usually forming a large hyaline zone lacking striae, occasionally slightly swollen	a large hyaline zone spanning the entire valve width	large unilateral hyaline zone with weakly shortened striae on the other side	clearly asymmetrical forming a distinct unilaterally hyaline zone with on the other side almost no shortened striae	clearly asymmetrical, unilaterally expanded, forming a distinct hyaline zone on one side with almost not shortened striae on the other	asymmetrical, slightly swollen and unilaterally expanded, forming a distinct unilateral hyaline zone with on the other side irregularly shortened striae
ghost striae	only rarely observed	often visible	occasionally visible	only rarely observed	only rarely observed	occasionally observed
striae in 10 µm	15-16	17-18	18-19	17-19	18-19	17-18
rimportulae per alve	2	1	1	1	1	1
pines	linking	linking	small, narrow, acute, located on the striae	small, thick, acute, located on the striae	thick, conical, located on the virgae	small, shark tooth-shaped, located on the striae

(Van de Vijver et al. 2021)

2. The *Fragilaria rumpens* group



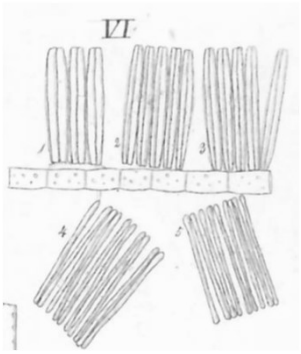
Fragilaria rumpens (Kützing) G.W.F.Carlson 1913

Basionym: ***Synedra rumpens*** **Kützing 1844**
Synonyms: ***Fragilaria capucina*** **ssp.** ***rumpens*** **(Kützing) Lange-Bert. 1993,** ***Fragilaria capucina*** **var.** ***rumpens*** **(Kützing) Lange-Bert. ex Bukhtiyarova 1995**

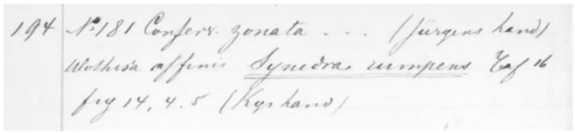
- **cells always producing long, ribbon-like colonies**
- **valves lanceolate, fusiform, sometimes irregularly curved**
- **rostrate apices**
- **length 20-80 µm, width 3.0-3.5 µm**
- **sternum narrow**
- **central area forming a wide, transverse fascia, sometimes unilateral**
- **striae alternate, parallel throughout, 19-20 in 10 µm**
- **spines clearly present**

Original description

Fragilaria rumpens



70. SYNEDRA RUMPENS. Taf. 16. Fig. VI. 4. 5. ($\frac{42^0}{1}$). S. affixa tabulata, tabulis demum disruptis; bacillis angustissime linearibus apice tumidulis obtusis, angulis alternis cohaerentibus.
Im Brackwasser der oldenburgschen Küste!

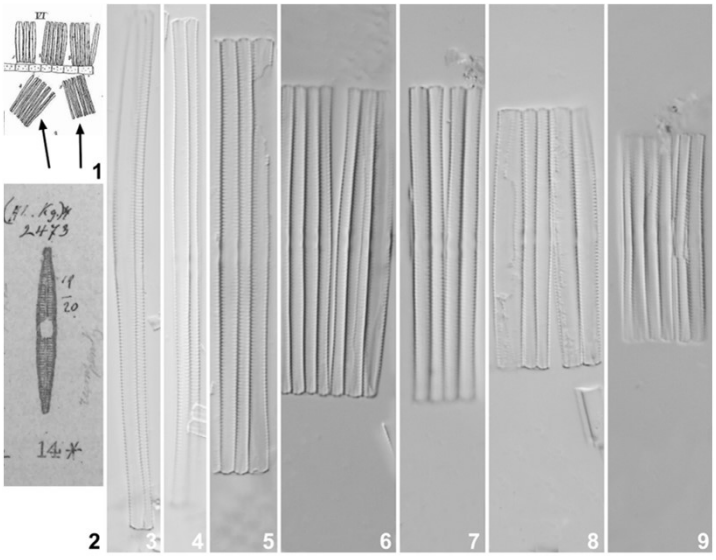


(Kützing 1844)

Type material

Fragilaria rumpens

***Synedra rumpens* Kützing - Slide BM18357 package no. 194 Brackwasser der Oldenburgschen Küste (Germany)**

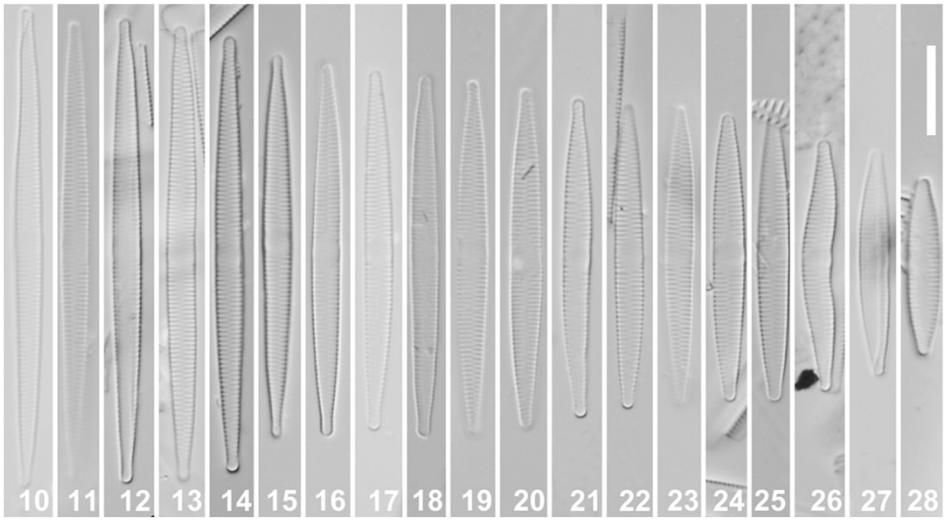


(Van de Vijver et al. 2022)

Type material

Fragilaria rumpens

***Synedra rumpens* Kützing - Slide BM18357**
package no. 194 Brackwasser der Oldenburgschen Küste (Germany)

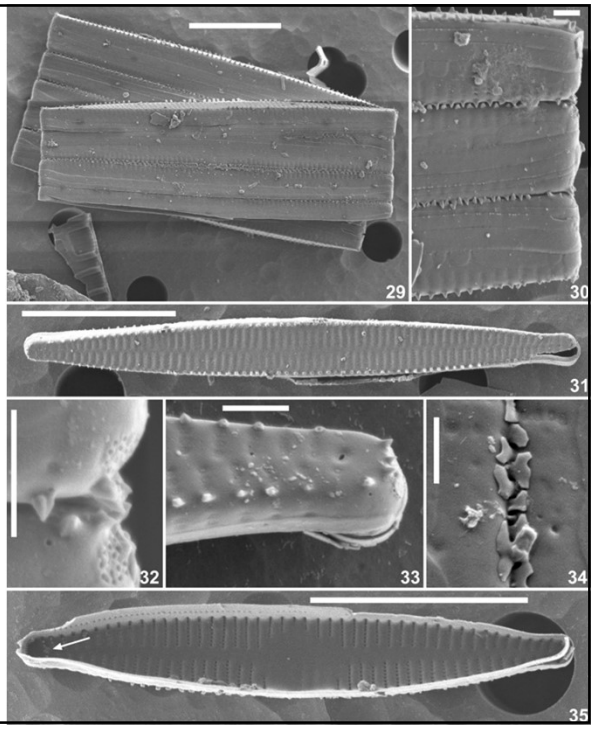


(Van de Vijver et al. 2022)

Type material

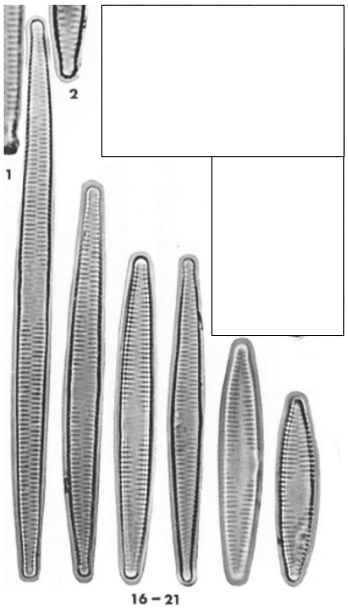
Fragilaria rumpens

***Synedra rumpens* Kützing**
package no. 194
Brackwasser der
Oldenburgschen Küste
(Germany)



(Van de Vijver et al. 2022)

Fragilaria rumpens



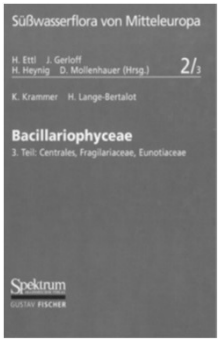
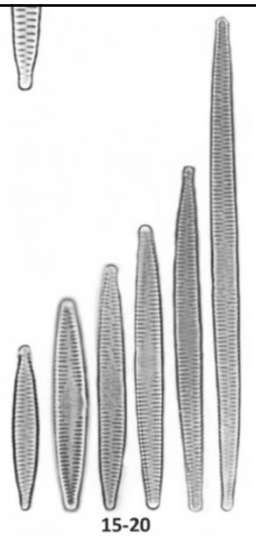
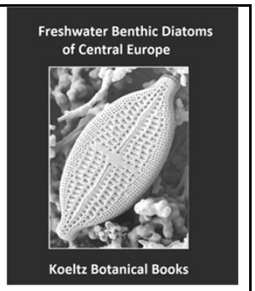


Fig. 16–21: Fragilaria capucina var. rumpens (Kützing) Lange-Bertalot (S. 122)

Fig. 16–22: *Synedra rumpens* Kützing, Lectotypus, Herb. Kützing 194 = B. M. 18 357

Fragilaria rumpens





Figs 15-20: ***Fragilaria rumpens*** (Kützing) Carlson

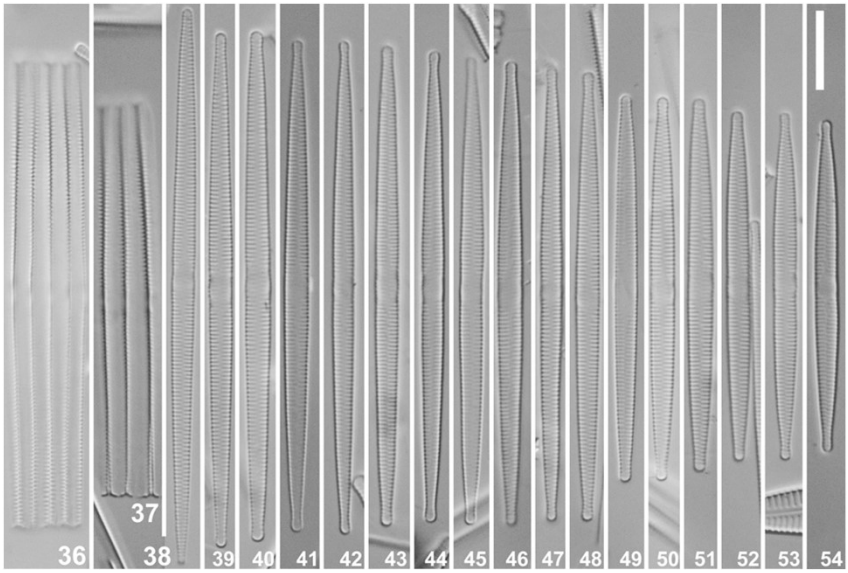
Lange-Bertalot et al. 2017, p. 275, plate 10, figs 15-20

Fresh material: Cells form ribbon-like colonies or tufts sharing a common pad of mucilage. Outline: Girdle view: Frustules linear-rectangular. Valve: Linear to linear-lanceolate. Ends: Obtusely rounded, not or only weakly drawn out.

Dimensions: Length range similar to that of *F. gracilis*, c. 20-65 µm, but valve width c. 3.5-4 µm and Striae slightly more widely spaced (18-20/10 µm).

Other populations

Fragilaria rumpens



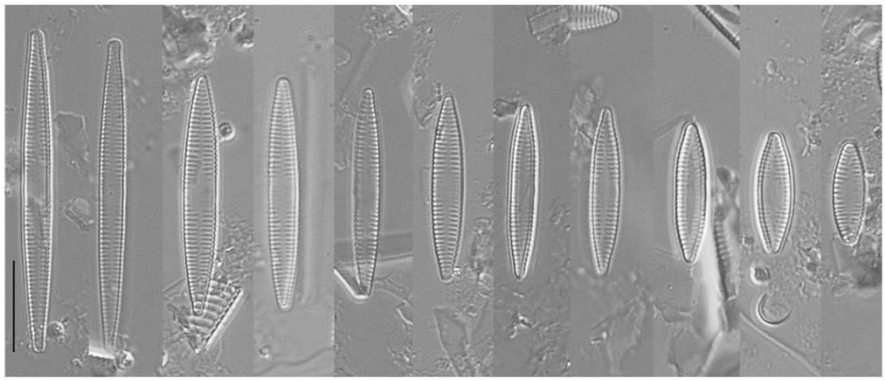
Van Heurck, types du Synopsis des diatomées de Belgique, slide 296
Labelled as *Synedra rumpens* var. *familiaris* – Holstein, Germany

(Van de Vijver et al. 2022)

Other European populations

Scotland

Fragilaria rumpens



Fordoun Burn, Scotland

Most certainly not *F. rumpens*
but an unknown species
in the *F. radians* group

DIATOM FLORA OF BRITAIN AND IRELAND

Ecology

Fragilaria rumpens

Lange-Bertalot et al. (2017)

oligo- to mesotrophic
electrolyte poor streams and small rivers
siliceous substrata
absent from moderately acidified, dystrophic habitats
also absent from eutrophic habitats

Van de Vijver et al. (2022)

The type material is dominated by *Fragilaria rumpens*. Other relatively frequent taxa in the sample include *Tabellaria flocculosa* (Roth) Kützing and *Meridion constrictum* Ralfs, both indicative of electrolyte poor, oligo- to mesotrophic, soft, running waters.

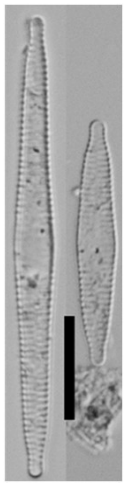
Can be confused with

colonies

F. rumpens
L 20-80 µm
W 3.0-3.5 µm
S 19-20 in 10 µm

colonies

F. capucina
L 28-47 µm
W 3-4 µm
S 14-17 in 10 µm



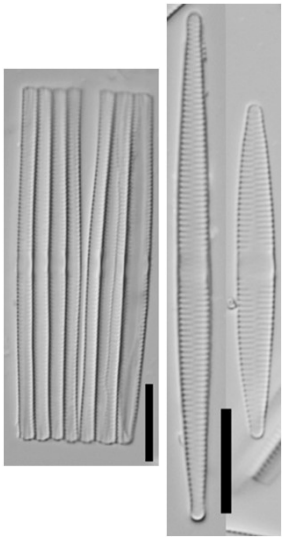
colonies

F. nevadensis
L 20-50 µm
W ca. 4 µm
S 17-18 in 10 µm

NO colonies

"F. gracilis"
L 30-55 µm
W 2-3 µm
S 21-22 in 10 µm

Can be confused with



F. rumpens
L 20-80 µm
W 3.0-3.5 µm
S 19-20 in 10 µm

***Fragilaria rumpens* has**

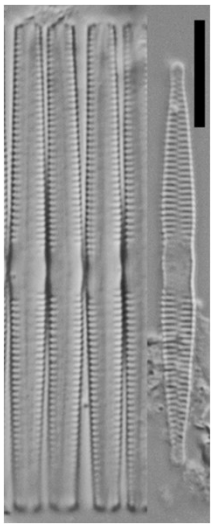
higher stria density

higher valve width
broader valves

less protracted, not capitate apices

no inflated central area

colonies with touching apices



F. pararumpens
L 25-50 µm
W 2.5-3 µm
S 16-18 in 10 µm

Can be confused with

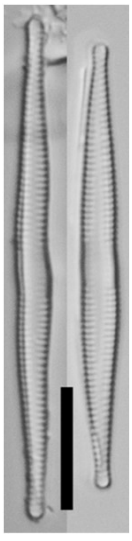
F. rumpens
L 20-80 µm
W 3.0-3.5 µm
S 19-20 in 10 µm

***Fragilaria rumpens* has**

less capitate apices

less inflated central area

Large, ribbon-like colonies !!!



F. campyla
L 35-70 µm
W 2.5-3.5 µm
S 19-21 in 10 µm

Fragilaria pararumpens Lange-Bertalot, G.Hofmann & Werum 2013

Synonym: *Synedra rumpens var. meneghiniana* Grunow in Van Heurck 1880

- **cells always producing band-like colonies, frustules connected by their centers, tapering ends not connected!**
- **valves lanceolate, narrow, tapering from center to ends**
- **apices (sub)capitate**
- **length 25-50 µm, width 2.5-3.0 µm**
- **sternum narrow**
- **central area inflated, hyaline or with ghost striae, almost quadratic**
- **striae alternate, parallel throughout, 16-18 in 10 µm**
- **spines clearly present**

Fragilaria pararumpens Lange-Bertalot, G. Hofmann & Werum nov. spec.

Tafel 8: 4-10 • DV-Nr. 36266

Syn. 16788 *Fragilaria familiaris* sensu Krasske

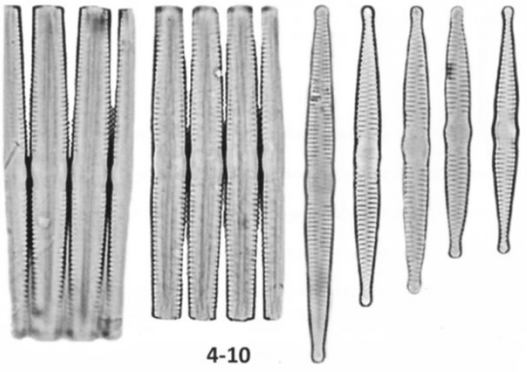
Frustula in situ catenas formantes in media parte coniuncta cum partibus distalibus liberis ita ut pecten apparentia similia *Fragilaria crotonensis* nec *Fragilaria rumpens*. Valvae angustius lanceolatae de medio ad apices capitatas sensim attenuatae, in curte media parte plus minusve inflatae vel aliquid geniculatae. Longitudo 25-50 µm, latitudo 2.5-3 (non 3-4) µm. Area axialis linearis angusta sive angustissima. Area centralis hyalina sive cum striis diffusis apparens circiter 2.5-3 µm ampla apicaliter. Striae transapicales alternantes utroque, 16-18 in 10 µm. Areolae non aspectabiles microscopio photonico, circiter 50 in 10 µm.

Holotypus: Praep. 841 ex Coll. G. Hofmann in Coll. Lange-Bertalot (FR) repräsentiert durch Fig. 4, 5 und 7

Locus typicus: Salm-Bach 22, bei Eisenschmitt, Rheinland-Pfalz, Westdeutschland (leg. D. Stelzer 8.8.2003)

Original description

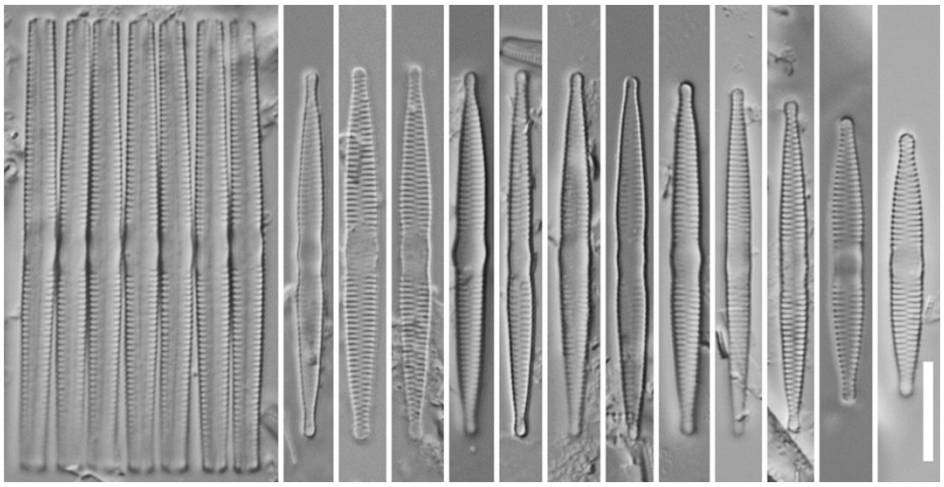
Fragilaria pararumpens



(Hofmann et al. 2013)

Type material

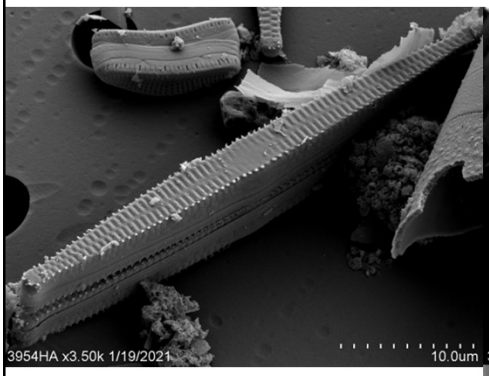
Fragilaria pararumpens

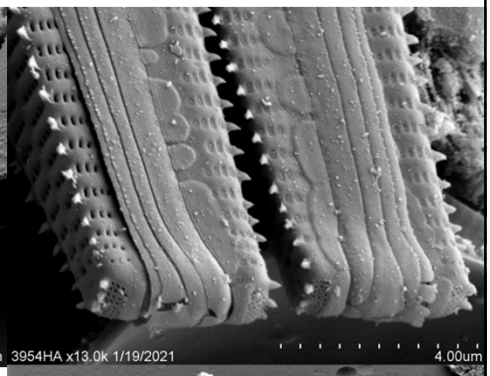


Salm Bach 22 by Eisenschmitt, Germany

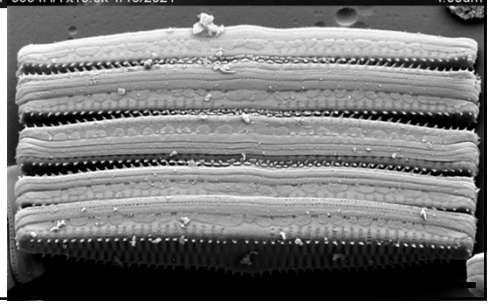
Type material

Fragilaria pararumpens



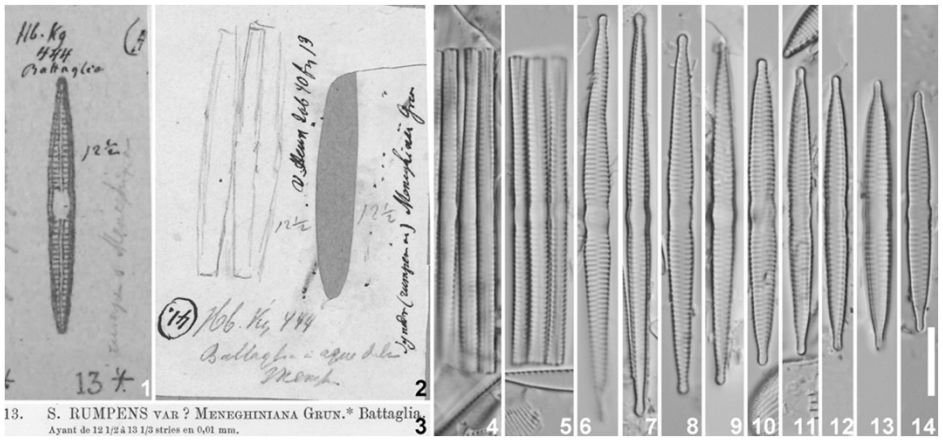


Salm Bach 22 by Eisenschmitt, Germany



Type material *Synedra rumpens* var. *meneghiniana*

= *FRAGILARIA PARARUMPENS*

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Was *Fragilaria pararumpens* Lange-Bertalot, G.Hofmann & Werum 2011 new to science?

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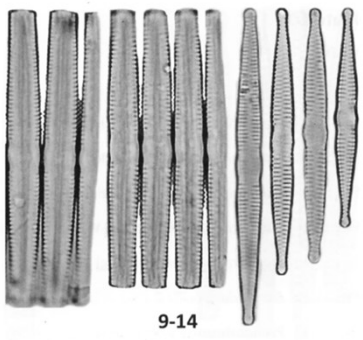
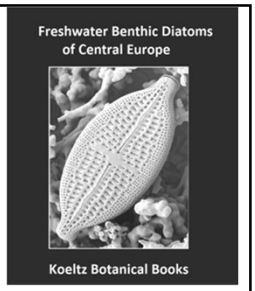
Wolf-Henning Kusber, *Botanischer Garten und Botanisches Museum, Freie Universität Berlin, Königin-Luise-Str. 6-8, 14195 Berlin, Germany*

Battaglia, Kützing sample 444

(Van de Vijver et al. 2021)



Fragilaria pararumpens



Lange-Bertalot et al. 2017, p. 271, plate 9, figs 9-14

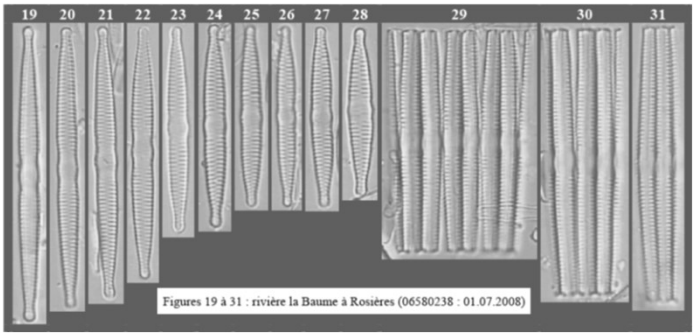
Figs 9-14: ***Fragilaria pararumpens*** Lange-Bertalot, G. Hofmann et Werum

Fresh material: Cells forming band-like aggregates: the frustules are connected by their centres (joined by linking spines), while their tapering ends are not in contact and consequently resemble a double comb, similar to the unprepared material of the planktic *Fragilaria crotonensis*. Outline: Valve: Rather narrow, lanceolate, tapering from the centre to the (sub)capitate Ends. Valves are more or less inflated in the centre, with margins appearing curved in some morphotypes.

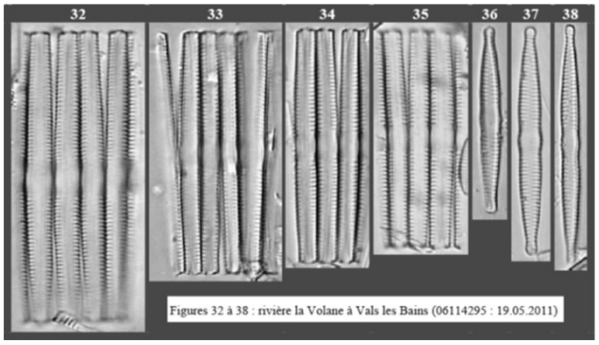
Dimensions: Length 25-50 µm, width 2.5-3 µm. Striae: 16-18/10 µm, alternate. Puncta: Not resolvable with LM (c. 50/10 µm, SEM).

Axial area: Linear, narrow to very narrow. Central area: Hyaline or with ghost striae, almost quadratical (length & width 2.5-3 µm).

Other European populations **France**

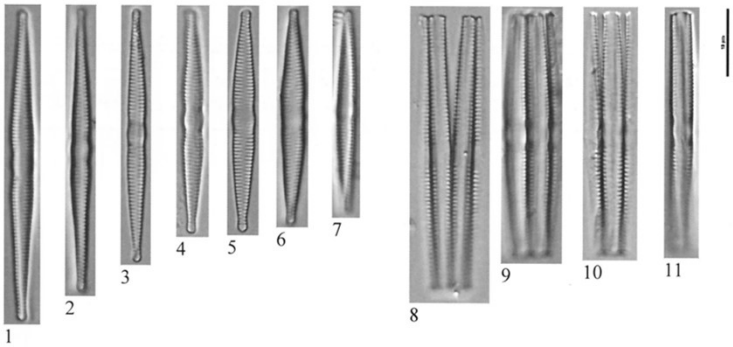


Fragilaria pararumpens



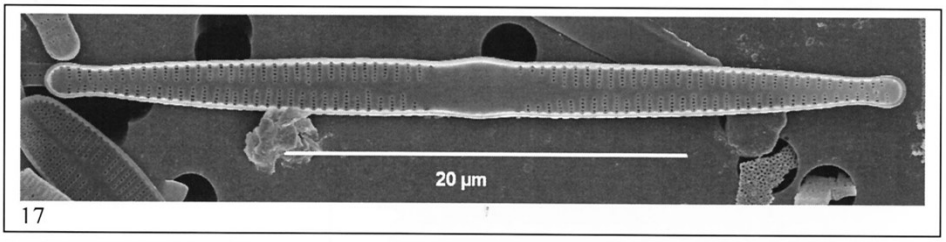
(Bey & Ector 2013)

Other European populations **France**



Figs 1-11 : La Romanée à Cussy-les-Forges 2010

Fragilaria pararumpens

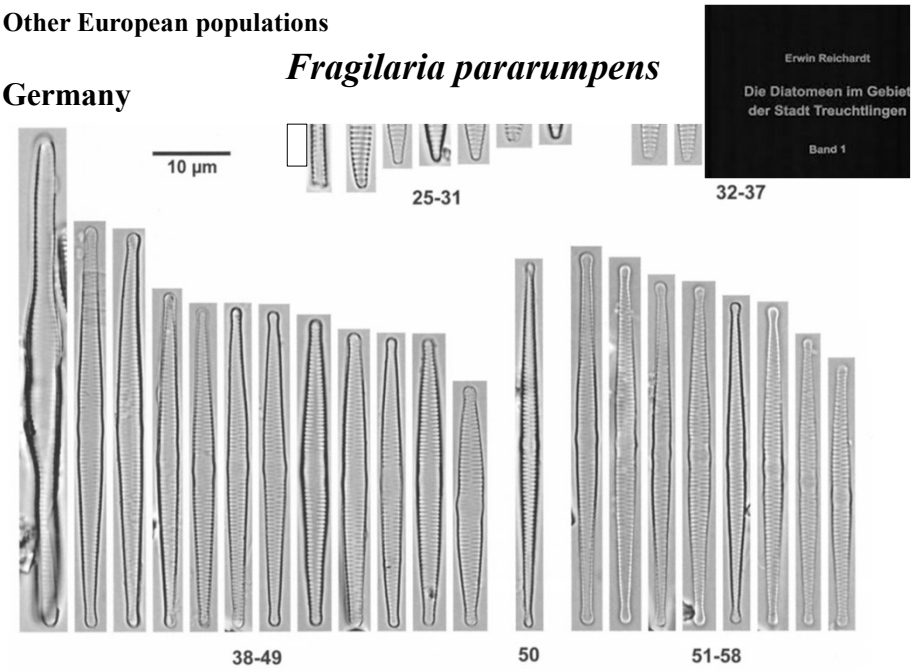


(Peeters & Ector 2017)

Other European populations

Fragilaria pararumpens

Germany



(Reichardt 2018)

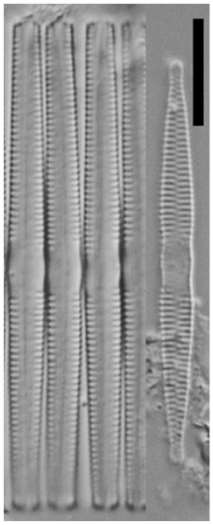
Ecology

Fragilaria pararumpens

<u>Bey & Ector (2013)</u>
sensitive to organic matter

<u>Peeters & Ector (2017)</u>
in waterbodies with low organic matter content

<u>Lange-Bertalot et al. (2017)</u>
smaller rivers and lakes on siliceous substrata
oligosaprobic



F. pararumpens
L 25-50 µm
W 2.5-3 µm
S 16-18 in 10 µm

Can be confused with

Fragilaria pararumpens **has**

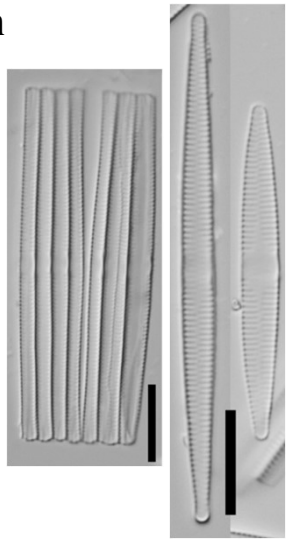
lower stria density

lower valve width
narrower valves

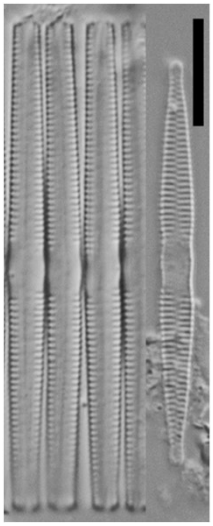
more protracted,
typically capitate apices

clearly inflated
central area

colonies with non-
touching apices



F. rumpens
L 20-80 µm
W 3.0-3.5 µm
S 19-20 in 10 µm



F. pararumpens
L 25-50 µm
W 2.5-3 µm
S 16-18 in 10 µm

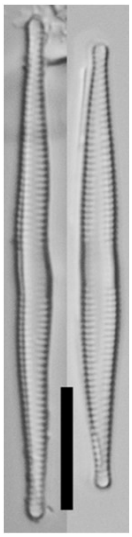
Can be confused with

Fragilaria pararumpens **has**

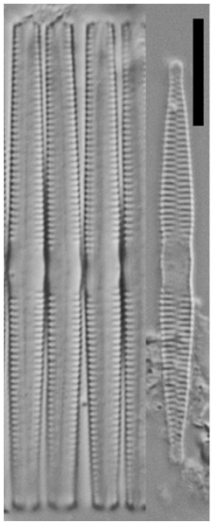
(slightly) lower stria
density

colonies with touching
edges

linking spines



F. campyla
L 35-70 µm
W 2.5-3.5 µm
S 19-21 in 10 µm



F. pararumpens
L 25-50 µm
W 2.5-3 µm
S 16-18 in 10 µm

Can be confused with

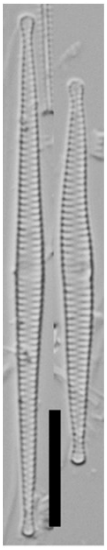
***Fragilaria pararumpens* has**

less slender valves

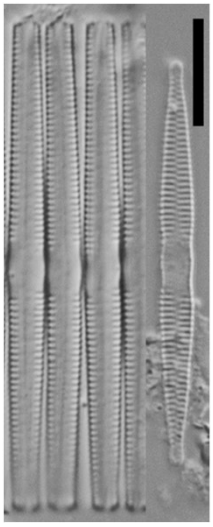
(slightly) lower stria density

colonies with touching edges

linking spines



F. pseudofamiliaris
L 30-50 µm
W 2-3 µm
S 18-19 in 10 µm



F. pararumpens
L 25-50 µm
W 2.5-3 µm
S 16-18 in 10 µm

Can be confused with

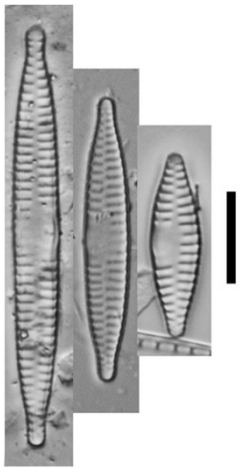
***Fragilaria pararumpens* has**

higher stria density

lower valve width narrower valves

more protracted, typically capitate apices

clearly inflated central area



F. radiantifalsa (radians)
L 35-55 µm
W 3.5-4.5 µm
S 9-11 in 10 µm

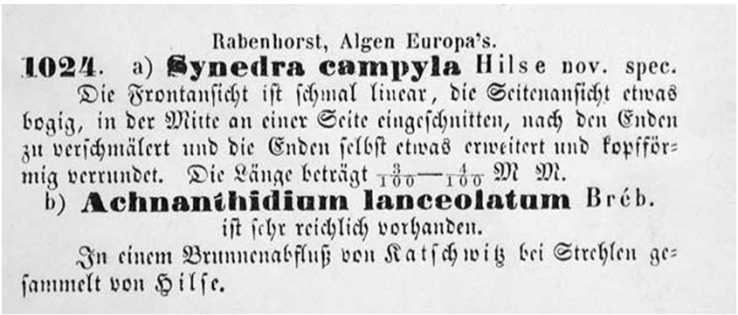
Fragilaria campyla (Hilse) Van de Vijver, Kusber & D.M.Williams

Basionym: ***Synedra campyla*** **Hilse in Rabenhorst 1860**
Synonyms: ***Synedra*** **(*rumpens* var.?)** ***familiaris*** **f.** ***parva*** **&** **f.** ***major*** **Grunow in Van Heurck 1881,** ***Fragilaria parva*** **(Grunow) Tuji & D.M.Williams**

- **cells solitary or 2 cells connected, no colonies!**
- **valves elongated, linear to linear-lanceolate**
- **apices protracted, capitate**
- **length 35-45 µm, width 2.5-3.0 µm**
- **sternum distinct but narrow**
- **central area forming large, rectangular hyaline zone, spanning entire valve width**
- **striae alternate, parallel throughout, 19-21 in 10 µm**
- **small, acute to shark tooth-shaped marginal spines**

Original description

Fragilaria campyla



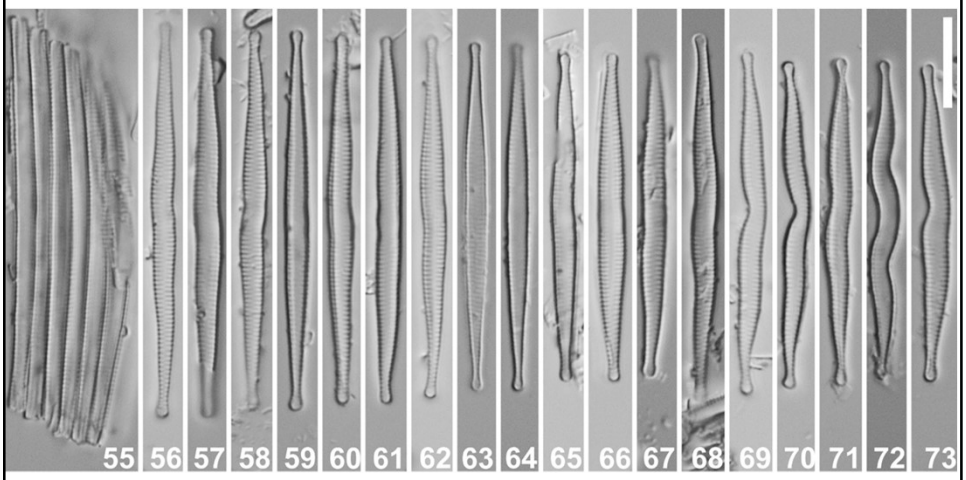
Rabenhorst, Algen Europa's.

1024. a) **Synedra campyla** Hilse nov. spec.
Die Frontansicht ist schmal linear, die Seitenansicht etwas bogig, in der Mitte an einer Seite eingeschnitten, nach den Enden zu verschmälert und die Enden selbst etwas erweitert und kopfförmig verrundet. Die Länge beträgt $\frac{3}{100}$—$\frac{4}{100}$ M M.
b) **Achnanthidium lanceolatum** Bréb.
ist sehr reichlich vorhanden.
In einem Brunnenabfluß von Katschwitz bei Strehlen gesammelt von Hilse.

Rabenhorst (1861) Alg. Eur. Dec. 103/104, n° 1024

Type material

Fragilaria campyla

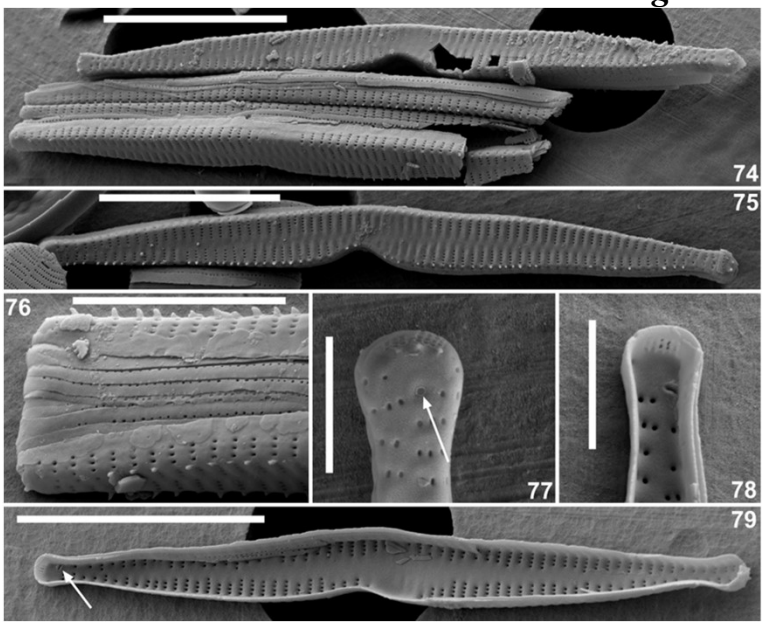


Rabenhorst (1861) Alg. Eur. Dec. 103/104, n° 1024

(Van de Vijver et al. 2022)

Type material

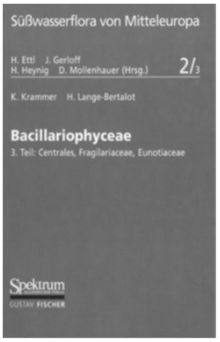
Fragilaria campyla



Rabenhorst (1861) Alg. Eur. Dec. 103/104, n° 1024

(Van de Vijver et al. 2022)

Fragilaria campyla



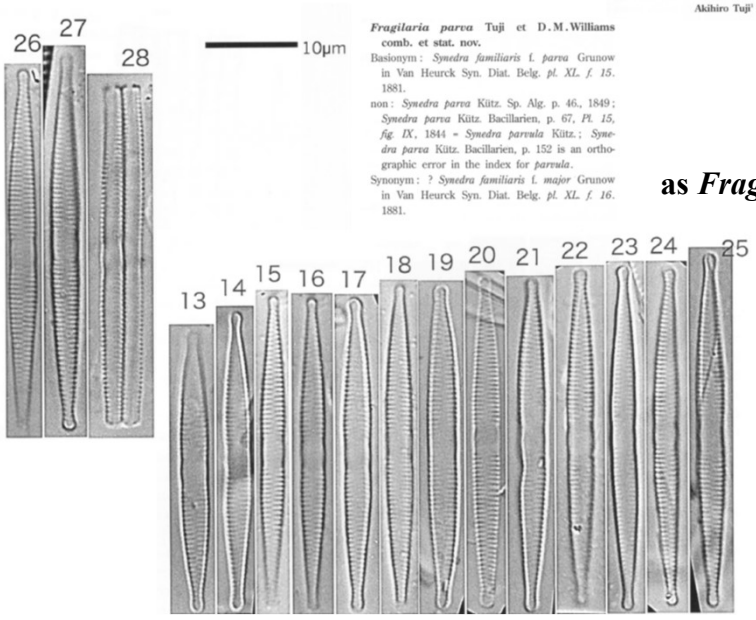
Krammer & Lange-Bertalot 1991, plate 110, Fig. 22

22

Fig. 22: Fragilaria capucina (? unbekannte Sippe)

Fig. 22: «*Synedra rumpens*» sensu Hustedt, sensu Cleve-Euler et auct. nonnull.

Fragilaria campyla



Diatom 24 : 25-29. December 2008

Typification and type examination of *Synedra familiaris* Kütz. and related taxa

Akihiro Tuji[1] and David M. Williams[2]

***Fragilaria parva* Tuji et D.M.Williams comb. et stat. nov.**

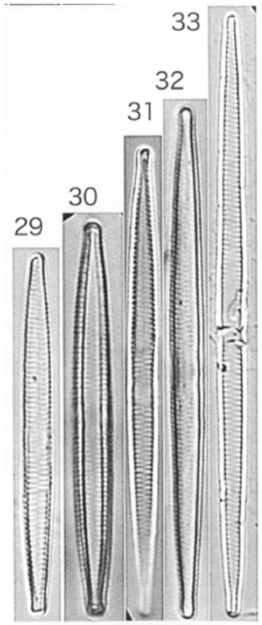
Basionym : *Synedra familiaris* f. *parva* Grunow in Van Heurck Syn. Diat. Belg. *pl. XL. f. 15.* 1881.

non : *Synedra parva* Kütz. Sp. Alg. p. 46., 1849 ; *Synedra parva* Kütz. Bacillarien, p. 67, *Pl. 15, fig. IX*, 1844 = *Synedra parvula* Kütz. ; *Synedra parva* Kütz. Bacillarien, p. 152 is an orthographic error in the index for *parvula*.

Synonym : ? *Synedra familiaris* f. *major* Grunow in Van Heurck Syn. Diat. Belg. *pl. XL. f. 16.* 1881.

as *Fragilaria parva*

(Tuji & Williams 2008)



Diatom 24: 25-29. December 2008

Typification and type examination of *Synedra familiaris* Kütz. and related taxa

Akihiro Tuji[1] and David M. Williams[2]

Fragilaria campyla

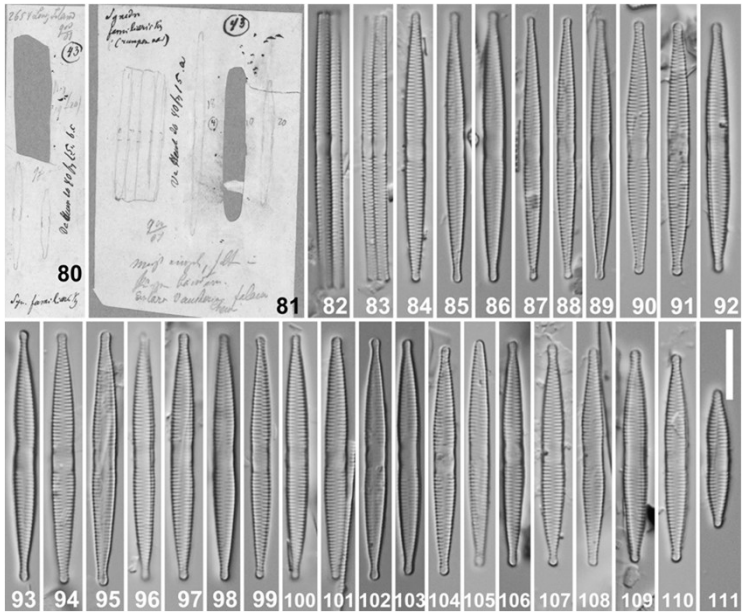
Synedra familiaris* f. *major Grunow in Van Heurck Syn. Diat. Belg. *pl. XL. f. 16*. 1881.
Holotype: slide 970 in Grunow collection in W.
Lectotype (designated here): an individual specimen from slide 970 in W (Fig. 31).

as *Synedra familiaris* f. *major*

(Tuji & Williams 2008)

Other European populations

Fragilaria campyla



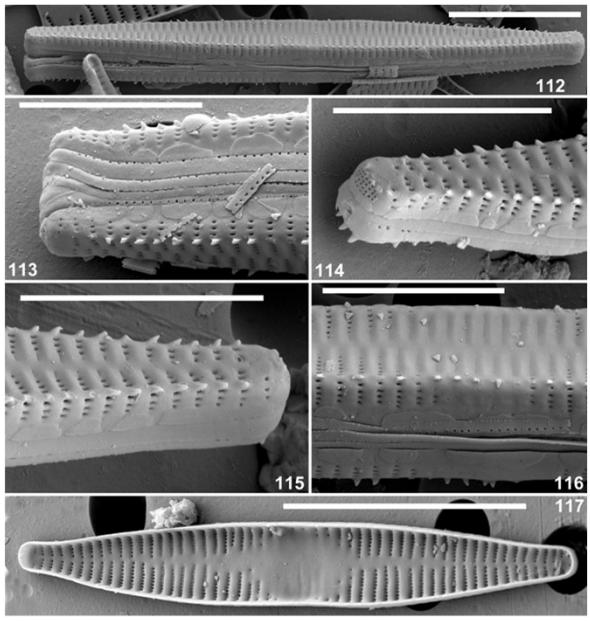
Walker Arnott sample S 701 (Glen Cove Long Island, USA) = Grunow 2654

Type material for *Fragilaria parva*

(Van de Vijver et al. 2022)

Other European populations

Fragilaria campyla



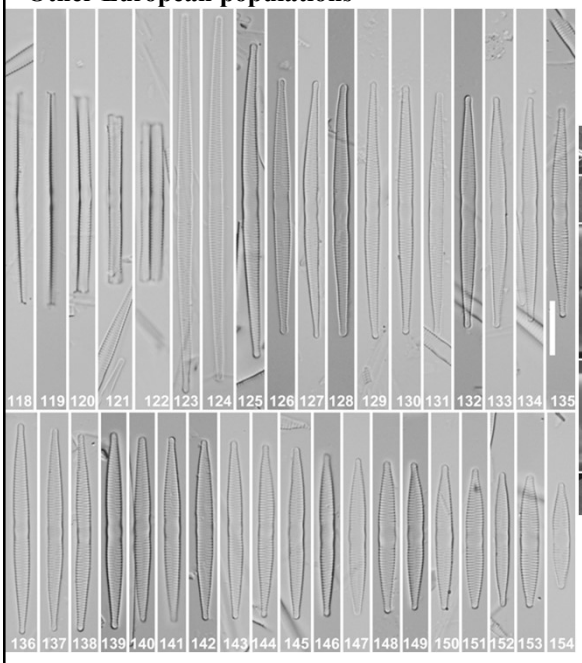
Walker Arnott sample S 701 (Glen Cove Long Island, USA) = Grunow 2654

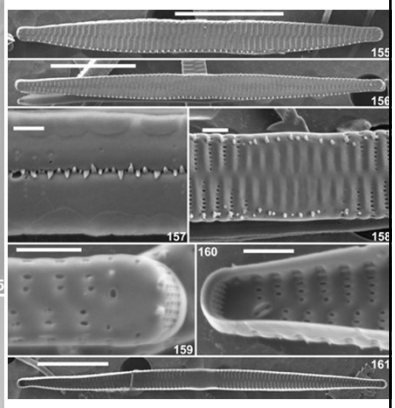
Type material for *Fragilaria parva*

(Van de Vijver et al. 2022)

Other European populations

Fragilaria campyla





Brébisson sample under the name *Synedra vaucheriae*

(Van de Vijver et al. 2022)

Ecology

Fragilaria campyla

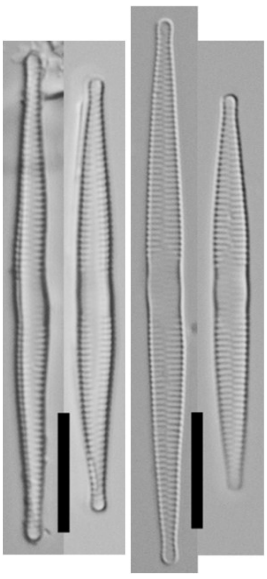
Van de Vijver et al. (2022)

The type sample is dominated by *Planothidium lanceolatum*, *P. frequentissimum*, *Sellaphora atomoides*, *Fragilaria campyla*, *Gomphonema exilissimum* and *Meridion circulare*.

This species composition indicates higher nutrient levels and α-mesosaprobic, circumneutral to alkaline conditions

The type of *F. parva* is dominated by *Melosira varians*, *Fragilaria rumpens*, *Gomphonema parvulum*, *Planothidium frequentissimum*, *Ulnaria oxyrhynchus*, *Surirella angusta*, and *Navicula cryptocephala*.

This species composition points to moderately to strongly electrolyte rich, eutrophic, circumneutral to alkaline running waters.



F. campyla
L 35-70 µm
W 2.5-3.5 µm
S 19-21 in 10 µm

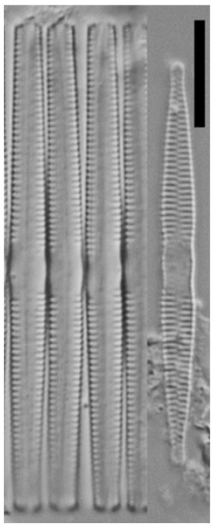
Can be confused with

***Fragilaria campyla* has**

higher stria density

NO colonies!!!

small spines



F. pararumpens
L 25-50 µm
W 2.5-3 µm
S 16-18 in 10 µm

Can be confused with

***Fragilaria campyla* has**

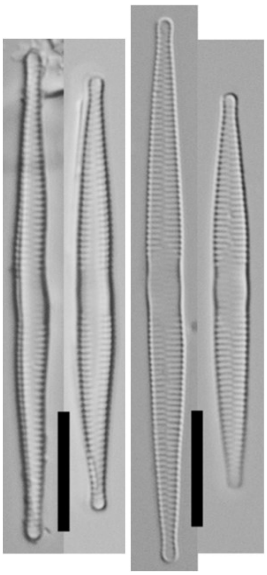
slightly higher stria density

slightly higher valve width

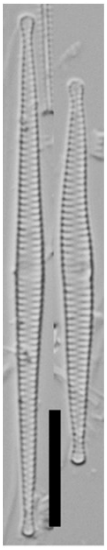
distinct central area

less capitate apices

NO colonies



F. campyla
L 35-70 µm
W 2.5-3.5 µm
S 19-21 in 10 µm



F. pseudofamiliaris
L 30-50 µm
W 2-3 µm
S 18-19 in 10 µm

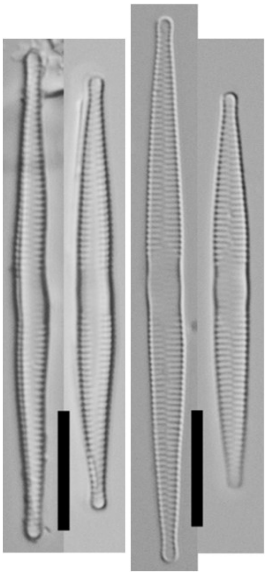
Can be confused with

***Fragilaria campyla* has**

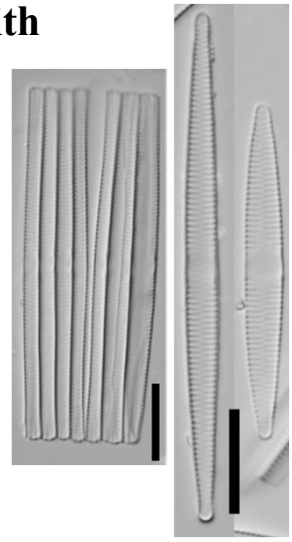
slightly lower valve width

distinct central area

NO colonies



F. campyla
L 35-70 µm
W 2.5-3.5 µm
S 19-21 in 10 µm



F. rumpens
L 20-80 µm
W 3.0-3.5 µm
S 19-20 in 10 µm

***Fragilaria pseudofamiliaris* Van de Vijver, T.M.Schuster, Kusber & D.M.Williams**

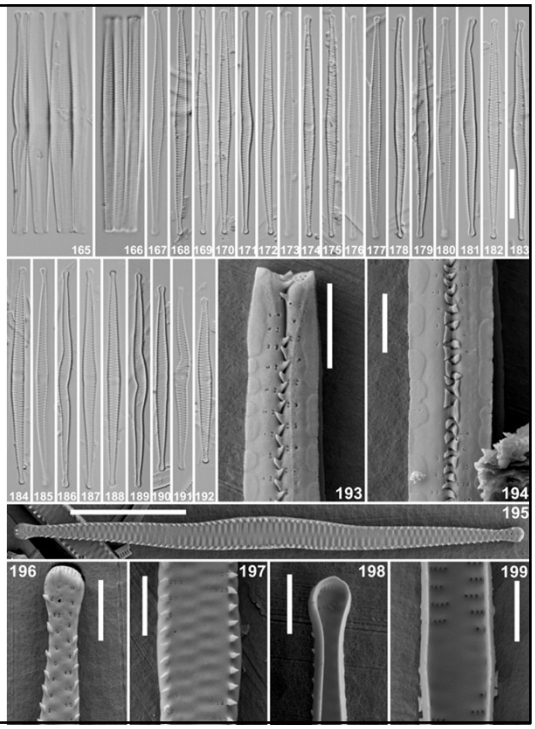
- **cells always producing band-like colonies, frustules connected by their centers, tapering ends not connected!**
- **valves elongated, narrowly lanceolate**
- **apices distinctly protracted, subcapitate to capitate**
- **length 30-50 µm, width 2.0-3.0 µm**
- **sternum narrow but distinct, linear**
- **central area forming small, rectangular, hyaline zone (occasionally absent)**
- **striae alternate, parallel throughout, 18-19 in 10 µm**
- **spines clearly present, linking, bifurcating**

Original description

Fragilaria pseudofamiliaris

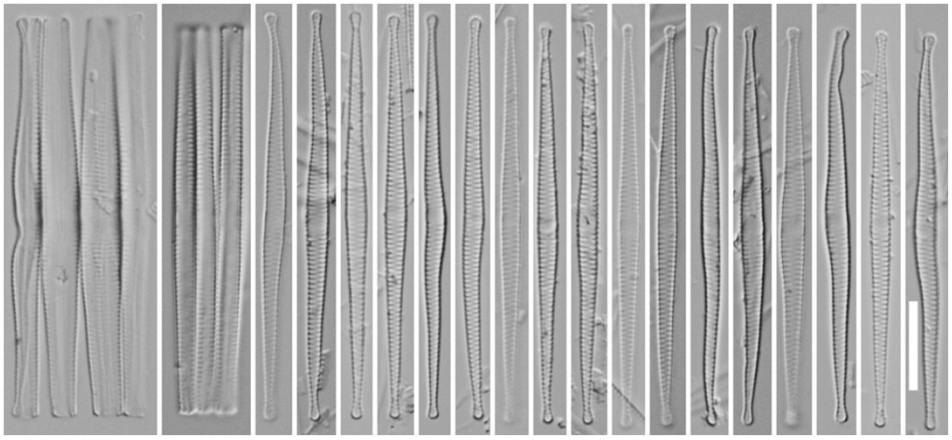
Artesischer Brunnen, Dresden, Germany (coll. date V.1888, leg. C. Schiller s.n.), Collection Hauck & Richter, Phykotheka universalis n° 300

(Van de Vijver et al. 2022)



Type population

Fragilaria pseudofamiliaris

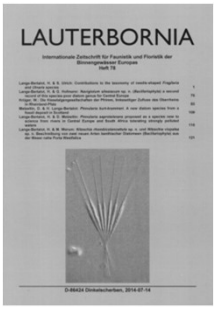


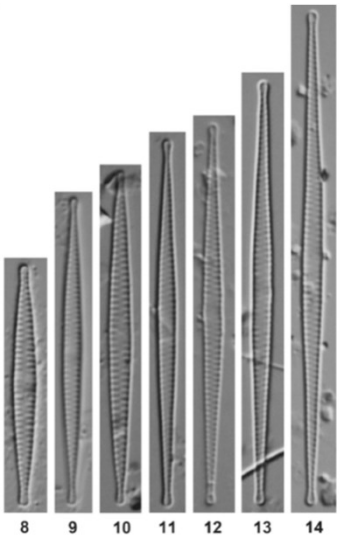
Artesischer Brunnen, Dresden, Germany (coll. date V.1888, leg. C. Schiller s.n.), Collection Hauck & Richter, Phykotheka universalis n° 300

(Van de Vijver et al. 2022)

Other European populations

Fragilaria pseudofamiliaris





identified as *F. perdelicatissima*

Plate 8 (×1500, LM)
Fig. 1-14: *Fragilaria perdelicatissima* Lange-Bertalot & Van de Vijver sp. nov.
Fig. 2 holotype, Fig. 1-7 holotype material from Lough Neagh, North Ireland (Photographed by Bart Van de Vijver), Fig. 8-14 Lake Olbersdorf, Saxony

Ecology

Fragilaria pseudofamilaris

Van de Vijver et al. (2022)

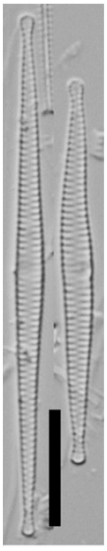
The dominant diatom species in the type material is *F. pseudofamiliaris*.

Other taxa in the sample include *Achnanthidium exile*, *A.* cf. *microcephalum*, *Brachysira neoexilis*, *Cymbella affinis*, *Diatoma tenuis*, *Encyonopsis subminuta* and *Fragilaria goeyersiana*.

Most of these species are typical for calcium bicarbonate enriched, meso- to eutrophic, medium electrolyte-rich lakes

(Van de Vijver et al. 2022)

Can be confused with



F. pseudofamiliaris
L 30-50 µm
W 2-3 µm
S 18-19 in 10 µm

***Fragilaria pseudofamiliaris* has**

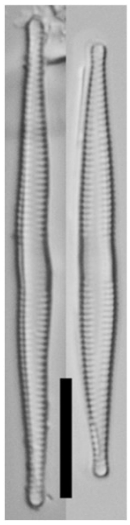
slightly lower stria density

slightly lower valve width

small central area

typical capitate apices

Colonies with free apices



F. campyla
L 35-70 µm
W 2.5-3.5 µm
S 19-21 in 10 µm

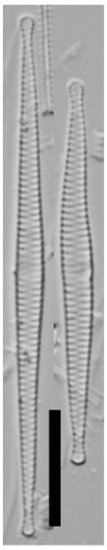
Can be confused with

Fragilaria pseudofamiliaris **has**

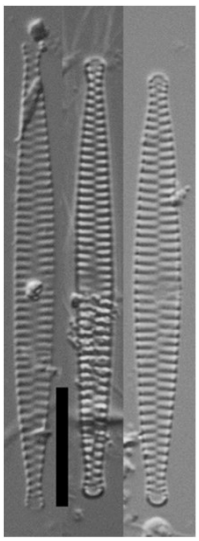
clearly higher stria density

lower valve width

colonies with free apices



F. pseudofamiliaris
L 30-50 µm
W 2-3 µm
S 18-19 in 10 µm



F. austriaca
L 25-63 µm
W 3-4 µm
S 12-15 in 10 µm

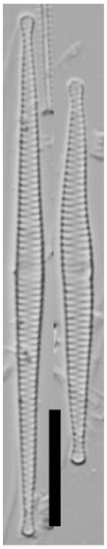
Can be confused with

Fragilaria pseudofamiliaris **has**

clearly higher stria density

lanceolate, NOT linear valves

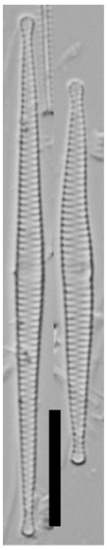
colonies with free apices



F. pseudofamiliaris
L 30-50 µm
W 2-3 µm
S 18-19 in 10 µm

F. amphicephaloides
L 40-75 µm
W 2-3 µm
S 10-14 in 10 µm

Can be confused with



F. pseudofamiliaris
L 30-50 µm
W 2-3 µm
S 18-19 in 10 µm

***Fragilaria pseudofamiliaris* has**

higher stria density

usually shorter valves

small sternum

colonies with free apices

spines

F. perdelicatissima
L 20-100 µm
W 2.0-2.5 µm
S 15-16 in 10 µm

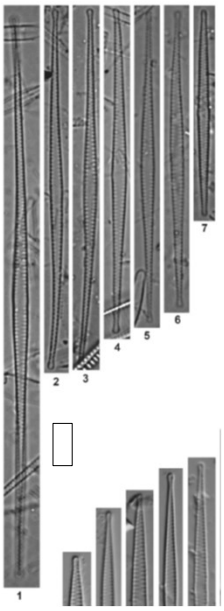
Fragilaria perdelicatissima Lange-Bertalot & Van de Vijver 2014

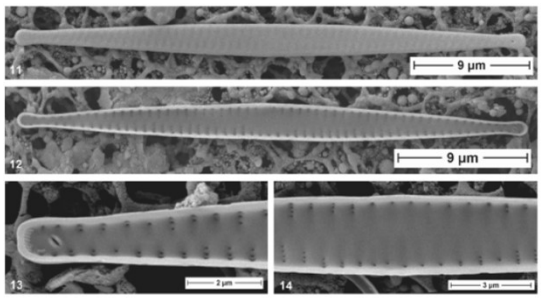
Synonym: *Fragilaria delicatissima* (W.Smith) Lange-Bertalot 1980, nom. illeg.
(≠ *Synedra delicatissima* W.Smith)

- Cells solitary or 2 frustules connected, no ribbon-like colonies!
- Valves elongated, linear-lanceolate with parallel margins, gradually tapering
- Apices distinctly protracted, capitate
- Length 20-100 µm, width 2.0-2.5 µm
- Sternum distinct, broad, linear to lanceolate
- Central area usually forming apically elongated, rectangular hyaline zone
- Striae alternate, short, marginal, parallel, 15-16 in 10 µm
- Spines absent

Original description

Fragilaria perdelicatissima





Diagnosis: Cells living single in apparently benthic assemblages, not forming colonies. LM views see Fig. 8: 1-7. Valves spindle- to needle-shaped, narrowly lanceolate rather than linear. Ends distinctly capitate to subcapitate. Valves often appearing more or less curved, at least concerning the type material. Length 36–95 µm, breadth 2.0–2.6 µm. Length-to-breadth ratio is 18–36. Axial area rather wide, at least in proximal parts of the valve. Central area present but variable in shape, sometimes with weakly contrasted "ghost striae". Other transapical striae alternating throughout, 14–16 in 10 µm. Areolae not discernible in the light microscope. SEM micrographs, internal view, show only one pole per valve with rimoportula (see Tuji & Houki 2004, Fig. 8-11).

Plate 8 (×1500, LM)
Fig. 1-14: *Fragilaria perdelicatissima* Lange-Bertalot & Van de Vijver sp. nov.
Fig. 2 holotype, Fig. 1-7 holotype material from Lough Neagh, North Ireland (Photographed by Bart Van de Vijver), . 8-14 Lake Olbersdorf, Saxony

(Lange-Bertalot & Ulrich 2014)

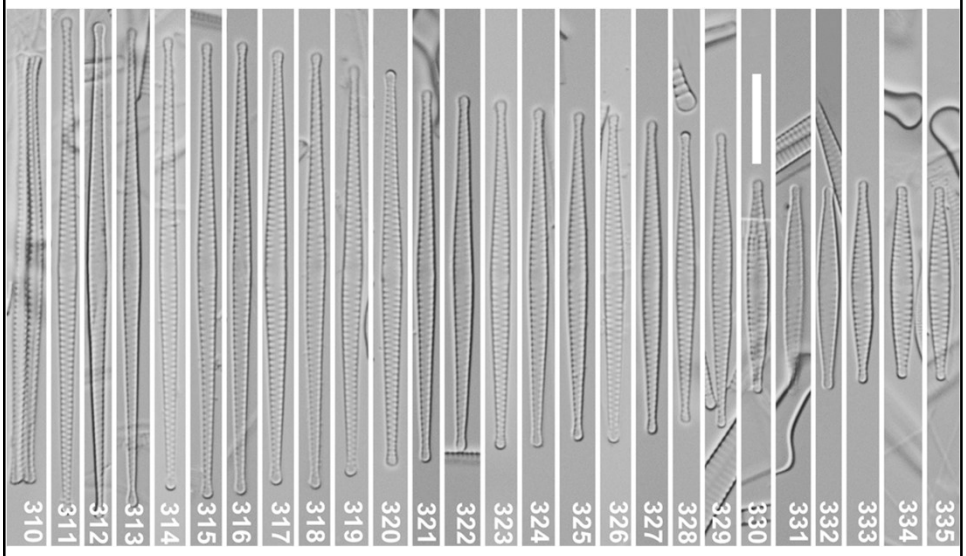
Type population

Fragilaria perdelicatissima

William Smith,
Campylodiscus hibernicus
sample, Lough Neagh
(Antrim, North Ireland, UK,
coll. date 1850,
leg. Dr G. Dickie s.n.)

(Van de Vijver et al. 2022)

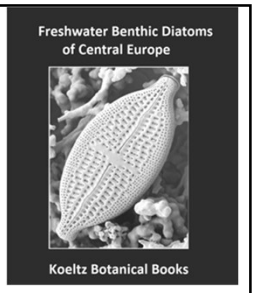
Other populations ***Fragilaria perdelicatissima***



Apmeljåkkå River, Sweden, 2002
(leg. Amelie Jarlman)

(Van de Vijver et al. 2022)

Fragilaria perdelicatissima



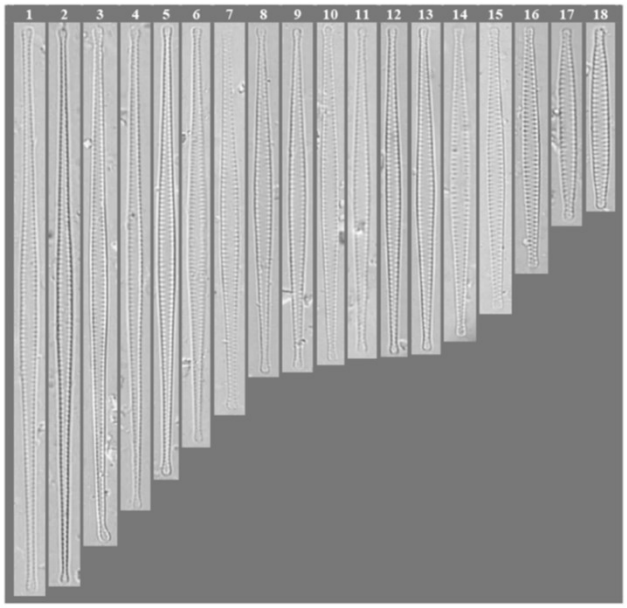
Figs 1-6: ***Fragilaria perdelicatissima*** Lange-Bertalot et Van de Vijver

Lange-Bertalot et al. 2017, p. 272, plate 8, figs 1-6

Other European populations

France

Fragilaria perdelicatissima



Figures 1 à 18 : exutoire du marais des Bouligons à Charens (06109060 : 18.03.2008)

As *F. delicatissima*

(Bey & Ector 2013)

Ecology (I)

Fragilaria perdelicatissima

Bey & Ector (2013) (as *F. delicatissima*)

- **calcareous habitats, moderately mineralized**
- **low to moderate levels of nutrients**

Lange-Bertalot & Ulrich (2014)

- **usually in phytobenthos, rarely in plankton**

Lange-Bertalot et al. (2017)

- **calcium-bicarbonate enriched waterbodies**
- **oligo- mesotrophic lakes and rivers**
- **indicator of very good quality**
- **can form blooms in spring**

Ecology (II)

Fragilaria perdelicatissima

Van de Vijver et al. (2022)

Type material dominated by *Achnanthidium affine* and *A.* cf. *microcephalum*, *Cymbella lange-bertalotii*, *Denticula tenuis*, *Diatoma ehrenbergii*, *Fragilaria perdelicatissima*, and *Tryblionella brunoi*.

Swedish sample dominated by *A. minutissimum*, *Fragilaria perdelicatissima*, *F. tenera*, *Hannaea linearis*, and *Tabellaria flocculosa* together with *Brachysira neoexilis*, various *Cymbella* species, and *Achnanthidium lineare*.

The site was characterized by an alkaline pH (8.0), a low conductivity value of 88 µS cm-1, low nitrogen (NH4+-N 5 µg/l, NO2-+NO3--N 25 µg/l) and phosphate (PO43--P 1 µg/l) levels

The observed diatom composition in both samples is typical for circumneutral to weakly alkaline, oligosaprobic, oligo- to mesotrophic conditions.

Can be confused with

***Fragilaria perdelicatissima* has**

lower stria density

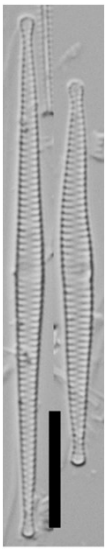
longer valves

broad sternum

no colonies with free apices

no spines

F. perdelicatissima
L 20-100 µm
W 2.0-2.5 µm
S 15-16 in 10 µm



F. pseudofamiliaris
L 30-50 µm
W 2-3 µm
S 18-19 in 10 µm

Can be confused with

***Fragilaria perdelicatissima* has**

higher stria density

longer valves

broad sternum

F. perdelicatissima
L 20-100 µm
W 2.0-2.5 µm
S 15-16 in 10 µm

F. amphicephaloides
L 40-75 µm
W 2-3 µm
S 10-14 in 10 µm

Can be confused with

***Fragilaria perdelicatissima* has**

lower stria density

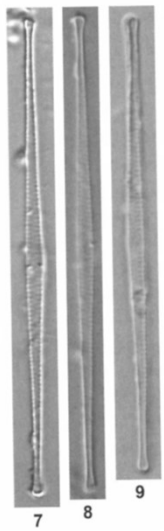
broad sternum

no colonies

no spines

F. perdelicatissima
L 20-100 µm
W 2.0-2.5 µm
S 15-16 in 10 µm

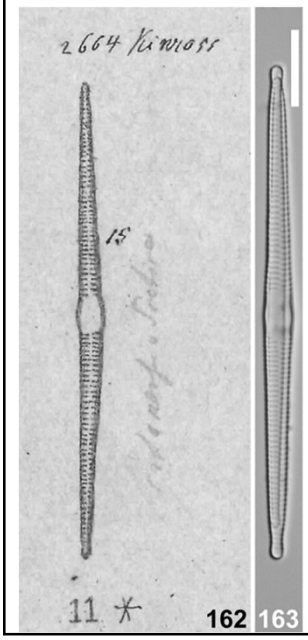
F. tenera
L 60-120 µm
W 2-2.5 µm
S 18-20 in 10 µm



F. tenera var. nanana
L 30-90 µm
W 2-2.5 µm
S 22-25 in 10 µm

Fragilaria scotica (Grunow) Van de Vijver, C.E.Wetzel & Ector

Basionym: *Synedra rumpens* var. *scotica* Grunow in Van Heurck 1881



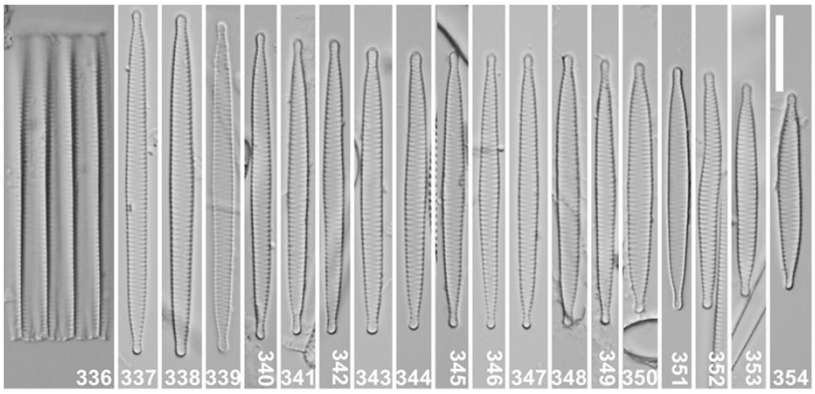
valves lanceolate
apices protracted, rostrate
length 65 µm, width 4 µm
central area large, clearly inflated
striae parallel to very weakly radiate,
15 in 10 µm

The diatom composition points to alkaline, meso- to slightly eutrophic, electrolyte-rich conditions.
Given the extreme rarity of the taxon, it is unclear whether these conditions should be attributed to *F. scotica*.

Walker Arnott sample 262
(Loch Leven near Kinross, Scotland, UK)
(=Grunow sample 2664)

(Van de Vijver et al. 2022)

Fragilaria spinaspeciosa Lange-Bertalot & Cantonati in Cantonati et al. 2019



Short, ribbon-like colonies
Valves strictly linear, parallel margins
Apices protracted, capitate
Length 25-45(57) µm, width 2.5-3.0 µm
Central area almost absent
Striae parallel, 15-17 in 10 µm
Marginal linking spines present

Environmental conditions at the type locality: conductivity (13 µS/cm), pH: 6.54, nitrate: 0.17 mg/L, TP: 5 µg/L), SRP: <1 µg/L), sulphate: 1.7 mg/L

Sample cLIM004 DIAT 1985, Helocrenic spring close to Lago Scuro, Italy
coll. date 31.VII.2011, leg. M. Cantonati

(Cantonati et al. 2017; Van de Vijver et al. 2022)

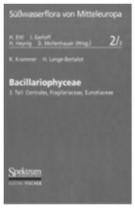
Comparison table for the *Fragilaria rumpens* group

Table 2. Comparison table of all *Fragilaria* taxa discussed in this paper

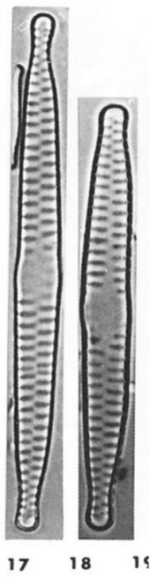
	Fragilaria rumpens	*Synedra rumpens var. familiaris sensu Van Heurck*	*Fragilaria campyla*	*Fragilaria parva*	*Synedra vaucheriae sensu Brébisson*	*Fragilaria scotica*	*Fragilaria pseudofamilaris*	*Fragilaria paraneogena*
original reference	Kützing 1844	this study	Hilse (1860)	Van Heurck (1881)	this study	Van Heurck (1881)	this study	Grunow (1882)
Figures	1-35	36-54	55-79	80-117	118-161	162-164	165-199	200-217
colonies	yes	yes	no	no	no	no	yes, apices not touching in girdle view	no
length (µm)	20-80	40-70	35-45	20-40	20-70	65	30-50	60-120
width (µm)	3.0-3.5	2.5-3.0	2.5-3.0	3.0-3.5	3.0-3.5	4	2-3	1-1.5 (2.5-3.5 for central area)
valve outline	linear to linear-lanceolate with almost straight to very weakly convex margins	elongated, linear-lanceolate with parallel margins, gradually tapering	elongated, linear to linear-lanceolate, teratological valves undulating	linear to linear-lanceolate with parallel to only very weakly convex margins	linear to linear-lanceolate with gradually narrowing valve margins	linear-lanceolate with gradually narrowing margins	elongated, narrowly lanceolate with gradually tapering margins	elongated, very thin, linear with distinctly inflated central part
apices	distinctly protracted, rostrate to often even capitate	distinctly protracted, subcapitate to capitate	protracted, capitate	distinctly protracted, capitate to rostrate in smaller specimens	distinctly protracted, capitate to rostrate	protracted, rostrate	distinctly protracted, subcapitate to capitate	protracted, slightly capitate
central area	relatively large, forming a rectangular hyaline area, occasionally weakly swollen	rectangular, weakly swollen, hyaline zone	large, rectangular hyaline zone	swollen, forming a large hyaline rectangular zone	distinctly swollen, forming a well-delimited large hyaline rectangular zone	clearly inflated and well delimited	small, occasionally absent, rectangular, hyaline zone	inflated, hyaline, well delimited
ghost striae	clearly present	clearly present	clearly present	clearly present	usually present	?	occasionally present	present
striae in 10 µm	19-20	19-20	19-20	19-21	19-21	15	18-19	ca. 18
rimoportulae per valve	1	1	1	1	1	1	1	1
spines	yes	probably yes	yes	yes	yes	?	yes	yes

(Van de Vijver et al. in press)

3. The *Fragilaria radians* problem



Krammer & Lange-Bertalot (1991)



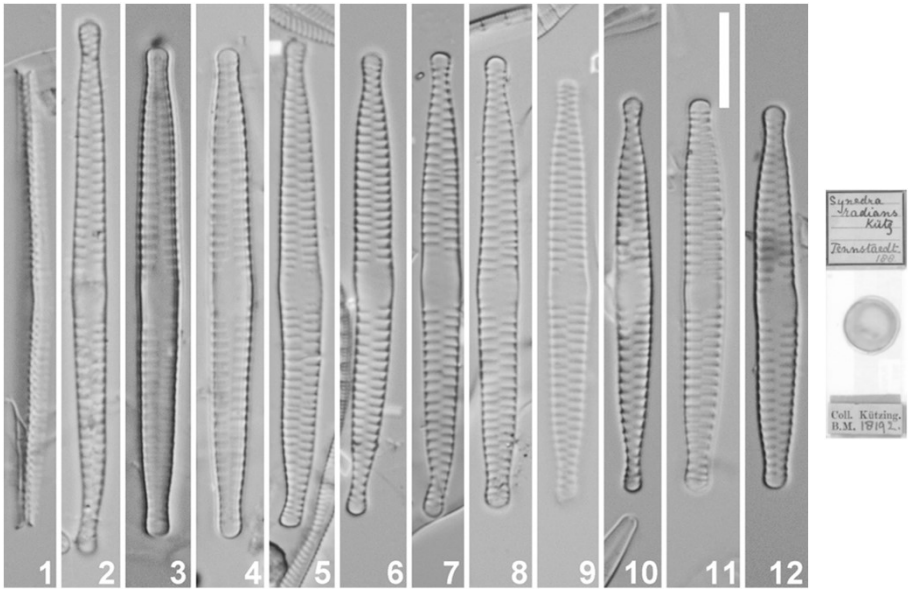
1.2 radians-Sippen (Fig. 109: 17, 18)
Synedra radians Kützing 1844

Schalen wie bei den *capucina*-Sippen, jedoch Str. durchschnittlich etwas weiter gestellt, um 10/10 µm. Die Merkmale überschneiden sich mit einigen anderen Sippen dieses Komplexes.

Als Lectotypus kommt im Zusammenhang mit dem Protolog nur ein Präparat aus dem Herbar Kützing 188, Tennstädt, in Frage, bezeichnet wurde B.M. 18192. Das Problem aber besteht darin, welche der Populationen darin Kützing wohl als *Synedra radians* angesehen hat. Es enthält nämlich: *F. pulchella*, *F. famelica* und verschiedene Populationen aus dem hier diskutierten *capucina*-Sippenspektrum, darunter *rumpens*- und *gracilis*-Sippen. Konform mit dem Protolog ist jedoch nur die hier durch Fig. 109: 17, 18) repräsentierte Sippe mit gröberen Str., weil alle anderen entweder die Länge von etwa 45 µm oder die Breite von etwa 4 µm überhaupt nicht aufweisen (vgl. Kützing 1844, Fig. 14: 7). Diese muß als Lectotypus-(Population) angesehen werden! Wahrscheinlich hat Kützing die diversen Populationen im Präparat aus Tennstädt und später auch im Präparat aus Falaise (Herbar Kützing 1211; es handelt sich darin um eine *rumpens*-Sippe, vgl. Fig. 110: 1, 2) nicht differenziert. In situ können mehrere davon «*radians*-Kolonieformen» bilden, das Merkmal ist nicht eindeutig. Kein einziges der später mit Kützings Taxon verbundenen jüngeren Taxa anderer Autoren hat wirklich etwas mit *Synedra radians* (Lectotypus) zu tun. Am wenigsten die in der neueren Literatur vorgestellten Sippen um *Synedra/Fragilaria acus*.

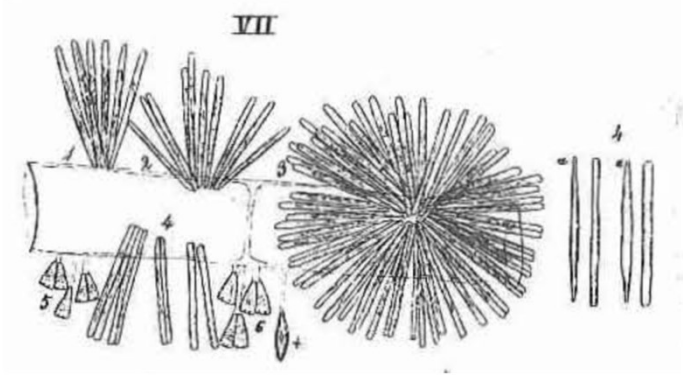
Fig. 17, 18: *Synedra radians*, lectotypisierte Sippe im B. M. 18 192 aus Herbar Kützing 188, Tennstädt

Type material ***Fragilaria radians* sensu Krammer & Lange-Bertalot**



***Synedra radians* Kützing - Slide BM18192**
package no. 188 an *Cladophora fracta* bei Tennstadt (Germany)

Original description




Die kieselschaligen
Bacillarien oder Diatomeen.

16. SYNEDRA RADIANS. Taf. 14. Fig. VII. 1 — 4. ($\frac{1}{14}$°). S. debilis, angustissima, linearis, radiatim et densissime aggregata, altero latere truncata, altero attenuata obtusiuscula.

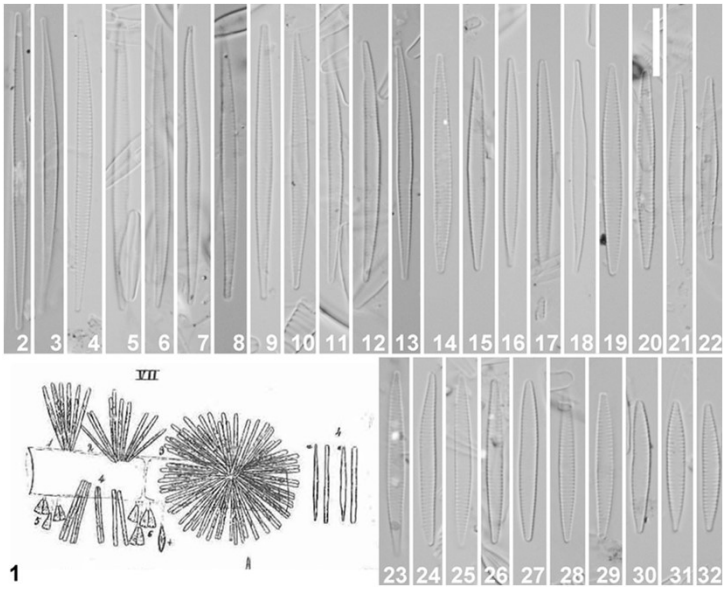
An Cladophora fracta bei Tennstädt! — Länge $\frac{1}{30}$‴.

small *Synedra*
very narrow, linear
grouped in dense bundles
one side truncated,
other side bluntly attenuated

(striae not visible!!!)

(Kützing 1844)

Fragilaria radians



Kützing sample 188, B.M.18192, Tennstadt, Germany

(Van de Vijver et al. 2022)

Fragilaria gracilis Østrup 1910

Synonym: *Fragilaria capucina* var. *gracilis* (Østrup) Hustedt 1950, *Fragilaria laevissima* Østrup 1910, *Fragilaria pseudolaevissima* Von Cellingham 1971, *Synedra utermoehlii* Hustedt, *F. utermoehlii* (Hustedt) Lange-Bertalot 1993

- **Cells solitary**
- **Valves narrow, linear to linear-lanceolate**
- **Apices obtusely rounded, very weakly to not protracted**
- **Length 20-60 µm, width 2.0-3.0 µm**
- **sternum narrow but distinct**
- **Central area forming a weakly developed fascia**
- **Striae alternate to opposite, almost parallel to slightly radiate, 19-24 in 10 µm**
- **Spines absent**

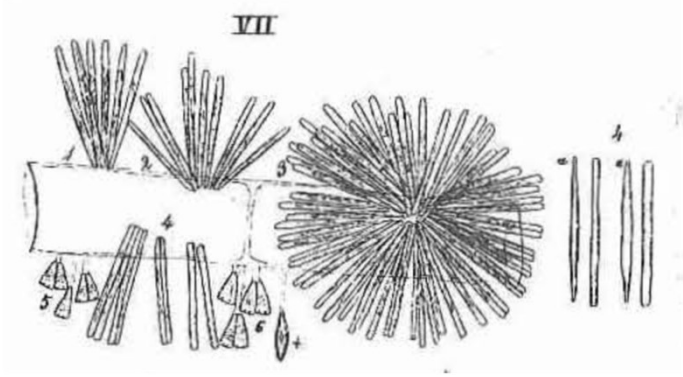
*Fragilaria radians (*Kützing) D.M.Williams & Round 1987

Basionym: ***Synedra radians*** **Kützing 1844**

Synonym: ***Fragilaria gracilis*** **Østrup 1910**, ***Fragilaria capucina*** **var.** ***gracilis*** **(Østrup) Hustedt 1950,** ***Fragilaria laevissima*** **Østrup 1910,** ***Fragilaria pseudolaevissima*** **VanLandingham 1971,** ***Synedra utermoehlii*** **Hustedt,** ***F. utermoehlii*** **(Hustedt) Lange-Bertalot 1993**

- **Cells solitary**
- **Valves narrow, linear to linear-lanceolate**
- **Apices obtusely rounded, very weakly to not protracted**
- **Length 20-60 µm, width 2.0-3.0 µm**
- **sternum narrow but distinct**
- **Central area forming a weakly developed fascia**
- **Striae alternate to opposite, almost parallel to slightly radiate, 19-24 in 10 µm**
- **Spines absent**

Original description




Die kieselschaligen

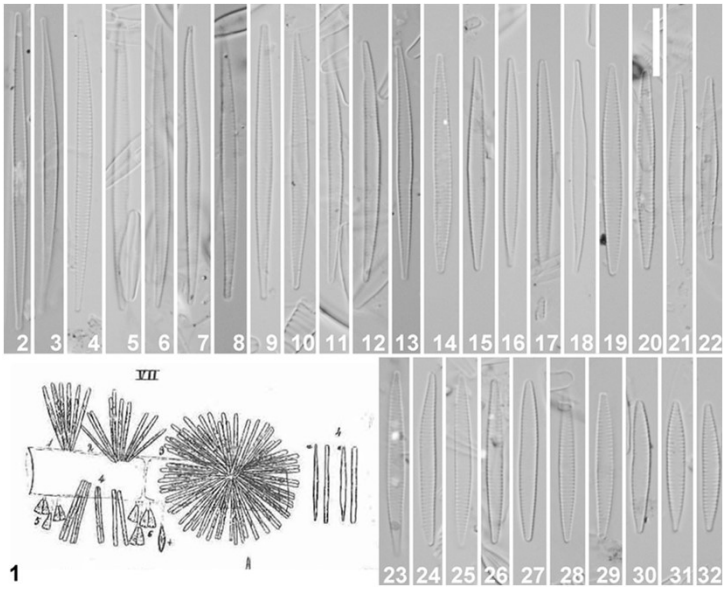
Bacillarien oder Diatomeen.

16. SYNEDRA RADIANS. Taf. 14. Fig. VII. 1 — 4. ($4\frac{1}{2}^{o}$). S. debilis, angustissima, linearis, radiatim et densissime aggregata, altero latere truncata, altero attenuata obtusiuscula.

An Cladophora fracta bei Tennstädt! — Länge $\frac{1}{30}'''$.

(Kützing 1844)

Fragilaria radians



Kützing sample 188, B.M.18192, Tennstadt, Germany

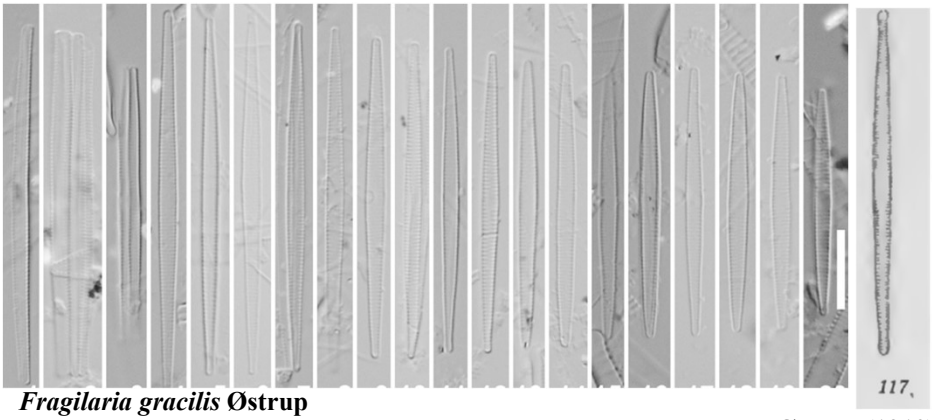
(Van de Vijver et al. 2022)

Original description

Fragilaria radians

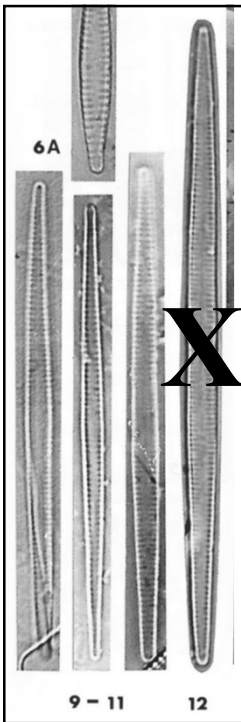
Type *Fragilaria gracilis* Østrup

— **gracilis** sp. nova. Tab. nost. V, fig. 117.
Long: 63 μ, Lat. 3,6 μ. Str. 20 in 10 μ.
Valva fere lineari, apices subcapitatos versus leniter attenuata. Striis abbreviatis, ad marginem modo perspiciendis, media in parte marginis aspectum punctorum præbentibus.
Sj: Et Bassin i Botanisk Have, Kjøbenhavn.



***Fragilaria gracilis* Østrup**
Basin in Botanic Garden Copenhagen

Østrup (1910)



Fragilaria radians

as ***Fragilaria capucina* var. *gracilis***

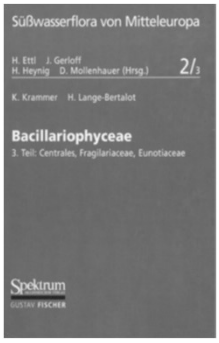
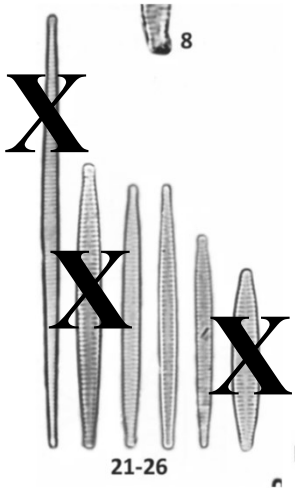


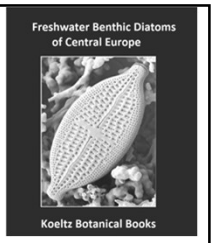
Fig. 8–12: Fragilaria capucina var. gracilis (Oestrup) Hustedt («*gracilis*-Sippen») vgl. auch *Fragilaria tenera* (S. 123)

Fig. 9–11: *Fragilaria gracilis* Oestrup, Lectotypus Coll. Oestrup 1342.
Fig. 12: Sehr fein gestreifte Sippe aus Froschhausen/Hessen

Fragilaria eutraphenta



Fragilaria radians



as ***Fragilaria capucina* var. *gracilis***

Lange-Bertalot et al. 2017, p. 270, plate 10, figs 21-26

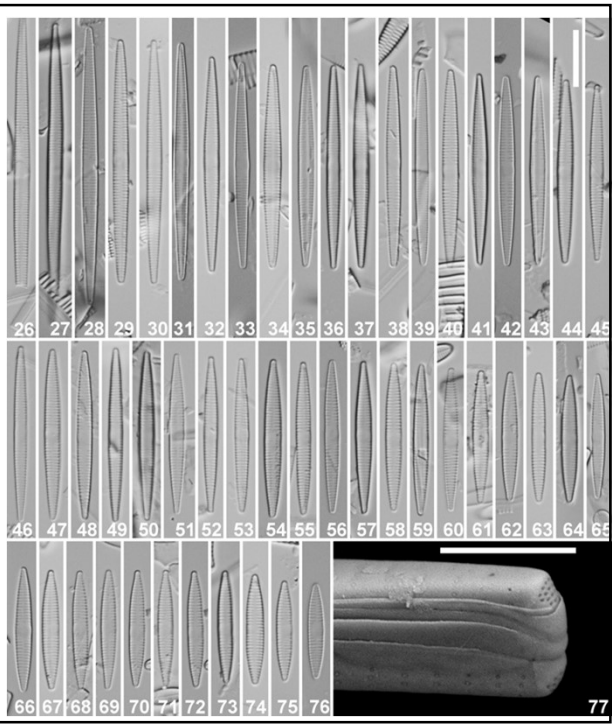
Figs 21-26: ***Fragilaria gracilis*** Østrup

Fresh material: Cells forming tufts sharing a common pad of mucilage or band-like colonies. Outline: Girdle view: Frustules narrowly linear-rectangular. Valve: Linear to linear-lanceolate. Ends: Obtusely rounded, not or only weakly drawn out.

Dimensions: Length from < 10 to c. 60 µm, width 2-3 µm. Striae: c. 20/10 µm, often weakened or interrupted in the centre of the valve by a distinct or indistinct Central area. Puncta: Pattern not resolvable.

Other European Population

Fragilaria radians

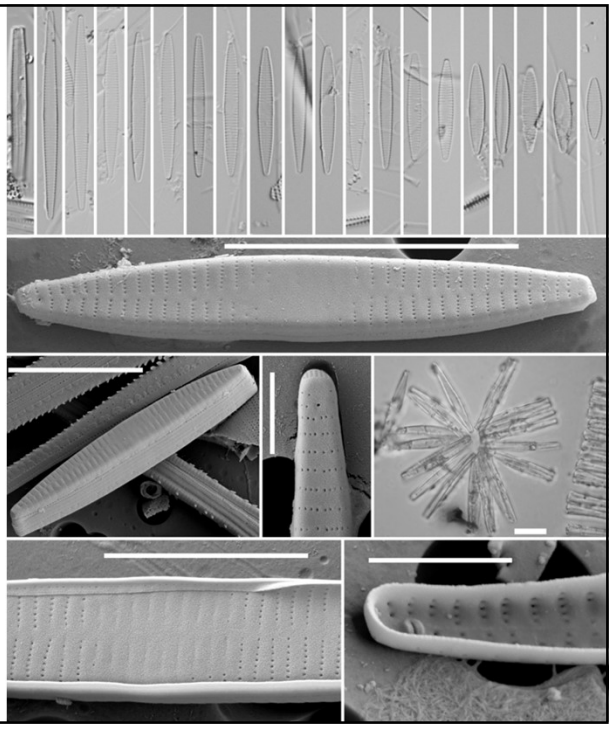


Eau Noire
Viroinval (Belgium)
BERW-03510
(=epitype population)

(Van de Vijver et al. 2022)

Other European Population

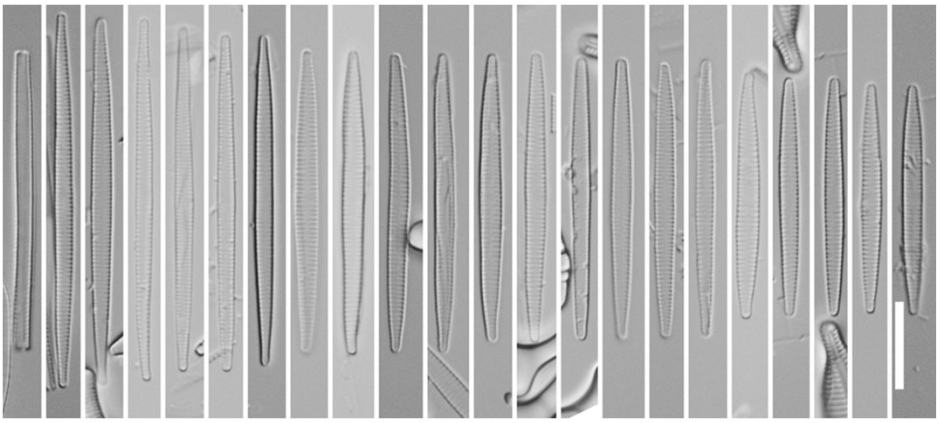
Fragilaria radians



Fragilaria utermoehlii
(Hustedt) Lange-Bertalot
Type material
Obersdorfer See
Schleswig-Holstein

(Van de Vijver et al. 2022)

Other European Population ***Fragilaria radians***

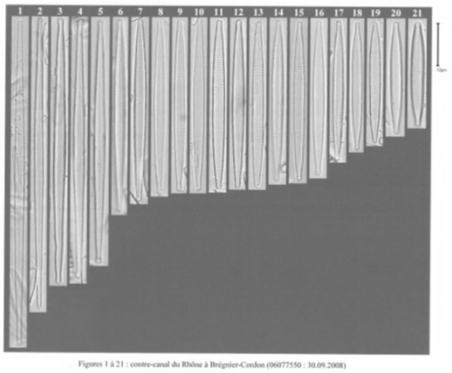


Fragilaria pseudolaevissima
VanLandingham
Type material
Kandestederne,
Jutland, Denmark
(= *Fragilaria laevissima* Østrup 1910)

(Van de Vijver et al. 2022)

Other European populations

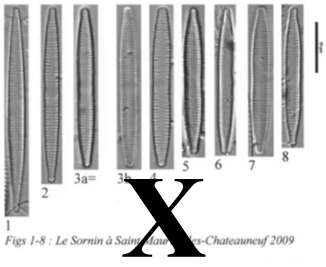
Fragilaria radians



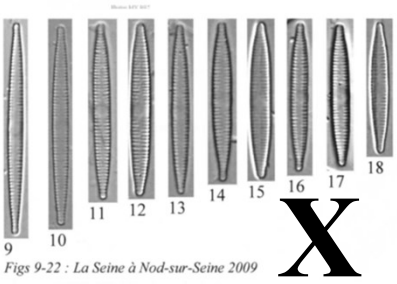
Bey & Ector (2013)

France

Peeters & Ector (2017)



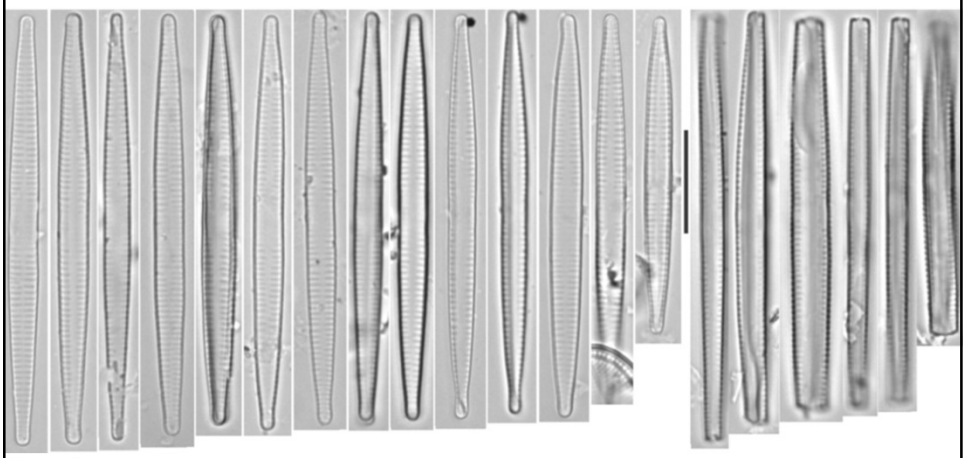
X



X

Other European populations

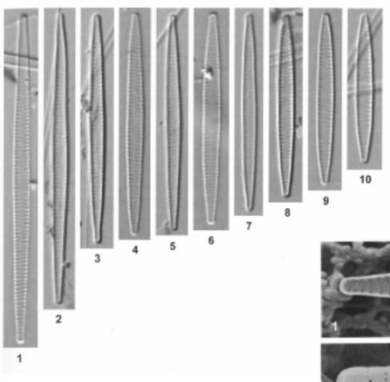
Fragilaria radians



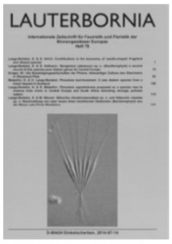
River Voutonne at Précigné 16-07-2008

Ector L., Wetzel C.E., Novais M.H. & Guillard D. (2015). Atlas des diatomées des rivières des Pays de la Loire et de la Bretagne. DREAL Pays de la Loire, Nantes.

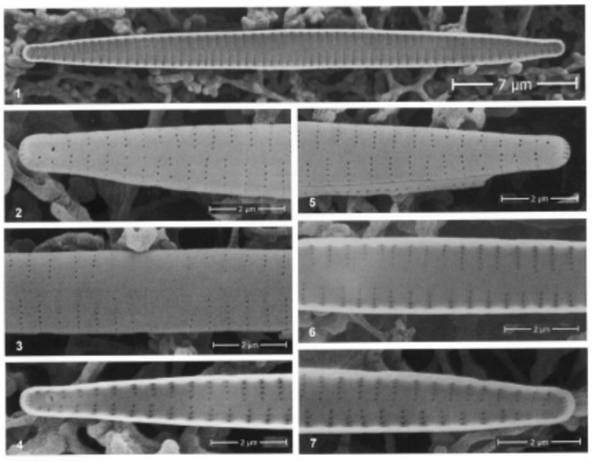
(Ector et al. 2015)



(Lake Schladitz, Germany)



Fragilaria radians



Lange-Bertalot & Ulrich (2014)

Other European populations (UK, Italy) ***Fragilaria radians***

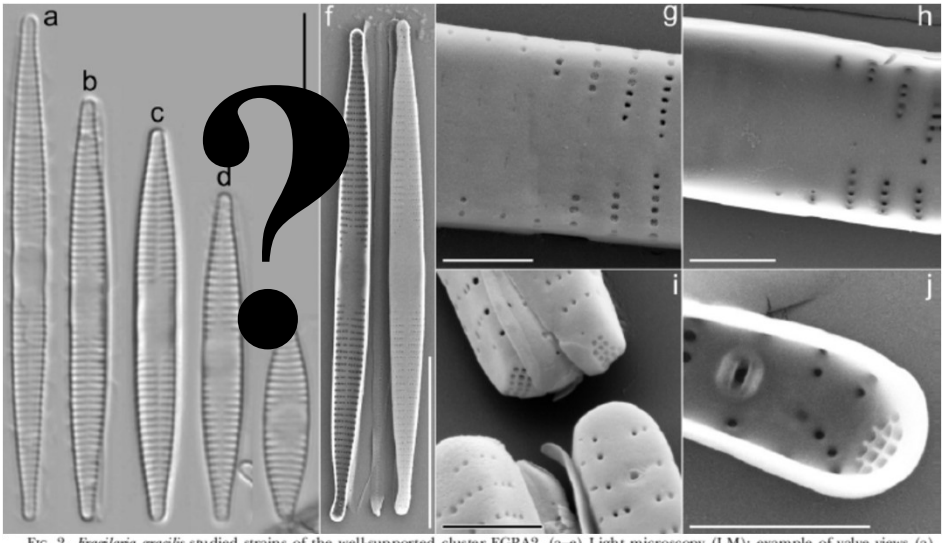


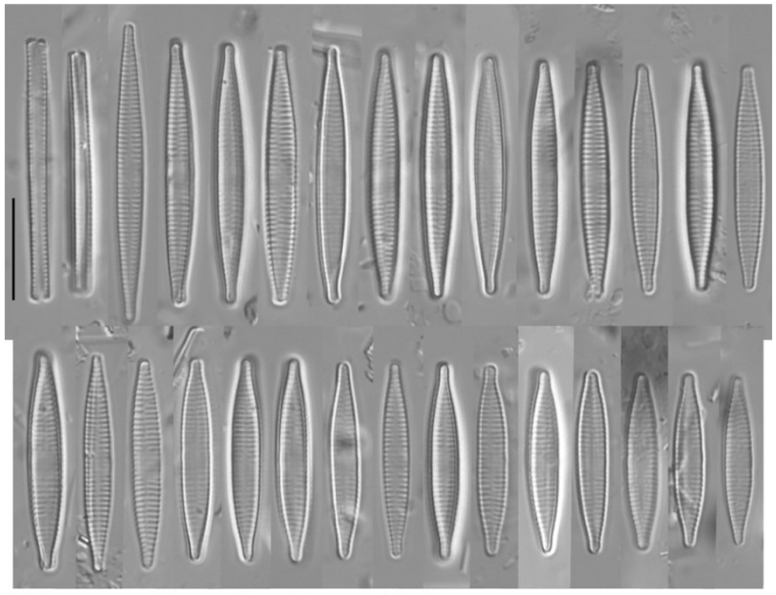
FIG. 2. *Fragilaria gracilis* studied strains of the well-supported cluster FGRA2. (a–e) Light microscopy (LM); example of valve views (a) 166FraB05, (b) 139FraB04, (c) 177FraB05, (d) 148FraB04, (e) 170FraB05; (f–j) Scanning electron microscopy (SEM); (f) general external view of valve of 166FraB05, no spines present, (g) external and (h) internal view of central area of 166FraB05, (i) external and (j) internal view of head poles with pore fields and rimoportula (i) 726FraB12, (j) 166FraB05. Scale bar 10 µm (a–f), or 1 µm (g–j).

(Kahlert et al. 2019)

Other European populations

Wales ***Fragilaria radians***

DIATOM FLORA OF BRITAIN AND IRELAND



Tributary to River Wye, Powys, Wales

Ecology

Fragilaria radians

Lange-Bertalot & Ulrich (2014 as *F. gracilis*)
- slightly acidic to circumneutral
- oligo- to mesotrophic

Lange-Bertalot et al. (2017 as *F. gracilis*)
- oligosaprobic
- oligo- to mesotrophic
- usually in smaller lakes and rivers
- weakly acidic to weakly alkaline
- lower to moderate electrolyte content
- not in highly acidic, dystrophic or eutrophic habitats

Peeters & Ector (2017 as *F. gracilis*)
- intolerant to organic matter and higher nutrients

Ecology

Fragilaria radians

Diatom community in the lectotype slide

Achnanthidium microcephalum
Denticula tenuis
Fragilaria radians
Nitzschia denticula
Ctenophora pulchella
Cymbella vulgata
Diatoma moniliformis
Gomphonella olivacea
Gomphonema lateripunctatum
Gomphonema pumilum var. rigidum
Gomphonema parvulum
Encyonopsis subminuta
Fragilaria fragilarioides
Cocconeis euglypta

Sample collected from *Cladophora fracta*, a species known to prefer higher nutrient and electrolyte levels (Michalak & Messyasz 2021).

The dominant taxa in the sample, however, point to a more mesotrophic (not eutrophic) calcium–bicarbonate enriched, alkaline to highly alkaline condition with a medium to high electrolyte content, the latter indicated by the presence of *Diatoma moniliformis*, *Ctenophora pulchella* and *Gomphonella olivacea* (Lange–Bertalot et al. 2017).

(Van de Vijver et al. 2022)

Ecology

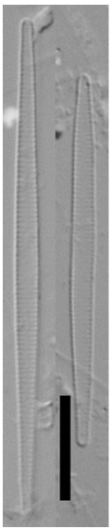
Fragilaria radians

Diatom community in the type slide of *F. gracilis*

Nitzschia dissipata
Nitzschia pusilla
Navicula gregaria
Fragilaria aequalis
Diatoma problematica
***Achnanthidium* spp.**
Ctenophora pulchella
…

Meso- to eutrophic community
Slightly higher saprobity
HIGHER electrolyte content

(Van de Vijver et al. 2022)

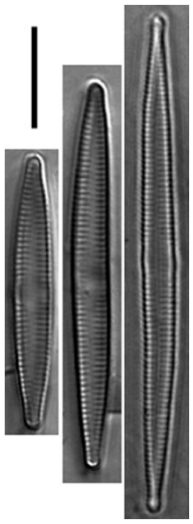


NO colonies

***F. radians* ("*gracilis*")**
L 20-60 µm
W 2-3 µm
S 19-24 in 10 µm

Can be confused with

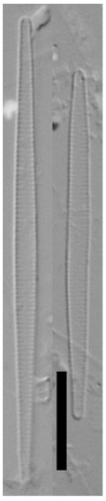
colonies



F. rumpens
L 20-65 µm
W 3.5-4 µm
S 18-20 in 10 µm

F. capucina
L 28-47 µm
W 3-4 µm
S 14-17 in 10 µm

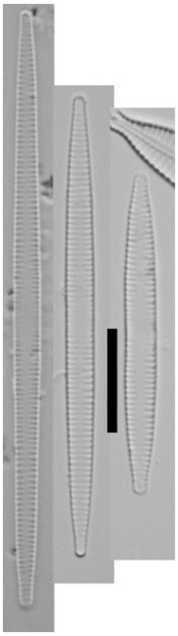
Can be confused with



Fragilaria radians has

higher stria density

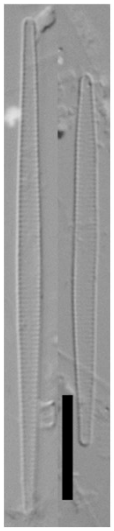
narrower valves,
less robust appearance



F. radians ("gracilis")
L 20-60 µm
W 2-3 µm
S 19-24 in 10 µm

F. eutraphenta
L 20-75 µm
W 3-4 µm
S 18-20 in 10 µm

Can be confused with



Fragilaria radians has

broader valves

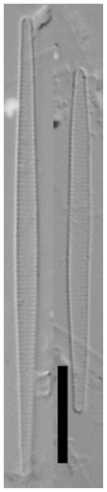
less acute apices

less narrowly
lanceolate valves

F. radians ("gracilis")
L 20-60 µm
W 2-3 µm
S 19-24 in 10 µm

F. acerosa
L 13-35 µm
W 1.5-2.5 µm
S 20-22 in 10 µm

Can be confused with



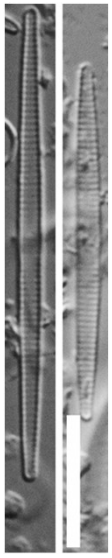
F. radians ("gracilis")
L 20-60 µm
W 2-3 µm
S 19-24 in 10 µm

Fragilaria radians has

broader valves

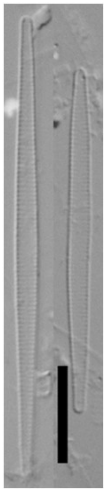
lower stria density

broader sternum
(*aquaplus* = no sternum)



F. aquaplus
L 22-45 µm
W1.5-2.5 µm
S 22-24 in 10 µm

Can be confused with



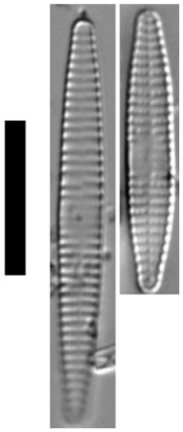
F. radians ("gracilis")
L 20-60 µm
W 2-3 µm
S 19-24 in 10 µm

Fragilaria radians has

narrower valves
usually longer valves

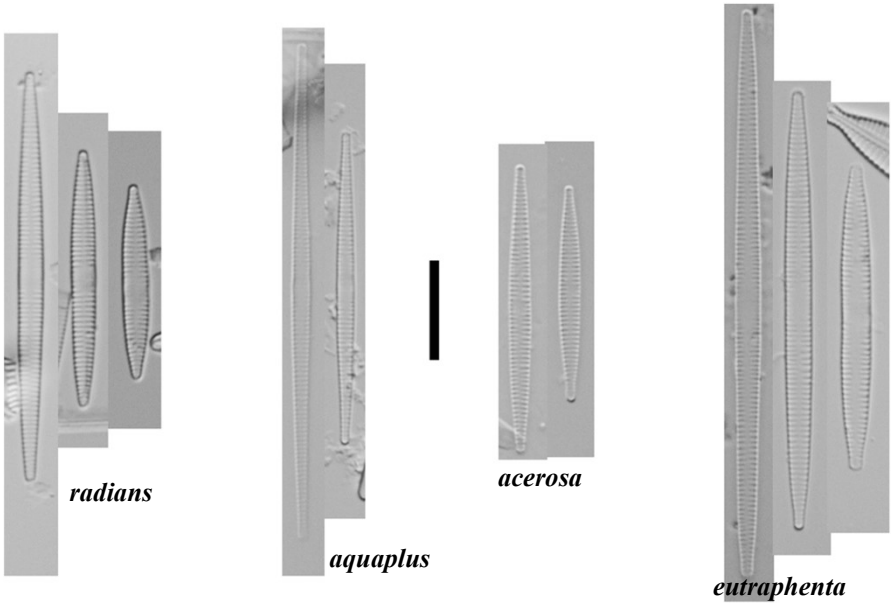
higher stria density

less coarse striae
(areolae not visible)



F. famelica
L 10-70 µm
W 2.5-4 µm
S 11-16 in 10 µm

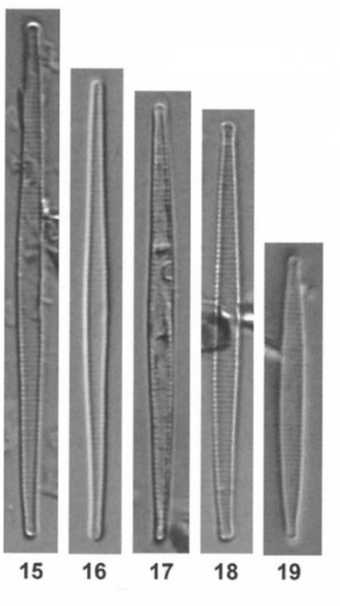
3A. The *Fragilaria radians* group (common taxa)



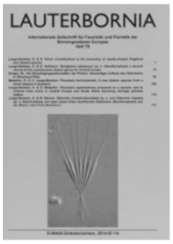
Fragilaria aquaplus Lange-Bertalot & S.Ulrich 2014

- **Cells solitary**
- **Valves narrow, needle-shaped, never inflated centrally**
- **Apices weakly subcapitate**
- **Length 22-45 µm, width 1.5-2.5 µm**
- **sternum extremely narrow to absent!**
- **Central area indistinct in LM, but present as hyaline area**
- **Striae very difficult to see in LM, NEVER alternate, almost parallel to slightly radiate, 22-24 (26 near apices) in 10 µm**
- **Spines absent**

Original description



Fragilaria aquaplus



3.8 *Fragilaria aquaplus* sp. nov. (Fig. 13: 15-19, 14: 9-14)

Diagnosis: Cellulae solitariae sive paucae affixae per frontes inter se ita catenas facientes. Frustula aspectu cinguli angustissime rectangularia 1.3–2.5 µm lata. Valvae aciculares de media parte non inflata sensim ad apices attenuatae. Apices minime subcapitati apparentes. Longitudo 22–45 µm, latitudo 1.5–2.4 µm proximaliter, 1,0–1,2 µm in partibus apicalibus subapicalibusque id est in apicibus non expansa, vide aspectus ultramicroscopicus. Area axialis angustissima linearis. Area centralis indistincte separata. Striae transapicales parum aspectabiles cum illuminatione obliqua microscopio photonico. Aspectus ultramicroscopicus externus internusque vide Fig. 14: 9-14. Striae transapicales oppositae utroque de medio ad apices interdum (raro) aliquid alternantes, 22–24 in 10 µm. Areolae 60–65 in 10 µm in limbos prolongatae etiam prope apices plus quam una singula areola utroque. Rimoportula ad polum unum valvarum adest. Spinae ad margines et apices absunt. Cingulum compositum e 2–3 copulis probabiliter apertis. Differt a specie *Synedra nana* associata in praeparatione typorum Meister 624 longitudine inferiori speciminum et spinis vacantibus etiam striis transapicalibus oppositis (nec regulariter alternantibus) et apicibus parum subcapitatis (nec conspicue inflatis capitatis). Differt a specie *Fragilaria gracilis* Østrup 1901 proprie area axiali valde angustiori et densitate striarum transapicalium minori.

Holotypus (designated here): Praep. Eu-CH-53 in Coll. Lange-Bertalot (FR), represented by Fig. 13:18.

Isotypus: Slide 1105081 in Coll. Meister, Zürich, Switzerland

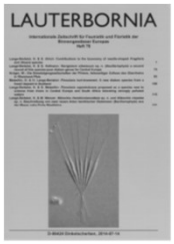
Locus typicus: Lago della Crocetta, Bernina Alps, Switzerland; leg. 11. August 1905

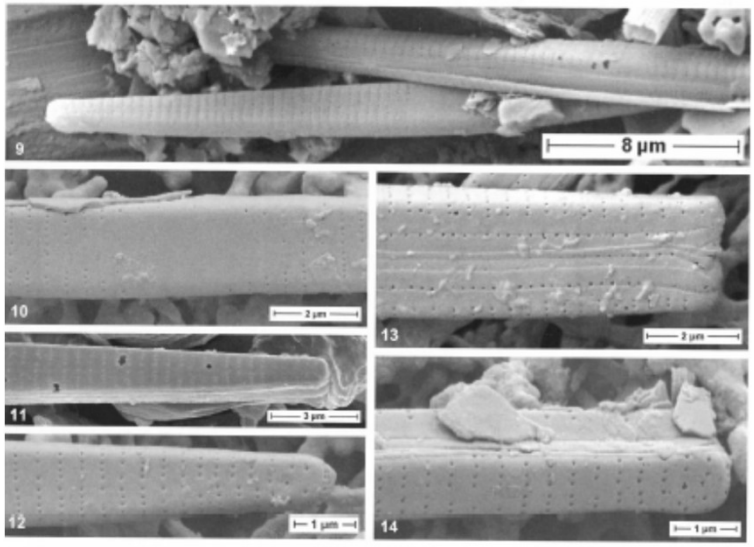
Etymology: Latin "aquaplus" means "water and more". The new taxon is dedicated to the colleagues of the water monitoring company Aquaplus, Zug, Switzerland, who have provided us with the original diatom material of *S. nana* Meister and likewise of *Fragilaria aquaplus*.

(Lange-Bertalot & Ulrich 2014)

Original description

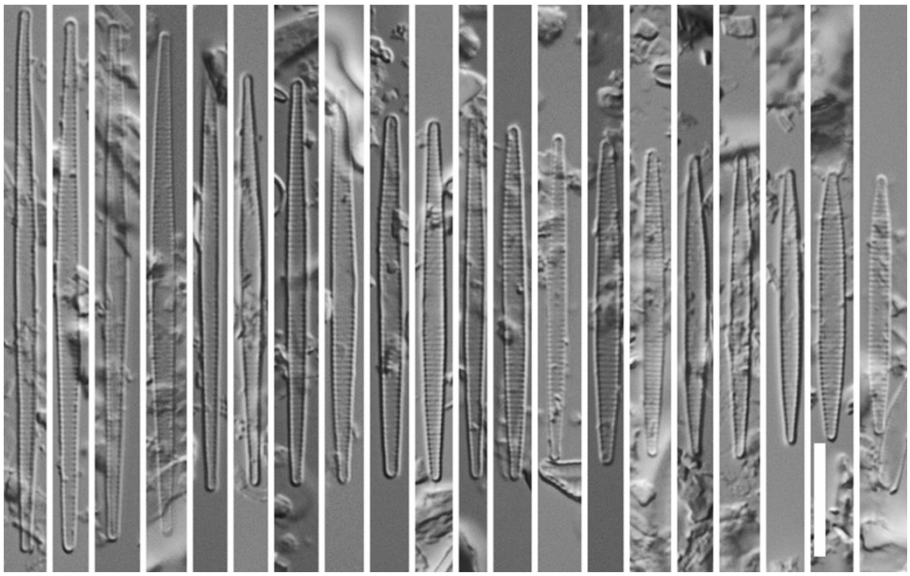
Fragilaria aquaplus





Type locality: Lago della Crocetta, Bernina Alps, Switzerland

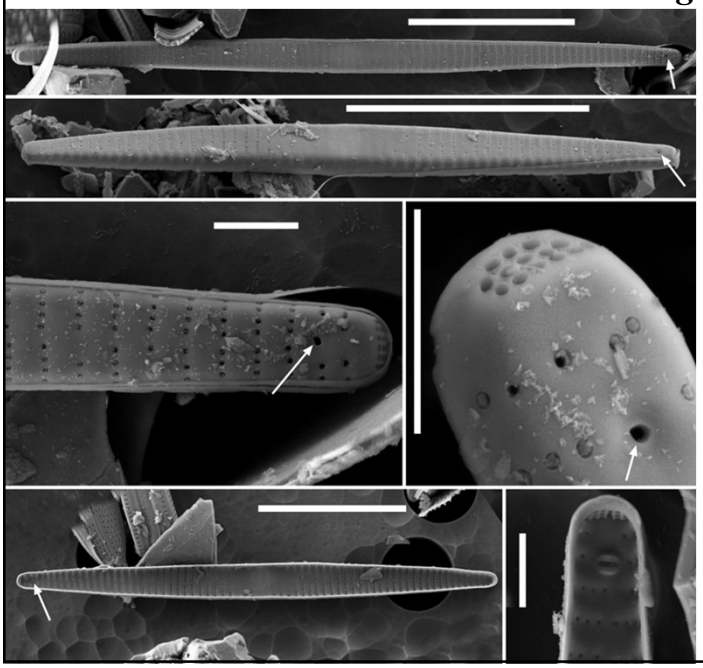
(Lange-Bertalot & Ulrich 2014)



Fragilaria aquaplus **Type locality: Lago della Crocetta, Bernina Alps, Switzerland (leg. J. Hürlimann, Aquaplus)**

(Van de Vijver et al. 2022)

Fragilaria aquaplus



Type locality: Lago della Crocetta, Bernina Alps, Switzerland

(Van de Vijver et al. 2022)

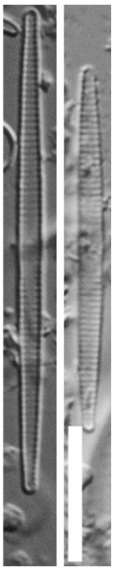
Ecology

Fragilaria aquaplus

Lange-Bertalot & Ulrich (2014)
found in a Swiss Lake

Van de Vijver et al. (2022)
dominant flora in type slide: *Cymbella langebertalotii*, *C. vulgata*, *Delicata delicatula*, *Encyonopsis subminuta*, several *Achnanthidium* species, *Denticula tenuis*, *Fragilaria tenera* var. *nana*, *Navicula radiosa* and *Tryblionella brunoi*.

typical for oligo-mesotrophic, oligosaprobic, calcium-bicarbonate rich, weakly alkaline lakes and rivers (Lange-Bertalot et al. 2017).



F. aquaplus
L 22-45 µm
W1.5-2.5 µm
S 22-24 in 10 µm

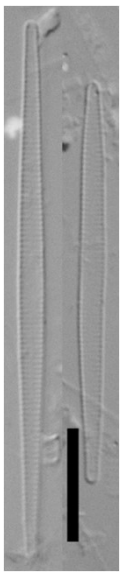
Can be confused with

***Fragilaria aquaplus* has**

narrower valves

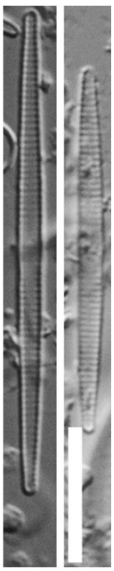
slightly higher stria density

narrower, almost absent sternum



F. radians ("gracilis")
L 20-60 µm
W 2-3 µm
S 19-24 in 10 µm

Can be confused with



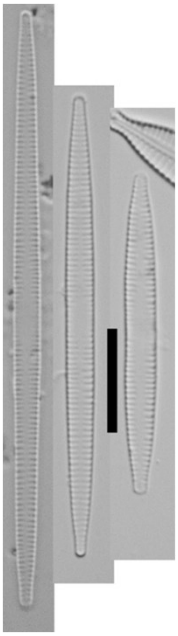
F. aquaplus
L 22-45 µm
W1.5-2.5 µm
S 22-24 in 10 µm

Fragilaria aquaplus has

narrower valves

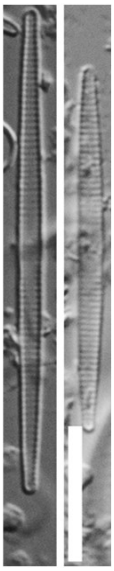
slightly higher stria density

sternum almost absent



F. eutraphenta
L 20-75 µm
W 3-4 µm
S 18-20 in 10 µm

Can be confused with



F. aquaplus
L 22-45 µm
W1.5-2.5 µm
S 22-24 in 10 µm

Fragilaria aquaplus has

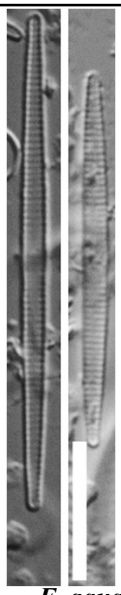
longer valves

slightly higher stria density

sternum almost absent

less lanceolate valves

F. acerosa
L 13-35 µm
W 1.5-2.5 µm
S 20-22 in 10 µm



F. aquaplus
L 22-45 µm
W 1.5-2.5 µm
S 22-24 in 10 µm

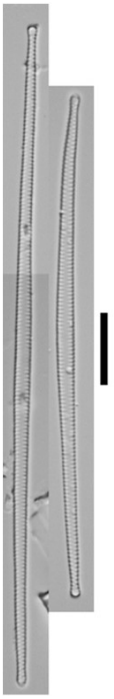
Can be confused with

Fragilaria aquaplus **has**

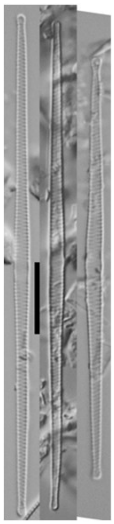
narrower valves
shorter valves

slightly higher stria density

no protracted apices



F. tenera
L 60-120 µm
W 2.0-2.5 µm
S 18-20 in 10 µm



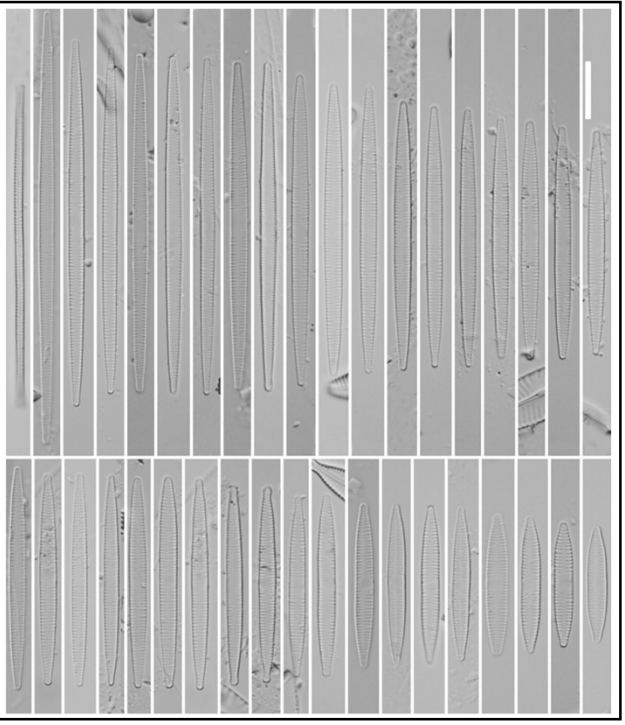
F. tenera var. nanana
L 22-70(90) µm
W 2.0-2.5 µm
S 18-20 in 10 µm

Fragilaria eutraphenta **Van de Vijver, Kusber & D.M.Williams**

- **cells solitary, colonies NEVER observed**
- **valves linear to narrowly lanceolate, margins almost parallel**
- **apices slightly protracted, weakly rostrate**
- **length 20-75 µm, width 3-4 µm**
- **sternum moderately narrow, distinct**
- **central area large, irregularly shaped hyaline area**
- **striae alternating, parallel, 18-20 in 10 µm**
- **spines absent**

Type population

Fragilaria eutraphenta

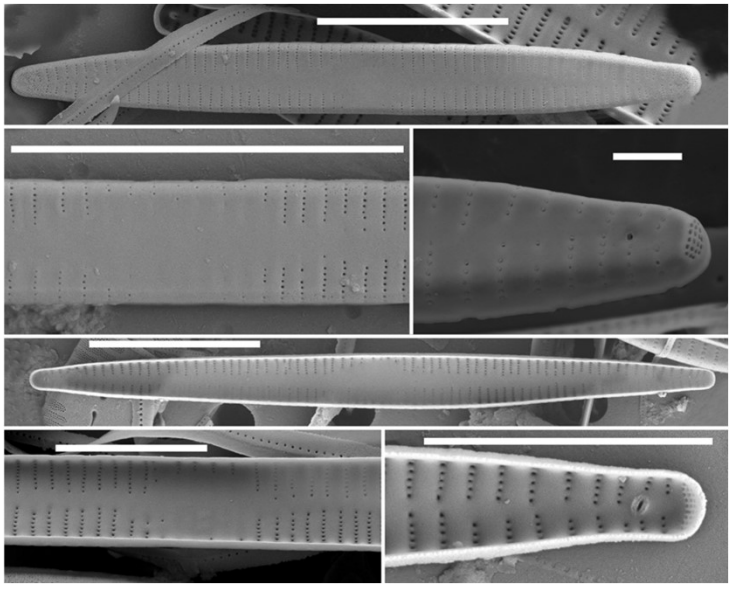


Grote Nete
Prov. Antwerp (Belgium)

(Van de Vijver et al. 2022)

Type population

Fragilaria eutraphenta

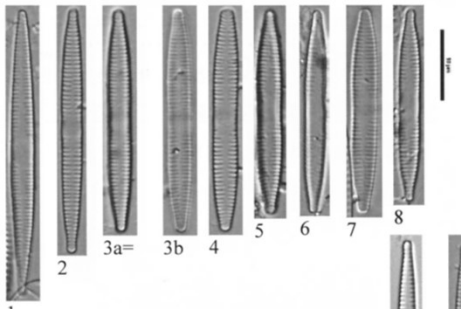


Grote Nete
Prov.
Antwerp
(Belgium)

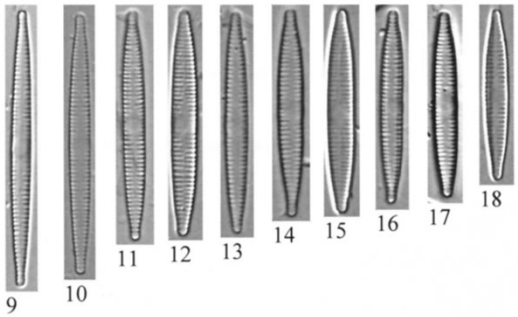
(Van de Vijver et al. 2022)

Other European populations

Fragilaria eutraphenta



Figs 1-8 : Le Sornin à Saint Maurice-les-Chateauneuf



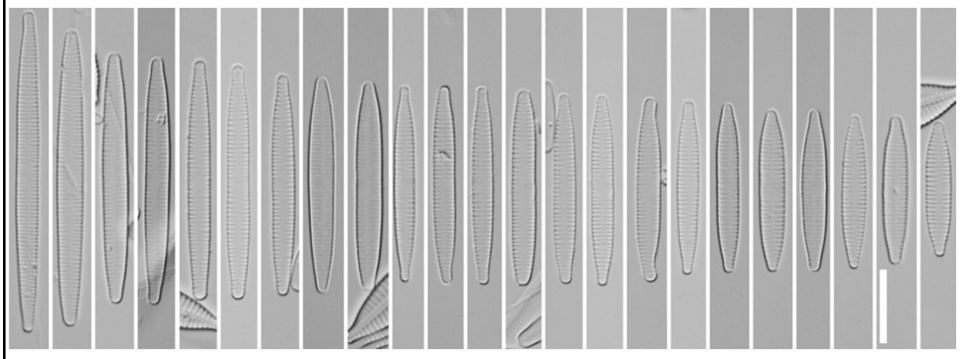
Figs 9-22 : La Seine à Nod-sur-Seine 2009

identified as *F. gracilis*

Peeters & Ector (2017)

Other European populations

Fragilaria eutraphenta



Switzerland
Straub 1811

(Van de Vijver et al. 2022)

Other European populations

Diatom Research (1991) Volume 6 (1), 21-47

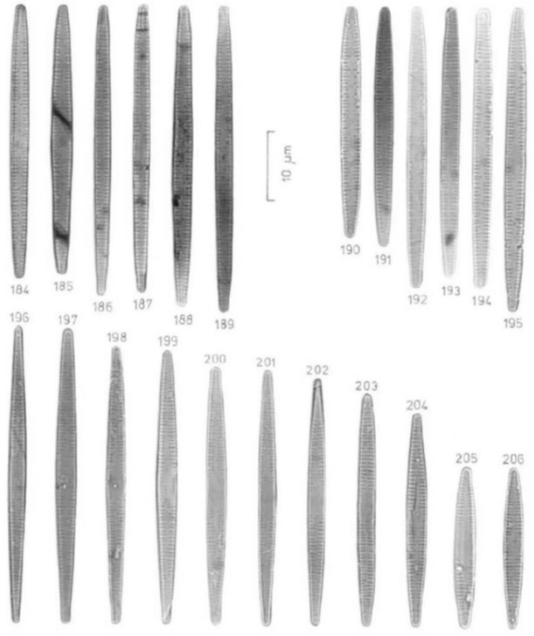
MORPHOLOGISCHE UND ÖKOLOGISCHE CHARAKTERISIERUNG VON SIPPEN UM DEN *FRAGILARIA CAPUCINA*-KOMPLEX SENSU LANGE-BERTALOT 1980

J. Hürlimann

Limnologische Station, Universität Zürich Seestrasse 187, CH-8802 Kilchberg und Aqua Plus, Hauptstrasse 6, CH-8832 Wollerau

F. Straub

Laboratoire d'algologie, Gymnase Cantonal Rue du Succès 45, CH-2300 La Chaux-de-Fonds



Figs 184-206. Sippe 5. Figs 184-189. Trinkwasserbrunnen (Probe 1). Figs 190-195. Trinkwasserbrunnen (Probe 2). Figs 196-206. Poschiavino (Probe 4).

Switzerland

Hürlimann & Straub (1991)

Ecology

Fragilaria eutraphenta

Unknown due to confusion with *F. radians ("gracilis")* and *F. rumpens*

Probably widespread!

Mainly observed in running waters

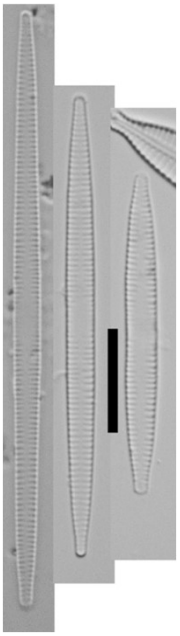
Eutrophic and higher organic pollution

pH > 7,5

Higher electrolyte content

(Van de Vijver et al. 2022)

Can be confused with

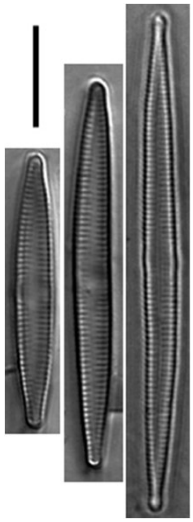


Fragilaria eutraphenta **has**

NO colonies

no spines

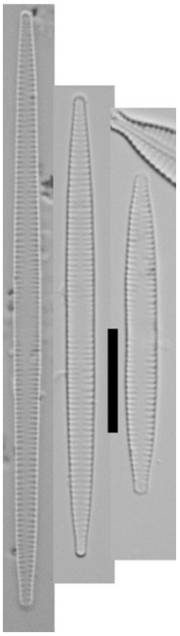
larger central area



Fragilaria eutraphenta
L 20-75 µm
W 3-4 µm
S 18-20 in 10 µm

F. rumpens
L 20-65 µm
W 3.5-4 µm
S 18-20 in 10 µm

Can be confused with



Fragilaria eutraphenta **has**

NO colonies

no spines

higher stria density

Fragilaria eutraphenta
L 20-75 µm
W 3-4 µm
S 18-20 in 10 µm

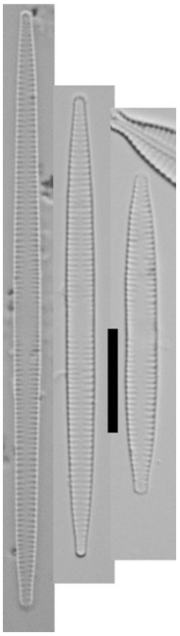
F. capucina
L 28-47 µm
W 3-4 µm
S 14-17 in 10 µm

Can be confused with

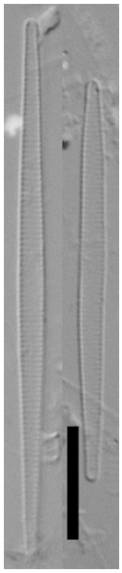
***Fragilaria eutraphenta* has**

broader valves

lower stria density



Fragilaria eutraphenta
L 20-75 µm
W 3-4 µm
S 18-20 in 10 µm



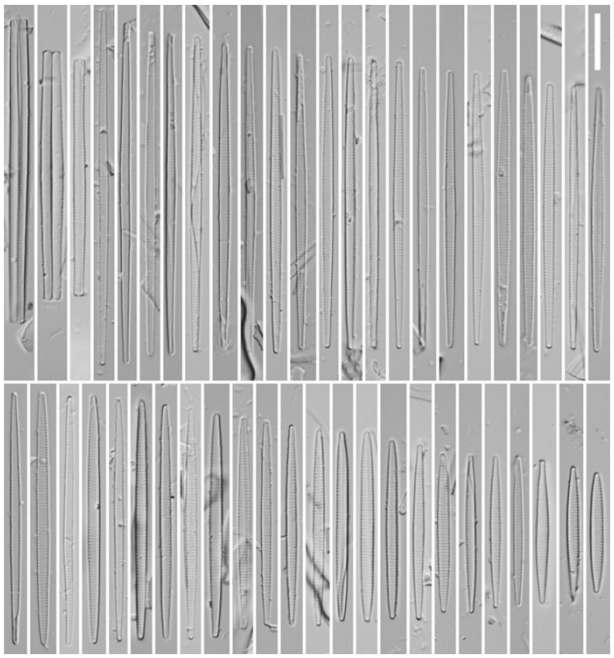
F. radians ("gracilis")
L 20-60 µm
W 2-3 µm
S 19-24 in 10 µm

***Fragilaria acerosa* Van de Vijver, C.E.Wetzel, Jarlman & Ector**

- **Cells solitary, colonies NEVER observed**
- **Valves linear-lanceolate (longer valves) to lanceolate (shorter valves), needle-shaped, gradually narrowing margins**
- **Apices wealy protracted, acutely rounded**
- **Length 13-62 µm, width 1.5-2.5 µm**
- **sternum narrow but distinct**
- **Central area very small, several central striae shortened**
- **Striae alternating, parallel, 18-22 (26 near apices) in 10 µm**
- **Spines absent**

Type population

Fragilaria acerosa

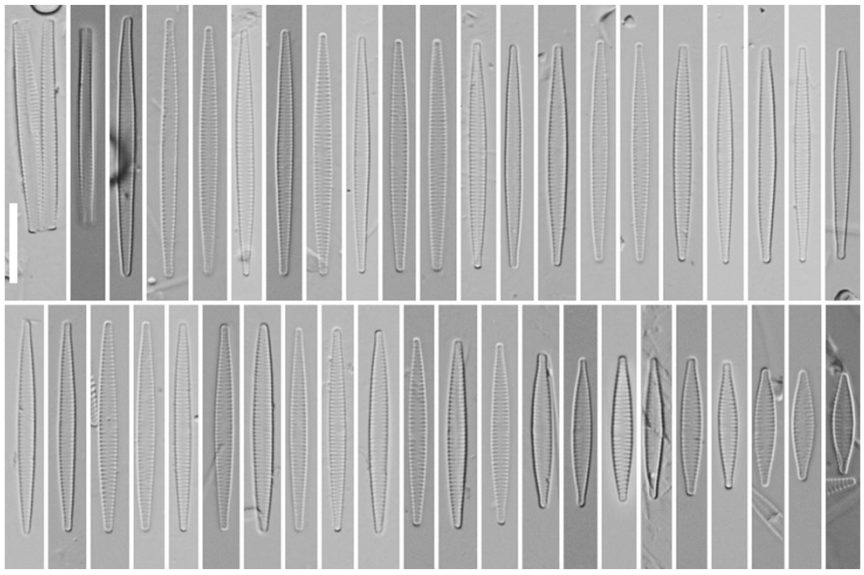


Haraldjöån (Sweden)

(Van de Vijver et al. 2022)

Other European populations

Fragilaria acerosa

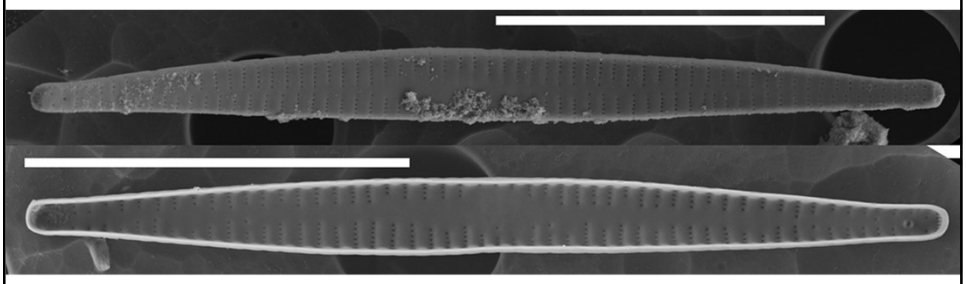


Hammarbäcken (Sweden)

(Van de Vijver et al. 2022)

Other European populations

Fragilaria acerosa



Hammarbäcken (Sweden)

(Van de Vijver et al. 2022)

Ecology

Fragilaria acerosa

Unknown due to confusion with *F. radians ("gracilis")*

Probably Nordic (Scandinavia) distribution!

Mainly observed in running waters

Highly oligotrophic and low organic pollution

Acidic waters

Together with *Brachysira*, *Eunotia*, *Tabellaria*, *Frustulia*…

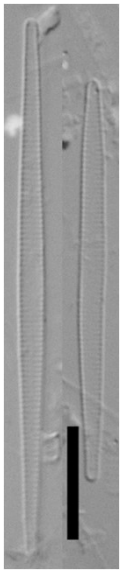
Can be confused with

***Fragilaria acerosa* has**

shorter valves

narrower valves

typical acute apices



F. acerosa
L 13-35 µm
W 1.5-2.5 µm
S 20-22 in 10 µm

F. radians ("gracilis")
L 20-60 µm
W 2-3 µm
S 19-24 in 10 µm

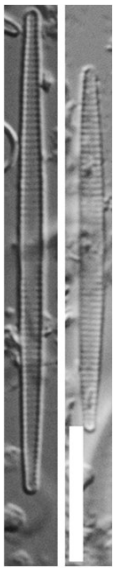
Can be confused with

***Fragilaria acerosa* has**

shorter valves

always lanceolate valves

typical acute apices



F. acerosa
L 13-35 µm
W 1.5-2.5 µm
S 20-22 in 10 µm

F. aquaplus
L 22-45 µm
W1.5-2.5 µm
S 22-24 in 10 µm

Can be confused with

F. acerosa
L 13-35 µm
W 1.5-2.5 µm
S 20-22 in 10 µm

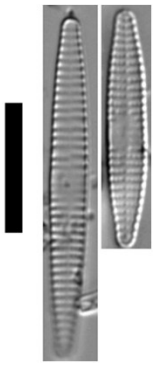
***Fragilaria acerosa* has**

narrower valves

always lanceolate valves

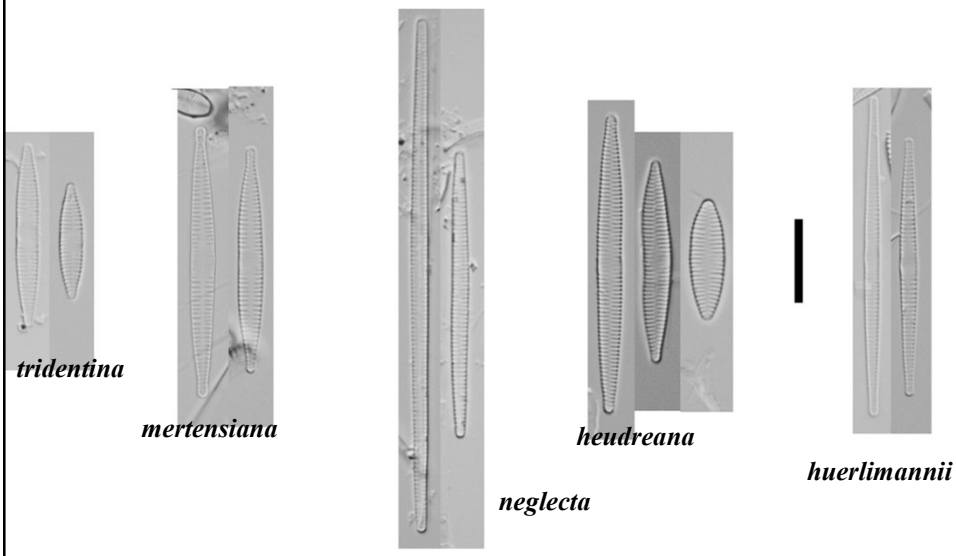
finely punctated striae (= areolae NOT visible)

much lower stria density

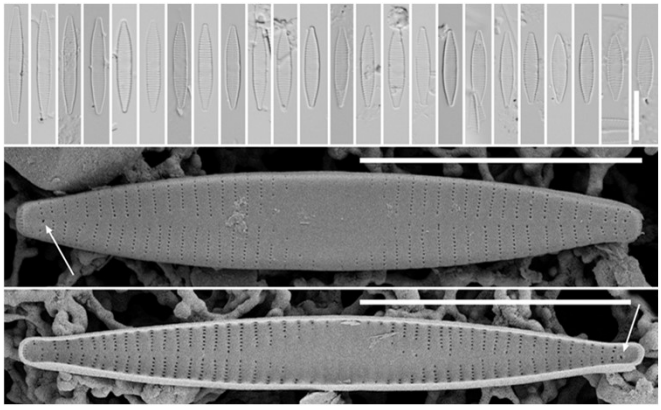


F. famelica
L 10-70 µm
W 2.5-4 µm
S 11-16 in 10 µm

3B. The *Fragilaria radians* group (rare taxa)



Fragilaria tridentina **Cantonati & Lange-Bertalot in Cantonati et al. 2017**



valves lanceolate to linear-lanceolate
length 11-27 µm, width 2.5-3.0 µm
sternum narrow, at apices very narrow
central area large, rectangular
striae parallel, opposite, 20-25 in 10 µm
spines absent

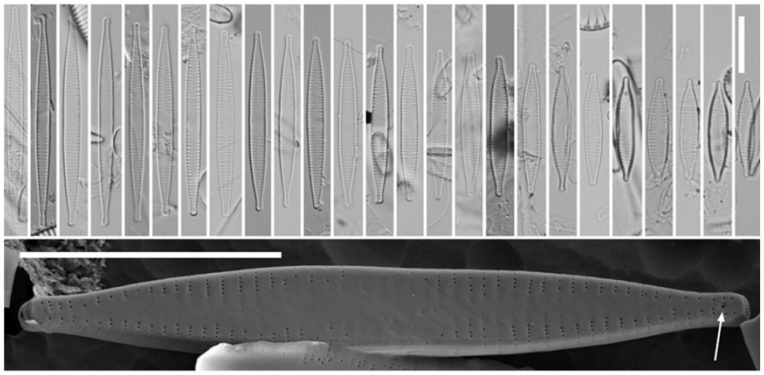
At present only found in Italy

Environmental conditions at the type locality: conductivity (16 µS/cm), nitrate: 0.20 mg/L, TP: <5 µg/L)

Sample cLIM004 DIAT 2513 Lake Ritorto outlet, on bryophythes, Italy
coll. date 24.IX.2012, leg. M. Cantonati

(Cantonati et al. 2017)

Fragilaria mertensiana **Van de Vijver, C.E.Wetzel & Ector**



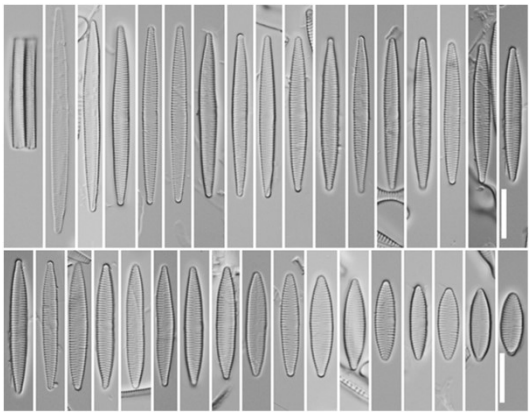
valves lanceolate to elliptic-lanceolate with protracted, rostrate apices
length 15-40 µm, width 2.5-3.0 µm
sternum very broad, lanceolate
central area large, rectangular
striae parallel, short, 17-20 in 10 µm
spines absent

At present only found in Belgium

species composition in type slide points to an eutrophic, α-meso- to polysaprobic environment with higher electrolyte content, often indicating increased levels of pollution.

(Van de Vijver et al. 2022)

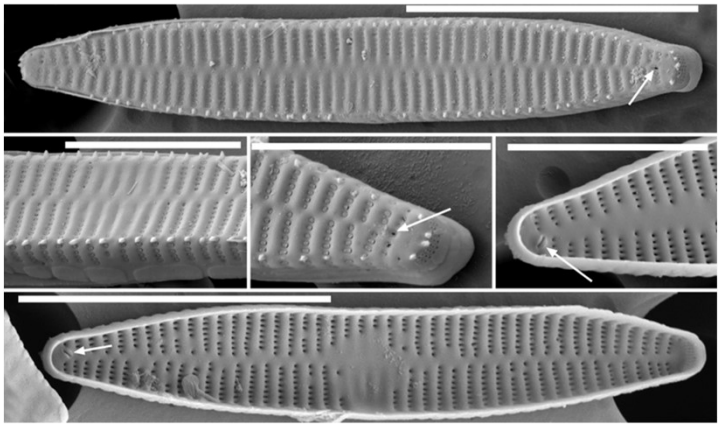
Fragilaria heudreana Van de Vijver, C.E.Wetzel & Ector



valves linear to narrowly lanceolate with almost parallel margins
apices protracted, rostrate
length 12-50 µm, width 3.0-5.0 µm
sternum very narrow, linear
central area unilateral, forming a large, irregularly shaped hyaline area
striae parallel, 18-21 in 10 µm
spines PRESENT

(Van de Vijver et al. 2022)

Fragilaria heudreana Van de Vijver, C.E.Wetzel & Ector

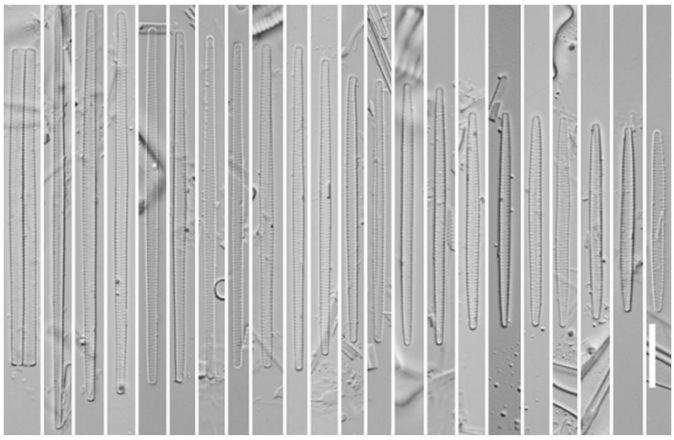


Species composition in type slide may point to a freshwater habitat with higher electrolyte content as some of the dominant species (e.g. *S. producta*, *F. cf. henryi*) can even be found in brackish conditions.

Kandestederne, Jutland, Denmark, Østrup sample 8681 (type material *F. laevissima*) archived at K!

(Van de Vijver et al. 2022)

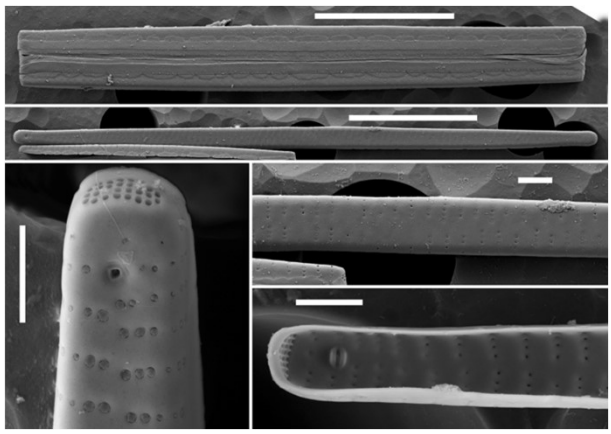
Fragilaria neglecta Van de Vijver, C.E.Wetzel, Jarlman & Ector



valves strictly linear, parallel margins, broadly rounded, non-protracted apices
length 30-70 µm, width 1.5-2.0 µm
sternum narrow but distinct
central area absent to very small
striae parallel, 20-21 in 10 µm
spines absent

(Van de Vijver et al. 2022)

Fragilaria neglecta Van de Vijver, C.E.Wetzel, Jarlman & Ector



Diatom community is typical for very oligotrophic, oligosaprobic, electrolyte-poor, acidic water bodies, indicating a very high water quality.

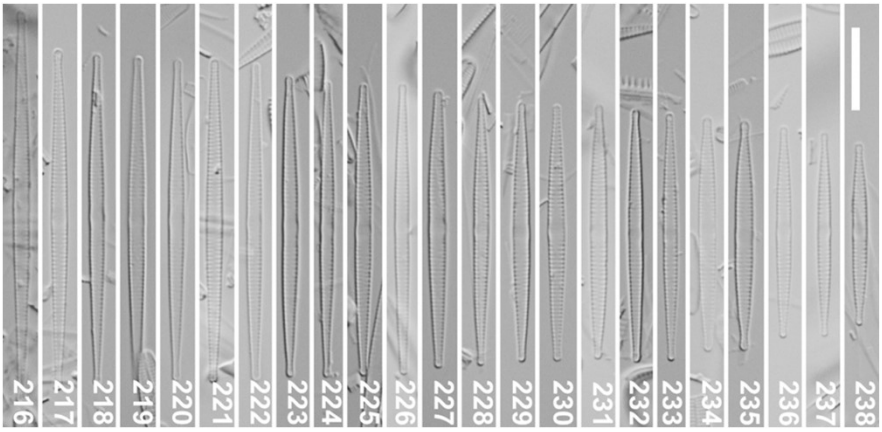
Measured chemical parameters:
pH of 6.5
very low TOT-P (11 µg/l) and TOT-N (228 µg/l) concentrations.

Mälskarbäcken, Vilhelmina Kommun, Västersbotten Län, Sweden

NORDIC species

(Van de Vijver et al. 2022)

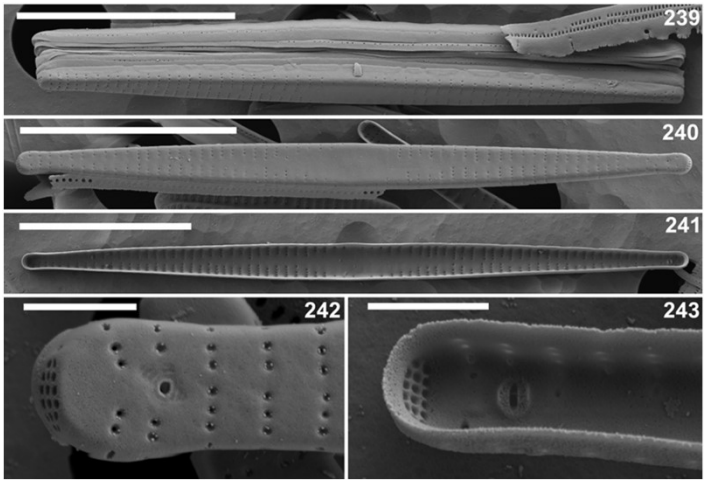
Fragilaria huerlimannii Van de Vijver



valves needle-shaped, narrowly lanceolate with gradually tapering margins
apices protracted, rostrate to weakly capitate
length 20-50 µm, width 1.5-2.0 µm
sternum narrow but distinct
central area forming a large hyaline fascia
striae parallel, 20-21 in 10 µm
spines Absent

(Van de Vijver et al. 2022)

Fragilaria huerlimannii Van de Vijver



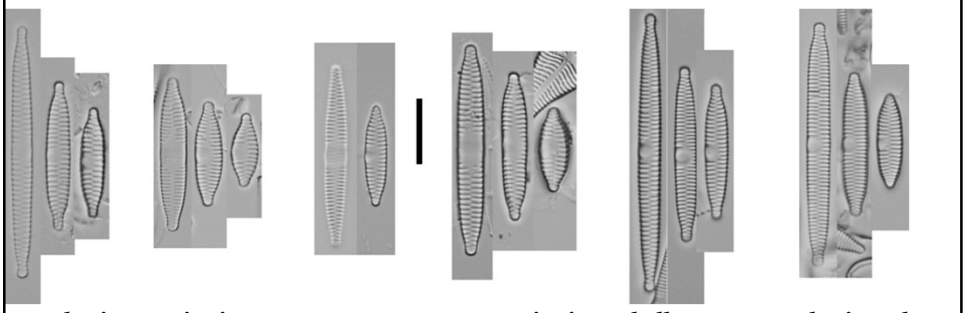
Species composition in type slide may points to moderately calcium–bicarbonate enriched, oligo– to mesotrophic conditions with low levels of organic pollution.

Fiume Ticino, canton Ticino, Switzerland, alt. 305 m a.s.l., coll. date 08.VII.2020, leg. J. Hürlimann

(Van de Vijver et al. 2022)

4. The *Fragilaria vaucheriae* group

I. More common taxa



vaucheriae *rinoi* *truncata* *catenarinoi* *kellyana* *vaucheriaerobusta*

Fragilaria vaucheriae (Kützing) J.B.Petersen 1938

Basionym: ***Exilaria vaucheriae*** **Kützing 1833**
Synonym: ***Fragilaria capucina*** **var.** ***vaucheriae*** **(Kützing) Lange-Bertalot 1980**

- **cells solitary, occasionally, two valves together, no colonies**
- **valves linear to linear-lanceolate (smaller specimens), abruptly narrowing, forming moderately developed shoulders**
- **apices protracted, rostrate to subcapitate**
- **length 12-50 µm, width 3.5-4.5 µm**
- **sternum very narrow but distinct**
- **central area unilateral, wide fascia, ghost striae occasionally present**
- **striae alternate, almost parallel to slightly radiate, 12-13 in 10 µm**
- **small, conical spines present, sometimes absent**

Original description

Fragilaria vaucheriae

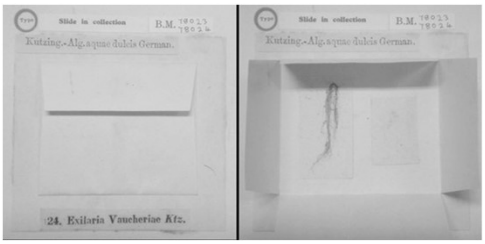
1. EXILARIA VAUCHERIAE. Ktz. (Fig. 38.)

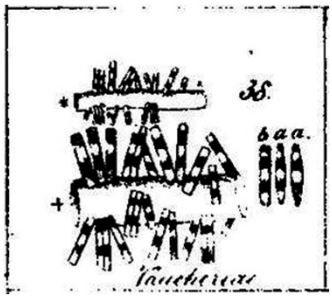
Frustulis aut solitariis aut fasciculatis, minutissimis, linearibus, utrinque obtusis, altero latere apicem versus subattenuatis et rotundato-obtusis, viridi-lutescentibus et varie maculatis.

Exil. Vaucheriae *Ktz.* Alg. Dec. III. No. 24. (excl. Syn. *Agardhii*).

Sie kam an *Vaucheria clavata* in einer Quelle bei Weissenfels in grosser Menge vor, ausserdem fand ich sie auch noch an *Scytosiphon velutinus* im Hallischen, aber etwas kleiner und zarter.

Sie ist die kleinste Art dieser Gattung.

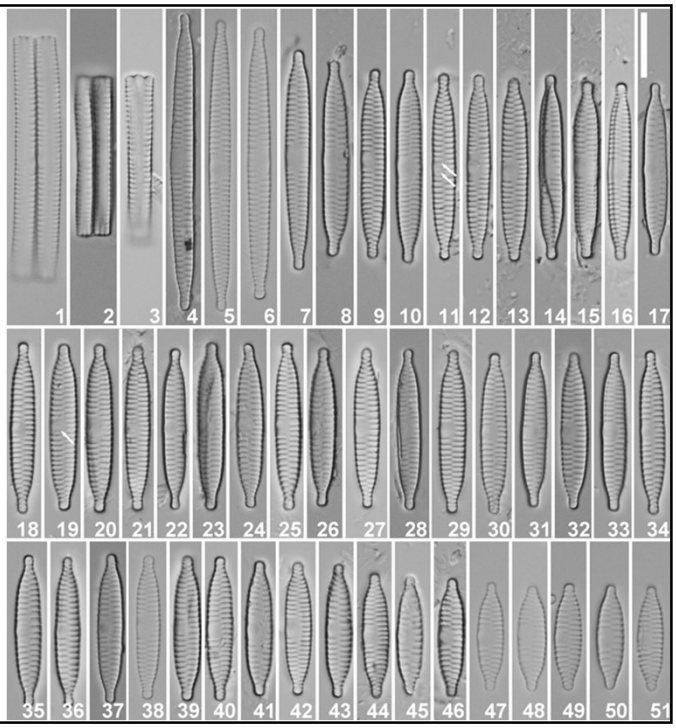




Kützing (1833)

Type material

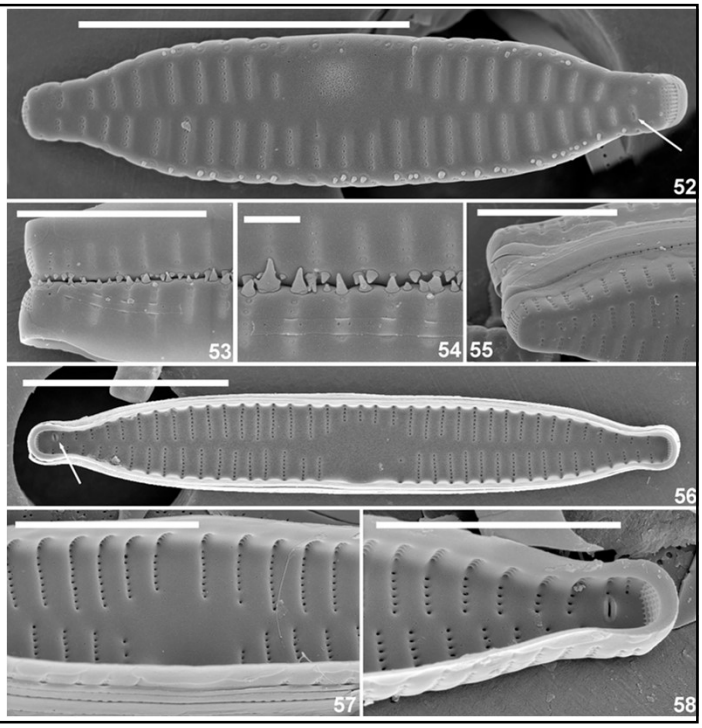
Fragilaria vaucheriae



Kützing 1833
Decas III, 24
Weißenfels (Germany)

Type material

Fragilaria vaucheriae



Kützing 1833
Decas III, 24
Weißenfels (Germany)

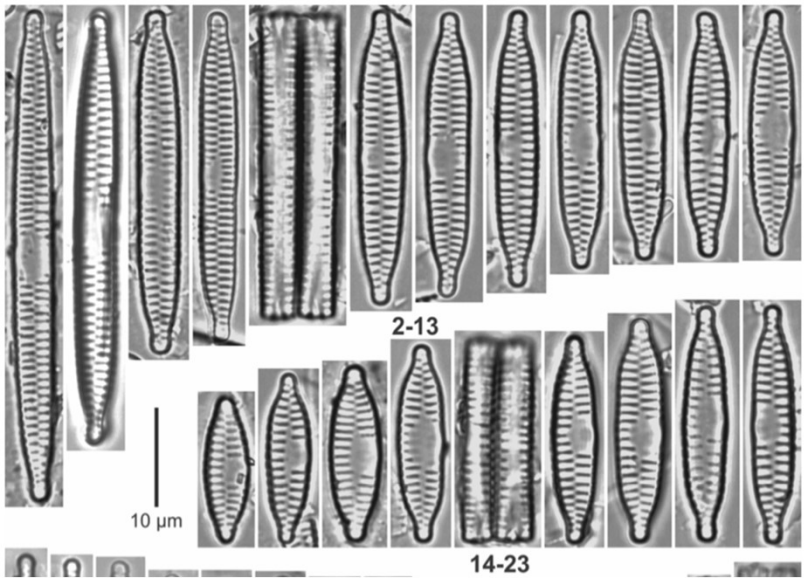
Type material ???

***Fragilaria vaucheriae* (Kützing) J.B.Petersen**
package no. 185 from Weißenfels (Germany)

Cryptogamie, Algologie, 2015, 36 (3): 271-289

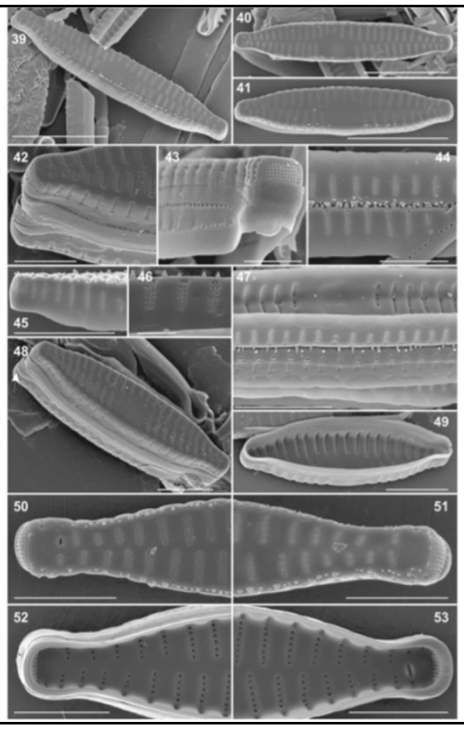
Taxonomy and ecology of *Fragilaria microvaucheriae* sp. nov. and comparison with the type materials of *F. uliginosa* and *F. vaucheriae*

Carlos E. WETZEL* & Luc ECTOR



Fragilaria vaucheriae

Wetzel & Ector (2015)



Cryptogamie, Algologie, 2015, 36 (3): 271-289
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Taxonomy and ecology of *Fragilaria microvaucheriae* sp. nov. and comparison with the type materials of *F. uliginosa* and *F. vaucheriae*

Carlos E. WETZEL & Luc ECTOR*

Type material ???

Fragilaria vaucheriae

Fragilaria vaucheriae
(Kützing) J.B.Petersen

package no. 185 from Weißenfels (Germany)

(Wetzel & Ector 2015)

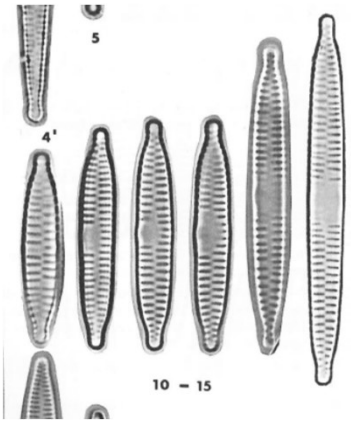
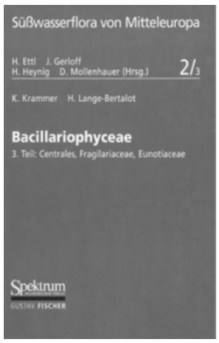


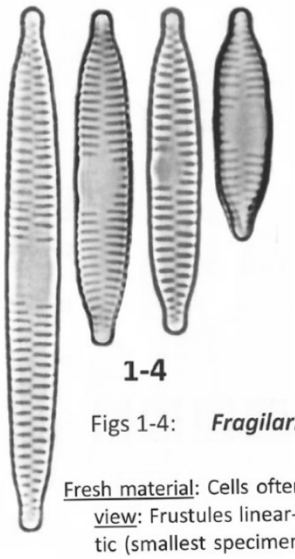
Fig. 10–15: Fragilaria capucina var. vaucheriae (Kützing) Lange-Bertalot (S. 124)

Fig. 10–15: *Exilaria vaucheriae*, Typenmaterial, Species originale Coll. Eulenstein 39 aus Weißenfels entspr. Kützing Alg. Eur. Dec. III no. 24; entspricht *Fragilaria intermedia* Grunow sensu Hustedt und sensu auct. nonnull.

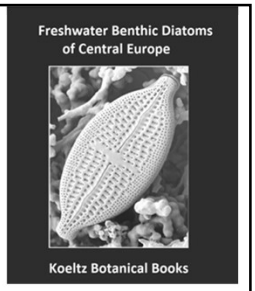


Fragilaria vaucheriae

(Krammer & Lange-Bertalot 1991/2000)



Fragilaria vaucheriae



Lange-Bertalot et al. 2017, p. 276, plate 10, figs 1-4

Figs 1-4: ***Fragilaria vaucheriae*** (Kützing) Petersen

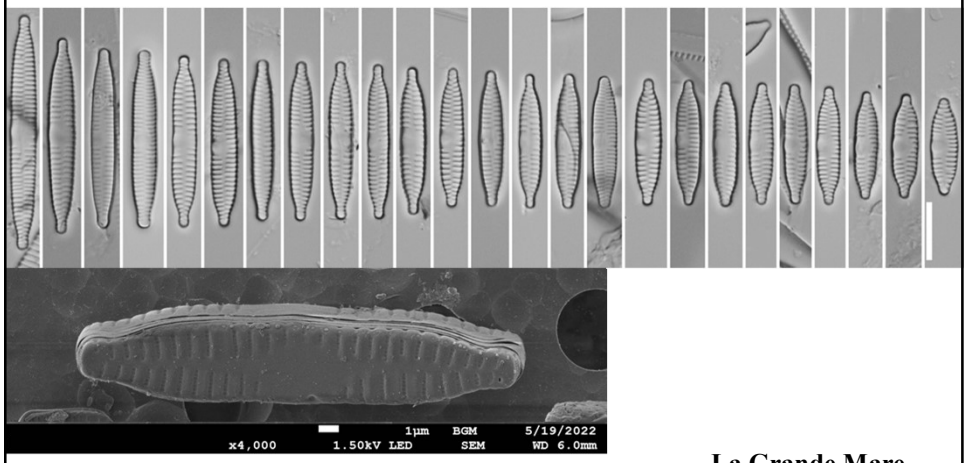
Fresh material: Cells often form ribbon-like colonies, joined by linking spines. Outline: Girdle view: Frustules linear-rectangular. Valve (variable during the cell cycle): From linear-elliptic (smallest specimens) to almost linear (largest individuals). Ends: Rostrate to subcapitate.

Dimensions: Length from < 10 to c. 50 µm, width 4-5 µm. Striae: c. 9-14/10 µm at the centre of the valve usually, but not always, interrupted by a unilaterally developed Central area.

(Lange-Bertalot et al. 2017)

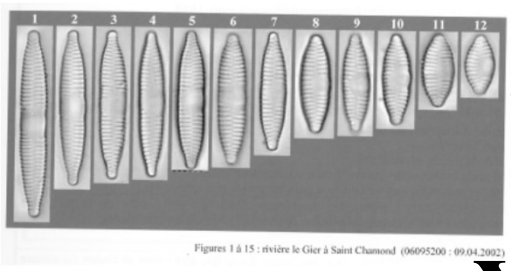
Other European populations

Fragilaria vaucheriae



La Grande Mare
Normandy (France)
Leg. Servanne Quiniou

Other European populations **France**

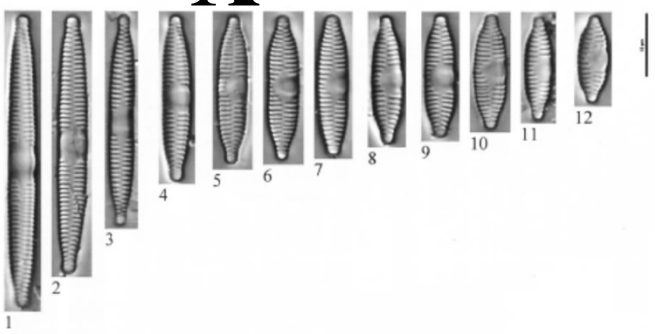


Figures 1 à 15 : rivière le Gier à Saint Chamond (06095200 : 09.04.2002)

Bey & Ector (2013)

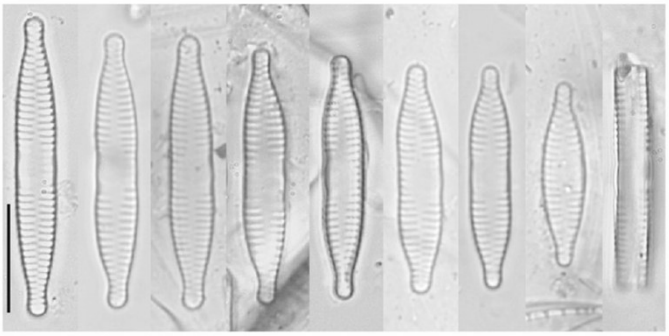
Fragilaria vaucheriae* X = *F. rinoi

Peeters & Ector (2017)



Other European populations **Wales**

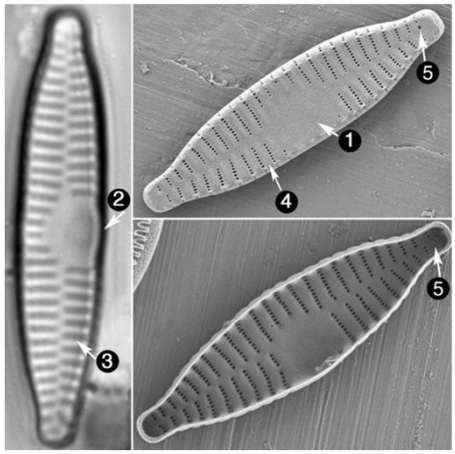
***Fragilaria vaucheriae* X**



Cardiff Bay, Wales

DIATOM FLORA OF BRITAIN AND IRELAND

Other populations



Fragilaria X *vaucheriae*

1. Central area expanded to one side of valve (or in some specimens, to both sides of the valve)
2. Central margin of valve expanded on one side
3. Striae broad
4. Striae widely spaced
5. Rimoportula present

Spaulding, Bishop, Edlund, Lee & Potapova (2018) Diatoms of North America. https://diatoms.org/

Ecology

Fragilaria vaucheriae

Unclear due to confusion with related taxa!!!

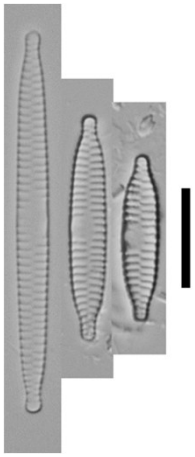
<u>Lange-Bertalot et al. (2017)</u>
eutrophic
mesosaprobic
high conductivity

<u>Peeters & Ector (2017)</u>
moderately impacted by organic matter
rather enriched in nutrients

<u>Van de Vijver et al. (2023)</u>
Together with *Frustulia vulgaris* (5%), *Rhoicosphenia abbreviata* (2%), *Diatoma ehrenbergii* (1%) and *Gomphonella olivacea* (1%).

typical for circumneutral to alkaline environments, preferring eutrophic conditions with saprobity levels up to β-α-mesosaprobic

Can be confused with



F. vaucheriae
L 12-50 µm
W 3.5-4.5 µm
S 12-13 in 10 µm

***Fragilaria vaucheriae* has**

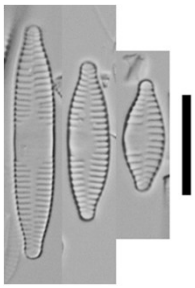
linear (not lanceolate) valves

typical "shoulders"

narrower valves

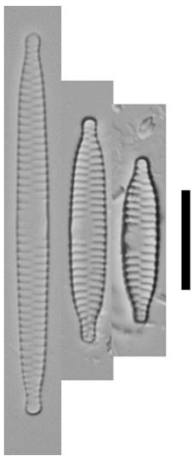
lower stria density

less obvious (not depressed) central area



F. rinoi
L 9-25 µm
W 4.5-6.0 µm
S 14-16 in 10 µm

Can be confused with



F. vaucheriae
L 12-50 µm
W 3.5-4.5 µm
S 12-13 in 10 µm

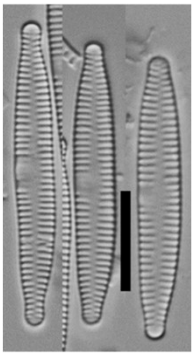
***Fragilaria vaucheriae* has**

usually more protracted apices

broader valves

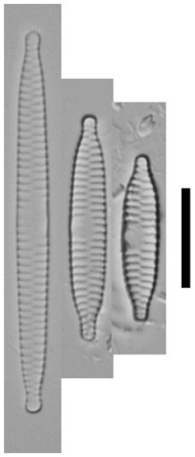
lower stria density

less obvious spot in central area



F. pectinalis
L 20-35 µm
W 3.5-5.0 µm
S 14-15 in 10 µm

Can be confused with



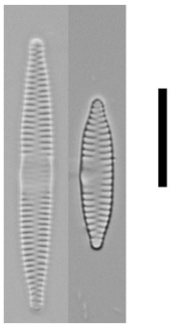
Fragilaria vaucheriae **has**

typical "shoulders"

more protracted apices

more linear valves

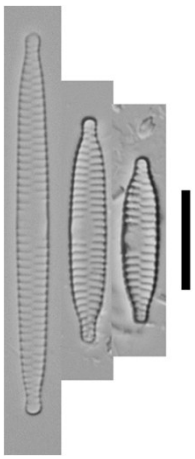
lower stria density



F. vaucheriae
L 12-50 µm
W 3.5-4.5 µm
S 12-13 in 10 µm

F. truncata
L 13-35 µm
W 3.5-4.0 µm
S 13-15 in 10 µm

Can be confused with



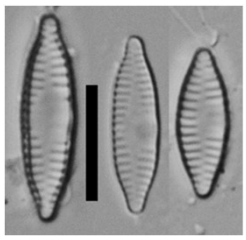
Fragilaria vaucheriae **has**

usually more protracted apices

more linear valves

higher valve dimensions

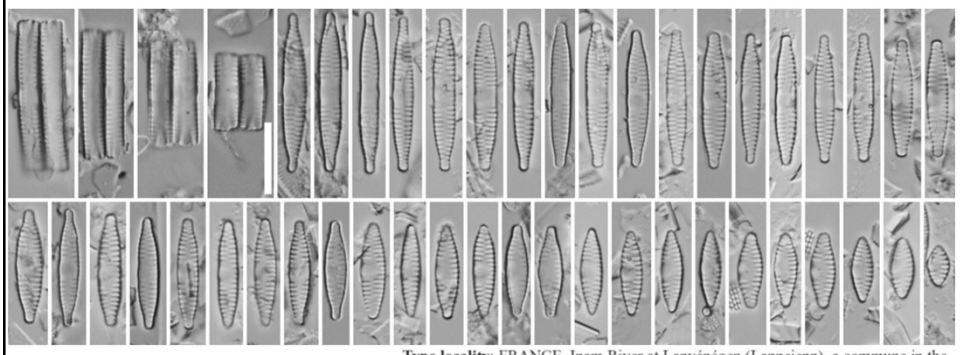
lower stria density



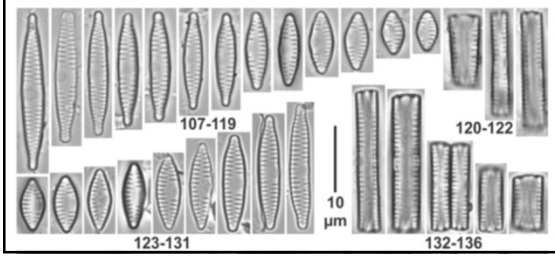
F. vaucheriae
L 12-50 µm
W 3.5-4.5 µm
S 12-13 in 10 µm

F. microvaucheriae
L 6-24 µm
W 2.5-4.0 µm
S 15-16 in 10 µm

For comparison: type of *F. microvaucheriae*



Type locality: FRANCE, Inam River at Lanvénégen (Lannejenn), a commune in the Morbihan department of the region of Brittany, north-western France; leg. Luc Ector, coll. date: 09/08/2006.

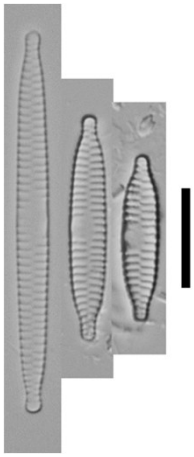


Cryptogamie, Algologie, 2015, 36 (3): 271-289

Taxonomy and ecology of *Fragilaria microvaucheriae* sp. nov. and comparison with the type materials of *F. uliginosa* and *F. vaucheriae*

Carlos E. WETZEL & Luc ECTOR*

Can be confused with



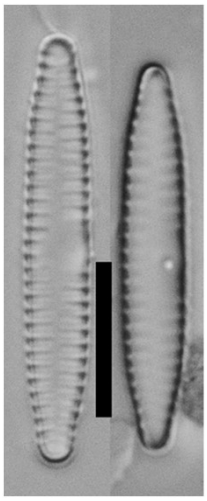
F. vaucheriae
L 12-50 µm
W 3.5-4.5 µm
S 12-13 in 10 µm

***Fragilaria vaucheriae* has**

usually more protracted apices

broader

never colonies!



F. intermedia
L 22.5-45 µm
W 3.5-4 µm
S 11-14 in 10 µm

Fragilaria rinoi
Almeida & C.Delgado in Delgado et al. 2016

- **cells solitary, or rarely two frustules connected, no colonies**
- **valves lanceolate (larger) to elliptic-lanceolate (smaller), very rarely linear**
- **apices weakly protracted, rostrate BUT not (sub-)capitate**
- **length 9-25 µm, width 4.5-6 µm**
- **sternum narrow, linear, widening towards central area**
- **central area unilateral, very wide fascia but not from side to side**
- **striae parallel in the middle, slightly radiate near the apices, 14-16 in 10 µm**
- **spines absent but very small marginal papillae present**

Original description

Fragilaria rinoi

European Journal of Taxonomy 248: 1–16
http://dx.doi.org/10.5852/ejt.2016.248
ISSN 2118-9773
www.europeanjournaloftaxonomy.eu
2016 · Delgado C. *et al.*

Research article

***Fragilaria rinoi* sp. nov. (Fragilariales, Fragilariophyceae) from periphytic river samples in Central Portugal**

Cristina DELGADO [1,*], M. Helena NOVAIS [2], Saúl BLANCO [3] & Salomé F.P. ALMEIDA [4]

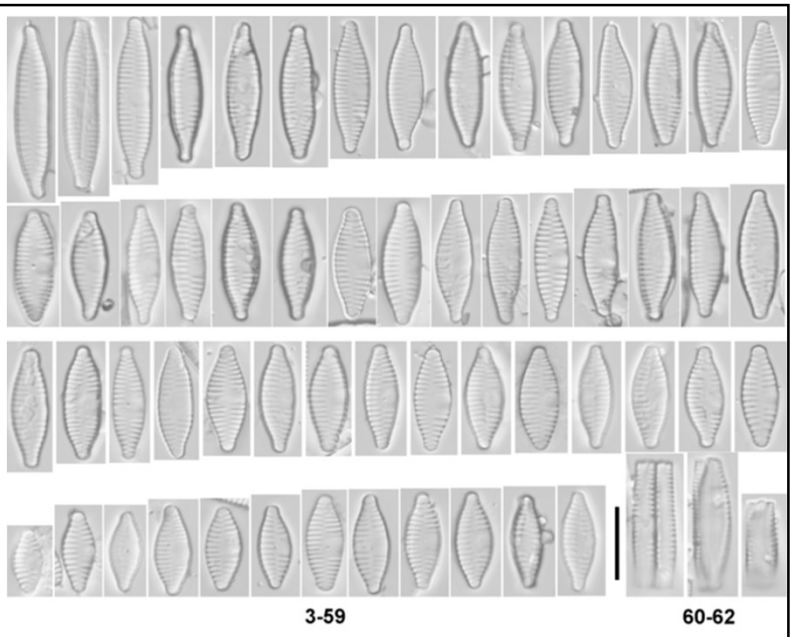
LM OBSERVATIONS (Figs 3–77). *Fragilaria rinoi* sp. nov. is characterized by the presence of solitary cells with lanceolate valves and slightly rostrate apices in larger specimens to rhombic lanceolate in smaller specimens. Frustules rectangular in girdle view with interruption of striation in the middle portion. Axial area narrow, linear, central area larger, unilateral in all specimens. Valve dimensions (n = 30): length 8.8–24.1 µm and width 4.2–5.6 µm. Sternum narrow, slightly widening towards the central area (Figs 3–77). Striae parallel to the transapical axis becoming slightly radiate at the poles, 14–16 in 10 µm.

SEM OBSERVATIONS (Figs 78–82). External valve face without spines. A single rimoportula is present at one pole and might vary from apically oriented (Fig. 79) to almost transapical orientation (Figs 80, 82). Striae uniseriate, composed of round areolae (13–14 areolae in 1 µm) on both valves (Figs 78–80). Each valve has two apical pore fields (APF) composed of simple fine porelli arranged in regular rows parallel to the apical axis (Fig. 78) and made up of 4 rows, each composed of 10 to 11 poroids (Fig. 81). Outer and inner areolar openings without siliceous depositions (Figs 78–82).

Delgado et al. (2016)

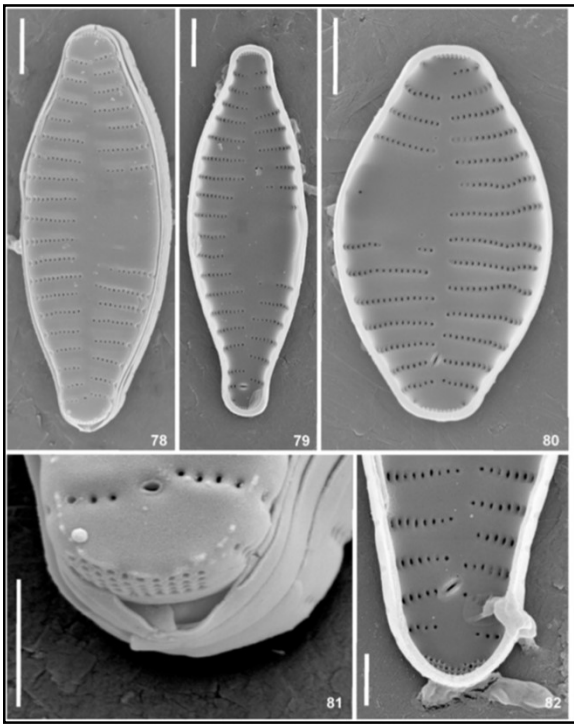
Original description

Fragilaria rinoi



Type material (BM 101 794)
Mogofores (Cértima river, Vouga river basin, 21 III 2012)

Delgado et al. (2016)



Original description

Fragilaria rinoi

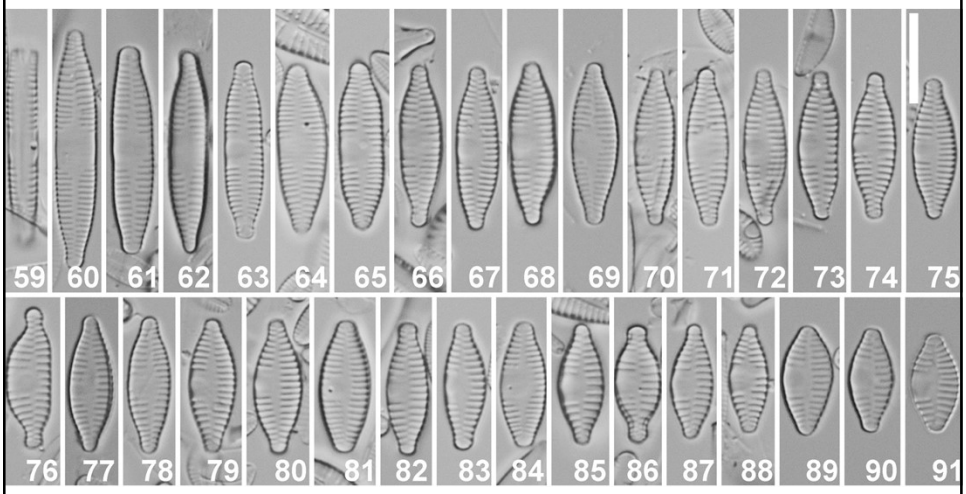
type material (BM 101 794)

Mogofores (Cértima river, Vouga river basin, 21 III 2012)

Delgado et al. (2016)

Type material

Fragilaria rinoi



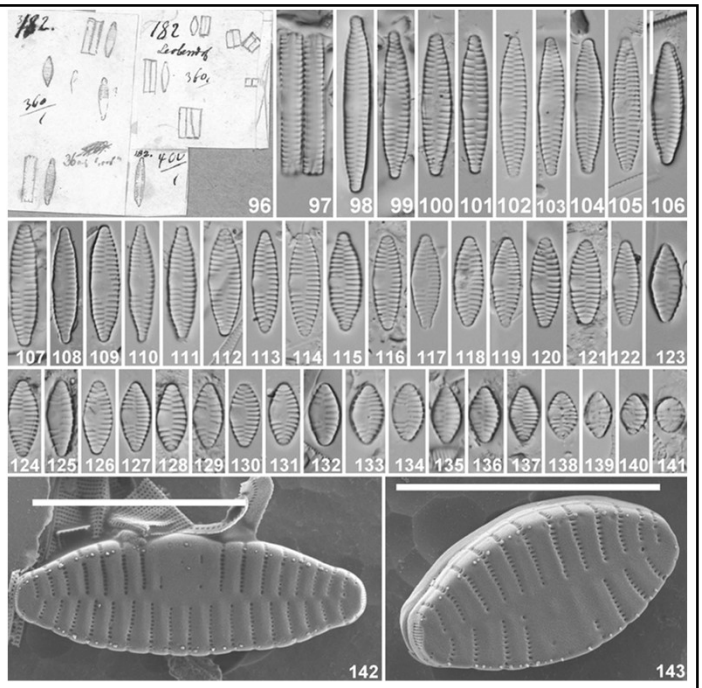
Type material (BM 101 794)
Mogofores (Cértima river, Vouga river basin, 21 III 2012)

Van de Vijver et al. (2023)

Other European populations

Fragilaria rinoi

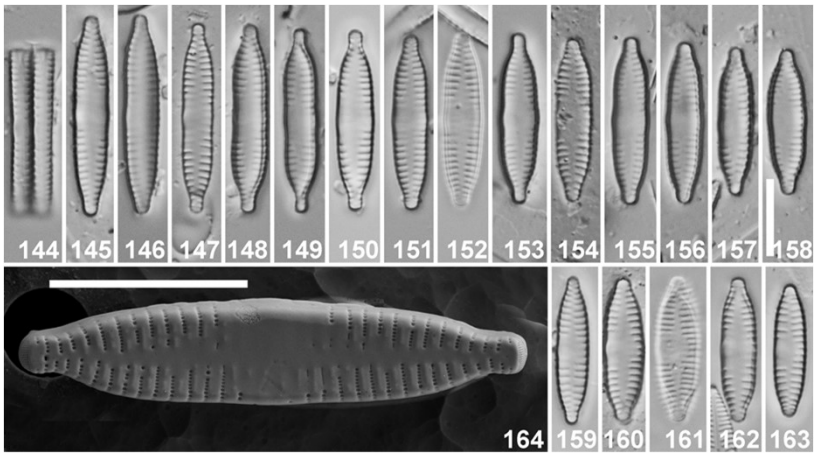
Grunow sample 182 stream near the town of Leobendorf (potentially also Leobersdorf) (Lower Austria, Austria) (28.VIII.1857)



Van de Vijver et al. (2023)

Other European populations

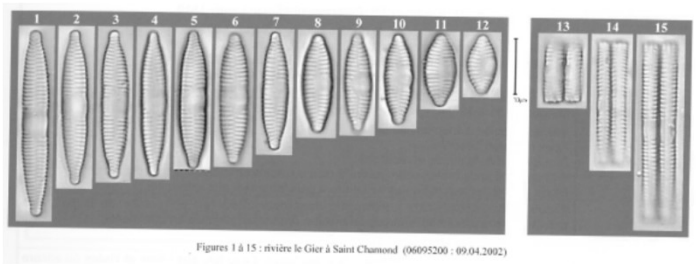
Fragilaria rinoi



channel Gent-Oostende near the Flemish village of Lievegem (Belgium)

Van de Vijver et al. (2023)

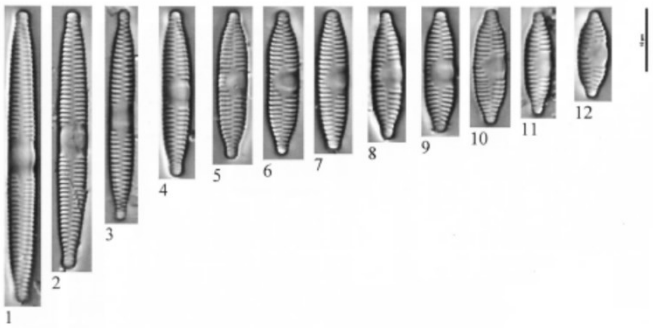
Other European populations **France**



Bey & Ector (2013)

***Fragilaria rinoi* (as *F. vaucheriae*)**

Peeters & Ector (2017)



Ecology

Fragilaria rinoi

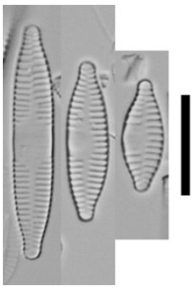
Delgado et al. (2016)

- epilithic species
- neutral to slightly alkaline pH (7.0–7.8)
- medium to high conductivity (43–765 µS/cm)
- relatively high nitrate-nitrogen (3.7 mg/l)
- relatively high ammonium (0.2–3.8 mg/l)
- relatively high phosphorus (0.2–1.4 mg P/l)
- high dissolved oxygen concentrations (between 82% and 103%)

Van de Vijver et al. (2023)

All observed species compositions point to eutrophic, alkaline conditions of electrolyte-enriched lakes and rivers.

Can be confused with



F. rinoi
L 9-25 µm
W 4.5-6.0 µm
S 14-16 in 10 µm

***Fragilaria rinoi* has**

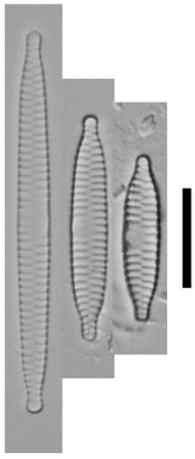
always (linear-) lanceolate valves

no typical "shoulders"

broader valves

higher stria density

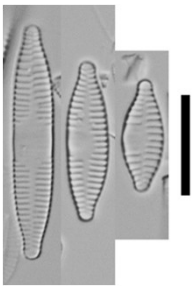
typical large, depressed central area



F. vaucheriae
L 12-50 µm
W 3.5-4.5 µm
S 12-13 in 10 µm

Can be confused with

***Fragilaria rinoi* has**

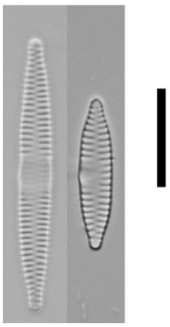


less slender valves

broader valves

slightly higher stria density

typical large, depressed central area

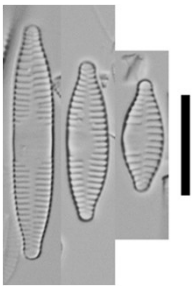


F. rinoi
L 9-25 µm
W 4.5-6.0 µm
S 14-16 in 10 µm

F. truncata
L 13-35 µm
W 3.5-4.0 µm
S 13-15 in 10 µm

Can be confused with

***Fragilaria rinoi* has**

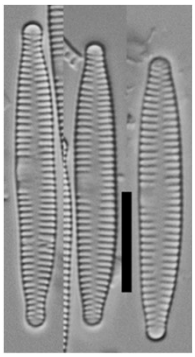


nore lanceolate valves

less (sub-)capitate apices

broader valves

typical large, depressed central area

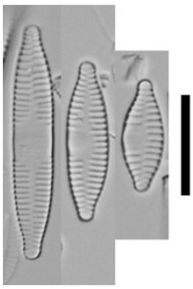


F. rinoi
L 9-25 µm
W 4.5-6.0 µm
S 14-16 in 10 µm

F. pectinalis
L 20-35 µm
W 3.5-5.0 µm
S 14-15 in 10 µm

Can be confused with

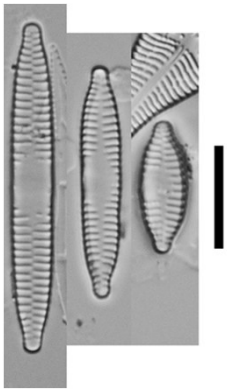
***Fragilaria rinoi* has**



slightly broader valves

lower stria density

no colonies!



F. rinoi
L 9-25 µm
W 4.5-6.0 µm
S 14-16 in 10 µm

F. catenarinoi
L 15-40 µm
W 3.5-5.0 µm
S 9-14 in 10 µm

Fragilaria truncata (Kützing) J.B.Petersen 1938

Basionym: ***Exilaria truncata*** **Greville 1827**
Synonym: ***Fragilaria vaucheriae var. truncata*** **(Greville) Stoermer & J.J.Yang nom. inval.,** ***Fragilaria capucina*** **var.** ***truncata*** **(Greville) Kharitonov nom. inval.**

- **cells solitary, occasionally two valves together, no colonies**
- **valves linear to linear-lanceolate (smaller specimens), parallel margins throughout, no shoulders**
- **apices weakly protracted, rostrate to subcapitate**
- **length 13-35 µm, width 3.5-4.0 µm**
- **sternum narrow but distinct**
- **central area very large, rarely unilateral, usually wide fascia, not depressed nor inflated, ghost striae occasionally present**
- **striae alternate, almost parallel to slightly radiate, 13-15 in 10 µm**
- **continuous series of very short, blunt, marginal spines present**

Original description

Fragilaria truncata

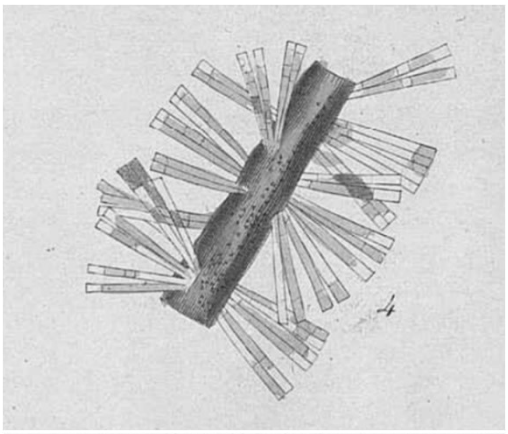


Fig. 1. and 2. *Echinella fasciculata on Ectocarpus littoralis, (Conferva littoralis,* Auct.) Fig. 3. *on Conferva rupestris.* Fig. 4. β, *on Vaucheria Dillwynii.—All more or less magnified.*

SPECIFIC CHARACTER.

ECHINELLA fasciculata; *corpuscula sessilia, æqualia, stricta, rigida, continua, fastigiata, subradiata, granulis luteo-viridis; in Algis filiformibus parasitica.*

E. minute bodies, sessile, equal, straight, continuous, fastigiate and subradiating; parasitic on the filiform algæ.

ECHINELLA fasciculata, *Lyng. Tent. Hydrophyt. Dan.* p. 210. t. 70. A.—*Grev. Fl. Edin. ined.*

DIATOMA fasciculata, *Ag. Disp.* p. 35.—*Syn.* p. 120.

FL. DAN. t. 945. *(quoad pilos qui in conferva pennatula, i. e. conferva flavescenti adsunt),* Lyngb.

β truncata, *aqua dulcis.*

HAB. On the filiform and capillary Algæ, plentiful; particularly on *Ectocarpus littoralis,* (*Conferva littoralis* of Eng. Bot.) Common in the Frith of Forth. β, in fresh water, attached to *confervæ,* stems of grass, the *Lemnæ,* &c. Ditches near Edinburgh. Both are found at all seasons.

Excessively minute, invisible to the naked eye, but giving a downy or dirty appearance to the Algæ on which it grows; under the microscope very distinctly composed of simple, sessile, and filiform bodies, slightly rounded and attenuated at each extremity; very short, straight, rigid, continuous, equal in diameter and in length, partly diaphanous, and partly filled with a mass of greenish-yellow granules, 2—8 growing together from the same point, in a fasciculated and radiating manner.

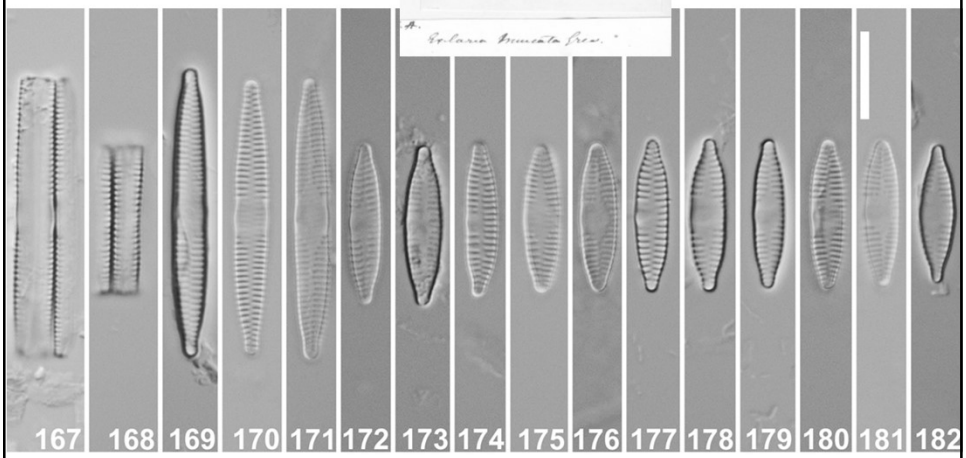
β resembles the other in all respects, except in being perfectly truncate, not attenuated at either extremity, and growing in fresh water.

Greville (1827)

Type material

Fragilaria truncata

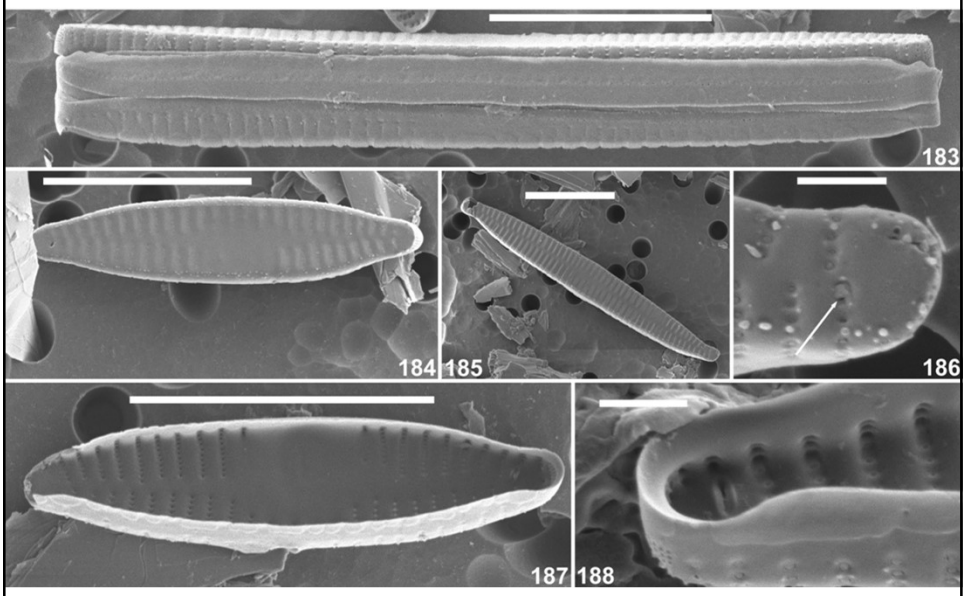
Greville material Edinburgh



Van de Vijver et al. (2023)

Type material

Fragilaria truncata

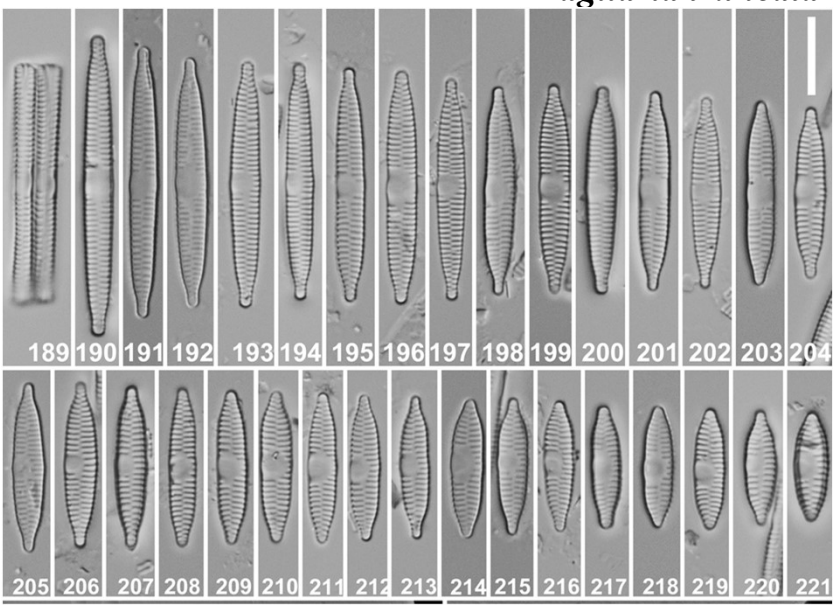


Greville material
Edinburgh

Van de Vijver et al. (2023)

Other European populations

Fragilaria truncata

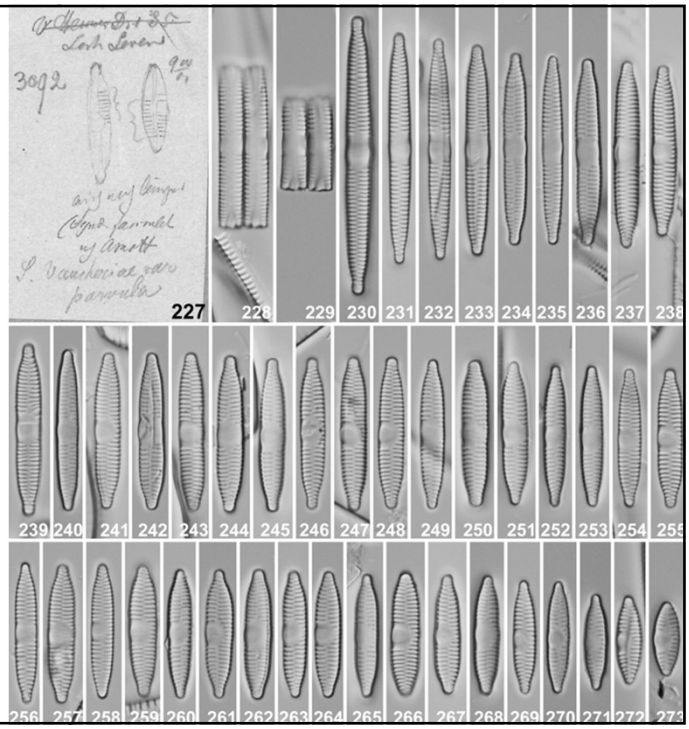


Walker Arnott sample 417
Haverfordwest (Wales) leg. F. Okeden

Van de Vijver et al. (2023)

Other European populations

Fragilaria truncata



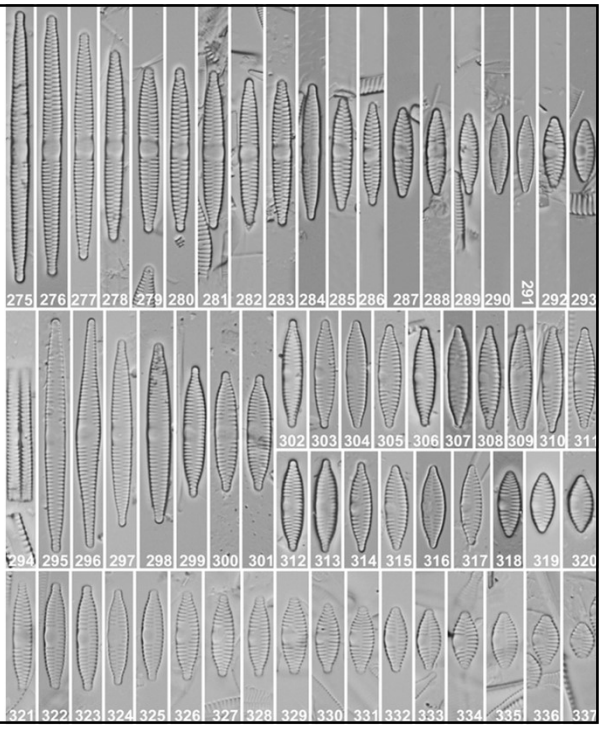
Walker Arnott 146
Loch Leven near Kinross (Scotland)
coll. date 7.X.1854

as *Synedra vaucheriae* var. *parvula*

Van de Vijver et al. (2023)

Other European populations

Fragilaria truncata



River La Cure in Montsauche-les-Settons (Burgundy, France) Leg. V. Peeters

River Kleine Nete (Flanders, Belgium) Leg. B. Van de Vijver

Salvan (Kanton Wallis, Switzerland) Leg. J. Brun

Van de Vijver et al. (2023)

Ecology

Fragilaria truncata

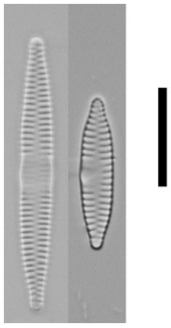
Most *F. vaucheriae* populations are probably *F. truncata* !!!

Van de Vijver et al. (2023)
meso-eutropic conditions
pollution-tolerant conditions

Ecological preferences need to be established.

Can be confused with

***Fragilaria truncata* has**

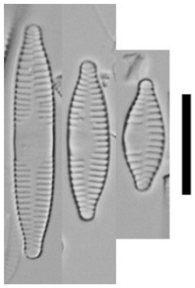


more slender valves

narrower valves

lower stria density

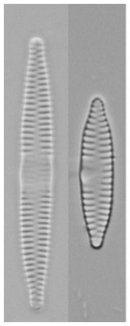
smaller, less depressed central area



F. truncata
L 13-35 µm
W 3.5-4.0 µm
S 13-15 in 10 µm

F. rinoi
L 9-25 µm
W 4.5-6.0 µm
S 14-16 in 10 µm

Can be confused with



F. truncata
L 13-35 µm
W 3.5-4.0 µm
S 13-15 in 10 µm

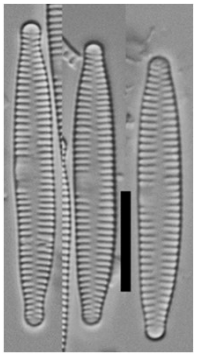
***Fragilaria truncata* has**

more lanceolate, less linear valve outline

less (sub-)capitate valves

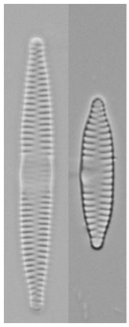
usually narrower valves

smaller, less depressed central area



F. pectinalis
L 20-35 µm
W 3.5-5.0 µm
S 14-15 in 10 µm

Can be confused with



F. truncata
L 13-35 µm
W 3.5-4.0 µm
S 13-15 in 10 µm

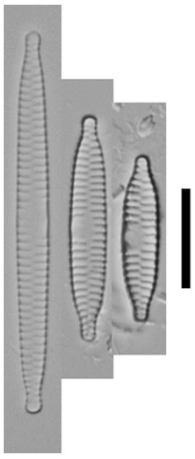
***Fragilaria truncata* has**

no typical "shoulders"

lanceolate (not linear) outline

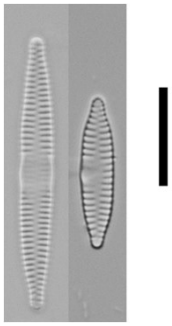
less protracted apices

higher stria density



F. vaucheriae
L 12-50 µm
W 3.5-4.5 µm
S 12-13 in 10 µm

Can be confused with

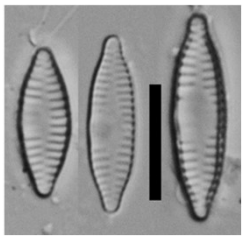


***Fragilaria truncata* has**

more linear-lanceolate, less strictly lanceolate outline

usually larger

lower stria density



F. truncata
L 13-35 µm
W 3.5-4.0 µm
S 13-15 in 10 µm

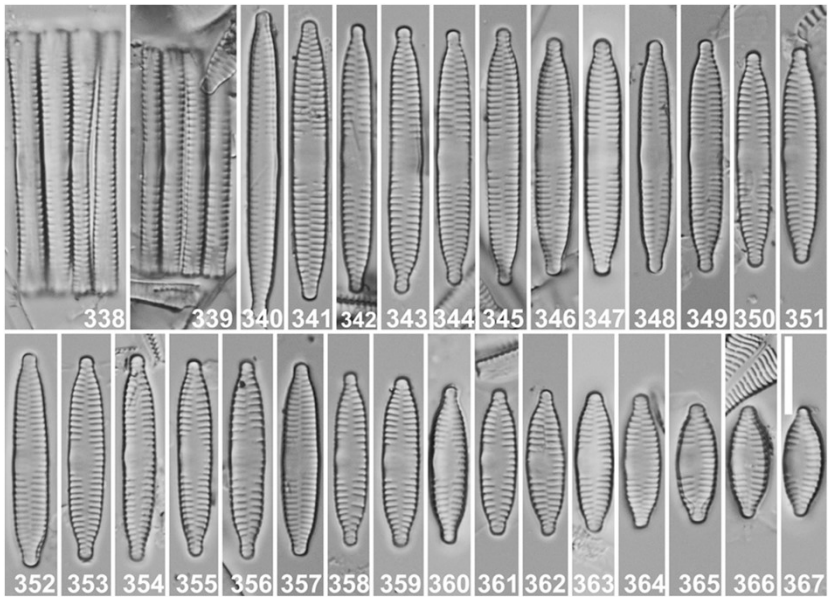
F. microvaucheriae
L 6-24 µm
W 2.5-4.0 µm
S 15-16 in 10 µm

Fragilaria catenarinoi
Van de Vijver & D.M.Williams 2023

- **cells in long, ribbon-shaped colonies**
- **valves strictly linear to weakly linear-lanceolate**
- **apices clearly but shortly protracted, rostrate**
- **length 15-40 µm, width 3.5-5.0 µm**
- **sternum variable in width, very narrow to moderately broad**
- **central area very large, spanning entire width, unilateral in long specimens**
- **striae alternate, almost parallel to slightly radiate, 9-14 in 10 µm**
- **well-developed, robust linking spines present**

Type material

Fragilaria catenarinoi

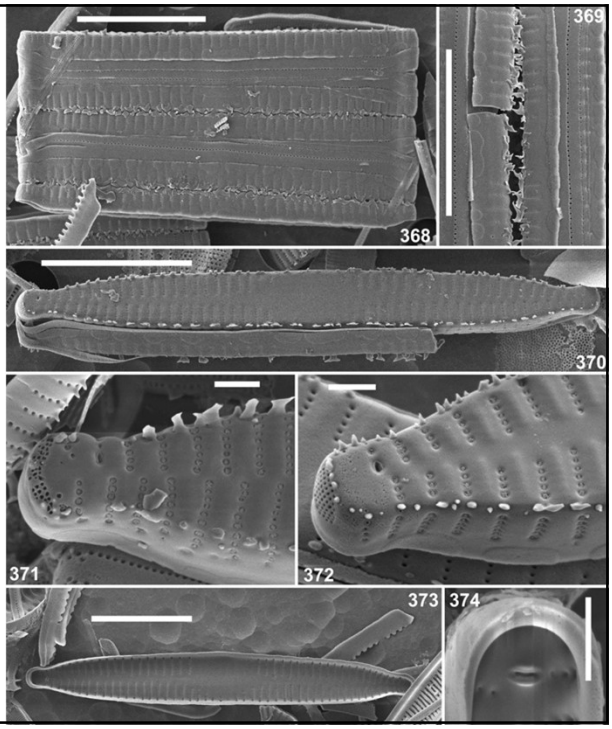


Kützing sample 918
Germany

Van de Vijver et al. (2023)

Type material

Fragilaria catenarinoi



Kützing sample 918
Germany

Van de Vijver et al. (2023)

Ecology

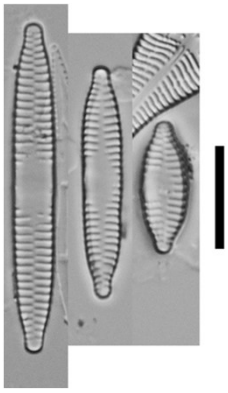
Fragilaria catenarinoi

Van de Vijver et al. (2023)

circumneutral to alkaline running water bodies
higher trophic and saprobity levels

Ecological preferences need to be established.

Can be confused with



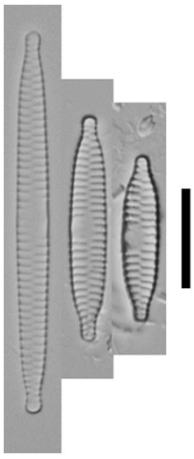
***Fragilaria catenarinoi* has**

no typical "shoulders"

larger central area

usually lower stria density

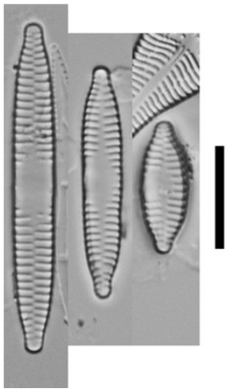
colonies!



F. catenarinoi
L 15-40 µm
W 3.5-5.0 µm
S 9-14 in 10 µm

F. vaucheriae
L 12-50 µm
W 3.5-4.5 µm
S 12-13 in 10 µm

Can be confused with



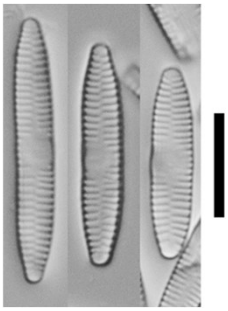
***Fragilaria catenarinoi* has**

larger central area

more protracted apices

lower stria density

colonies with spines!



F. catenarinoi
L 15-40 µm
W 3.5-5.0 µm
S 9-14 in 10 µm

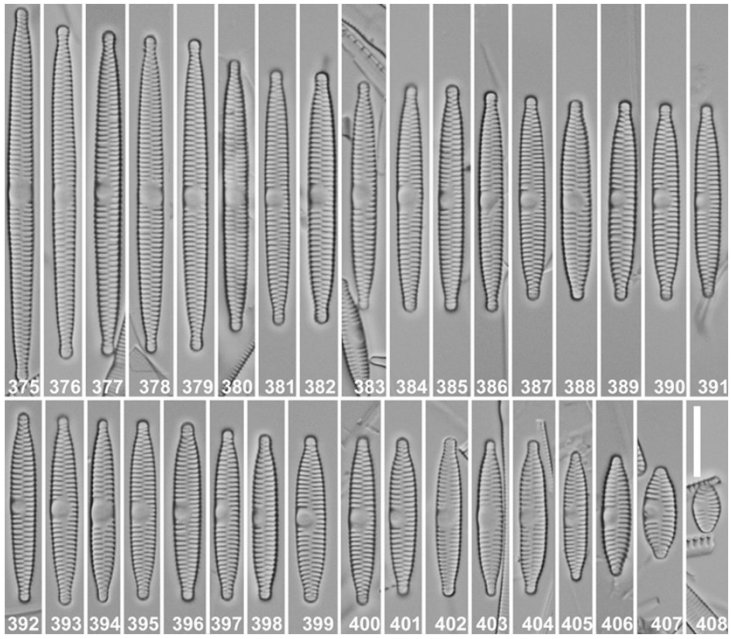
F. joachimii
L 5-34 µm
W 3.5-4.5 µm
S 14-16 in 10 µm

Fragilaria kellyana
Van de Vijver, D.M.Williams & Ector 2023

- **cells in girdle view not observed, most likely solitary**
- **valves linear to weakly linear-lanceolate, parallel margins**
- **apices clearly protracted, rostrate to subcapitate**
- **length 8-55 µm, width (3.5) 4.0-4.5 (5.0) µm**
- **sternum narrow**
- **central area large, unilateral, often depressed hyaline zone**
- **striae alternate, almost parallel to slightly radiate, 14-16 in 10 µm**
- **large, irregularly shaped, triangular marginal spines present**

Type material

Fragilaria kellyana

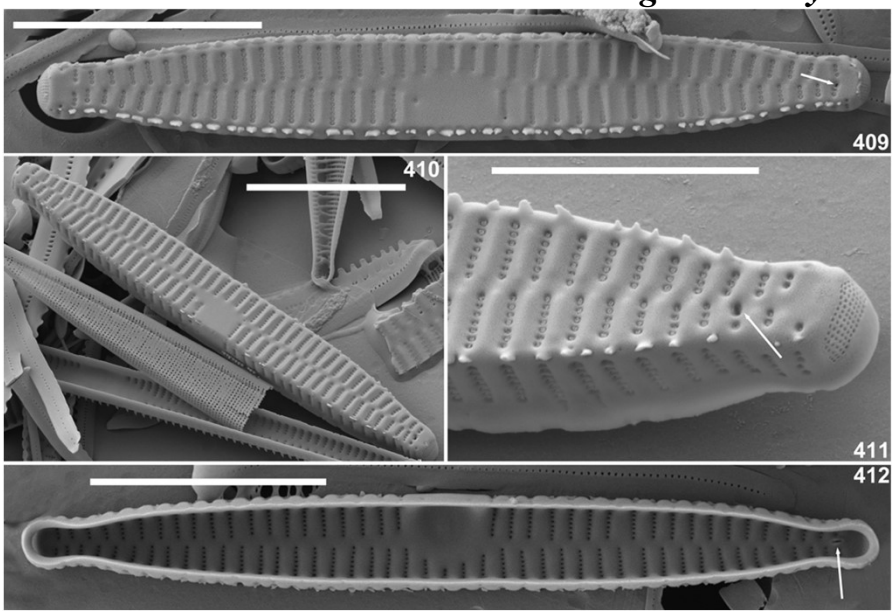


River Don, Towie (Aberdeenshire, Scotland, UK), coll. date 15.V.2018, leg. Sarah Stenhouse

Van de Vijver et al. (2023)

Type material

Fragilaria kellyana



River Don, Towie (Aberdeenshire, Scotland, UK), coll. date 15.V.2018, leg. Sarah Stenhouse

Van de Vijver et al. (2023)

Ecology

Fragilaria catenarinoi

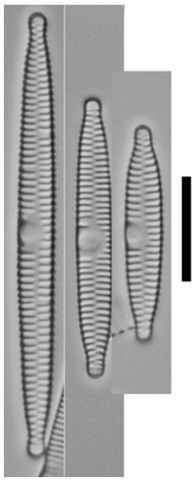
Van de Vijver et al. (2023)

Average water chemistry of the River Don at Towie between November 1999 and December 2016 was as follows:
pH: 7.7
conductivity: 124 µS/cm1
very high levels of nitrate-N (3.34 mg /L)

Ecological preferences need to be established.

PROBABLY ONLY IN THE UK.

Can be confused with

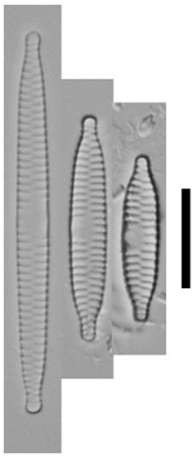


***Fragilaria kellyana* has**

higher stria density

typical (sub-)capitate apices

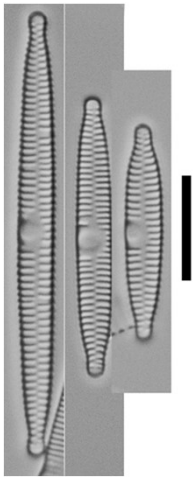
well determined central area



F. kellyana
L 8-55 µm
W 4.0-4.5 µm
S 14-16 in 10 µm

F. vaucheriae
L 12-50 µm
W 3.5-4.5 µm
S 12-13 in 10 µm

Can be confused with



F. kellyana
L 8-55 µm
W 4.0-4.5 µm
S 14-16 in 10 µm

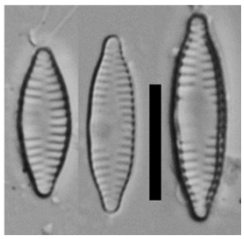
***Fragilaria kellyana* has**

usually much longer valves

broader valves

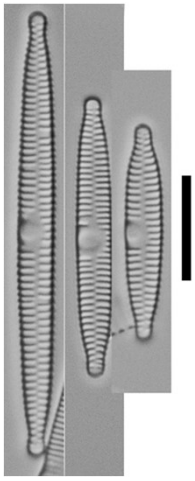
typical (sub-)capitate apices

well determined central area



F. microvaucheriae
L 6-24 µm
W 2.5-4.0 µm
S 15-16 in 10 µm

Can be confused with



F. kellyana
L 8-55 µm
W 4.0-4.5 µm
S 14-16 in 10 µm

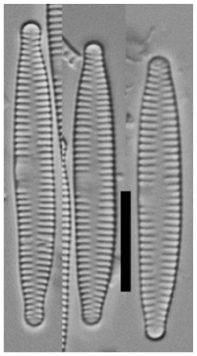
***Fragilaria kellyana* has**

usually much longer valves

narrower sternum

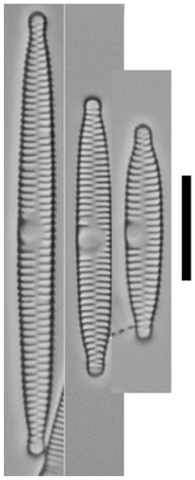
more slender valve outlook

well determined central area



F. pectinalis
L 20-35 µm
W 3.5-5.0 µm
S 14-15 in 10 µm

Can be confused with



F. kellyana
L 8-55 µm
W 4.0-4.5 µm
S 14-16 in 10 µm

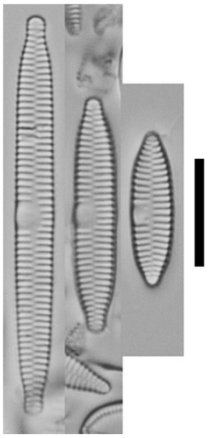
***Fragilaria kellyana* has**

more slender valve outlook

well determined central area

more (sub-)capitate apices

no real shoulders



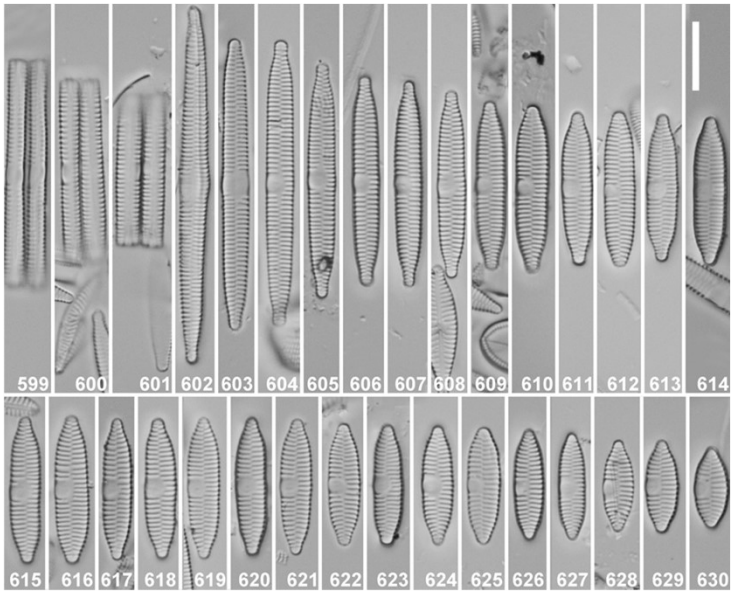
F. vaucheriaerobusta
L 12-55 µm
W 4.0-5.0 µm
S 15-16 in 10 µm

Fragilaria vaucheriaerobusta
Van de Vijver, C.E.Wetzel & Ector in Vd Vijver et al. 2023

- cells solitary or joined in pairs
- valves linear to weakly linear-lanceolate, parallel margins, smaller valves more lanceolate
- apices weakly protracted, rostrate to subrostrate
- length 12-55 µm, width 4.0-5.0 µm
- sternum narrow
- central area large, strictly unilateral, with depressed hyaline zone
- striae alternate, parallel, 15-16 in 10 µm
- spines usually absent, very rarely marginal spines present

Type material

Fragilaria vaucheriaerobusta



Duddingston Loch, Edinburgh, Scotland, UK (leg. Dr Gregory)

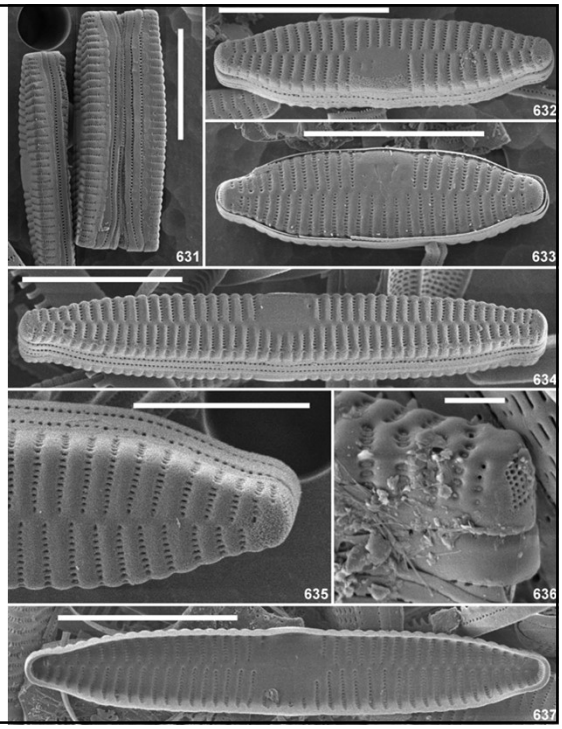
Van de Vijver et al. (2023)

Type material

Fragilaria vaucheriaerobusta

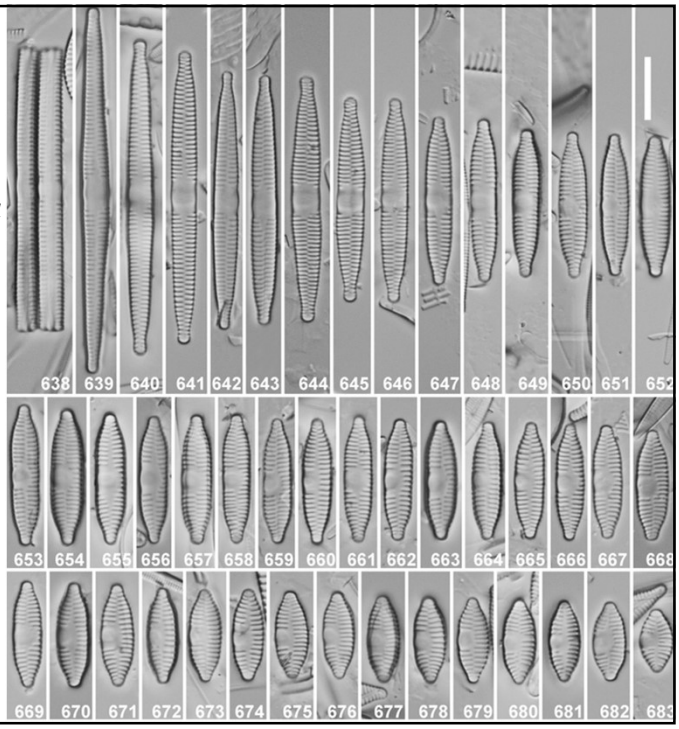
Walker Arnott 238
Duddingston Loch, Edinburgh, Scotland, UK
(leg. Dr Gregory)

Van de Vijver et al. (2023)



Other European populations

Fragilaria vaucheriaerobusta



BERW-03803
Masblette
(near the village of Nassogne, province of Luxembourg, Belgium)
Leg. SPW

Van de Vijver et al. (2023)

Ecology

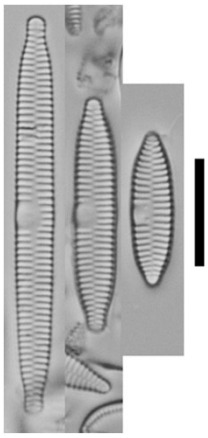
Fragilaria vaucheriaerobusta

<u>Van de Vijver et al. (2023)</u>

The species composition in the type slide points to rather alkaline, eutrophic conditions with a high electrolyte content.
Most taxa observed are tolerant up to the β-α-mesosaprobic level.

Ecological preferences need to be established.

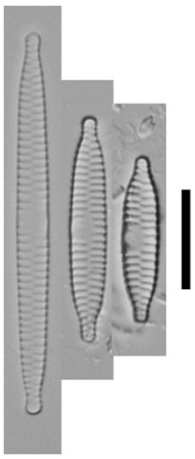
Can be confused with



Fragilaria vaucheriaerobusta
has

more sturdy valve outlook

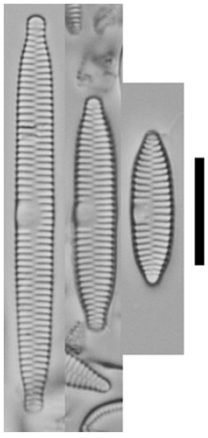
higher stria density



F. vaucheriaerobusta
L 12-55 µm
W 4.0-5.0 µm
S 15-16 in 10 µm

F. vaucheriae
L 12-50 µm
W 3.5-4.5 µm
S 12-13 in 10 µm

Can be confused with



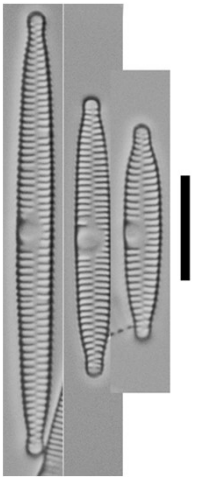
Fragilaria vaucheriaerobusta
has

more sturdy valve outlook

less determined central area

more rostrate apices

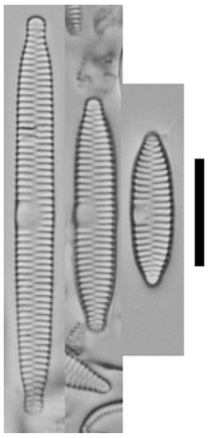
more or less shoulders



F. vaucheriaerobusta
L 12-55 µm
W 4.0-5.0 µm
S 15-16 in 10 µm

F. kellyana
L 8-55 µm
W 4.0-4.5 µm
S 14-16 in 10 µm

Can be confused with



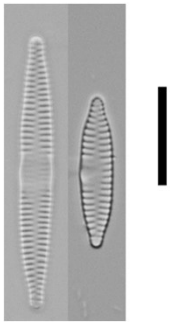
Fragilaria vaucheriaerobusta **has**

more sturdy valve outlook

higher stria density

broader valves

more or less shoulders

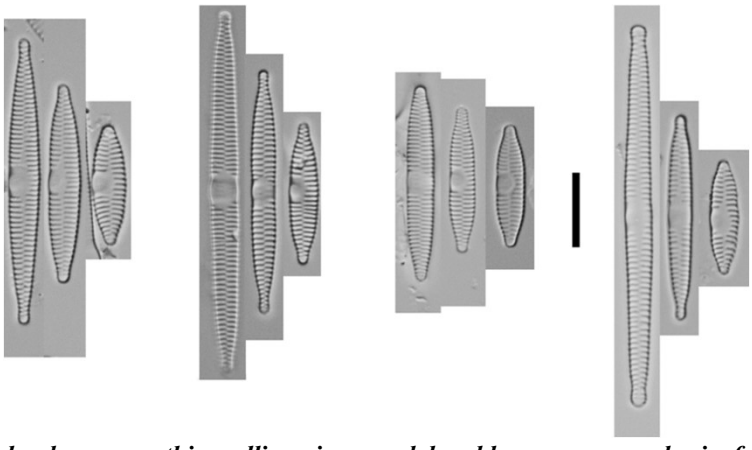


F. vaucheriaerobusta
L 12-55 µm
W 4.0-5.0 µm
S 15-16 in 10 µm

F. truncata
L 13-35 µm
W 3.5-4.0 µm
S 13-15 in 10 µm

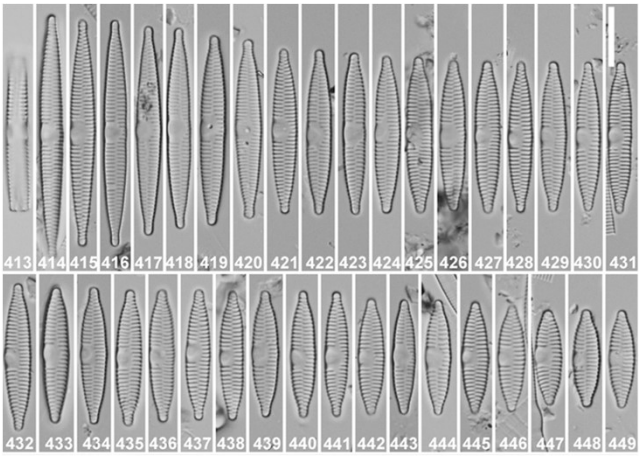
4. The *Fragilaria vaucheriae* group

II. Some rare species



landnama ***thingvellirensis*** ***vandekerckhoveana*** ***vaucheriaefalsa***

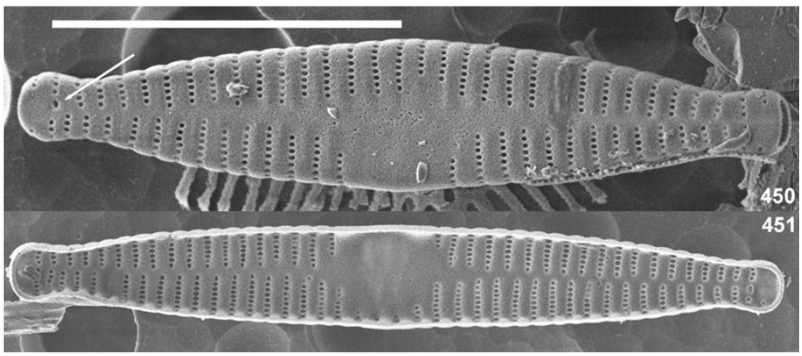
Fragilaria landnama **Van de Vijver & Iris Hansen in VdVijver et al. (2023)**



valves distinctly lanceolate to linear-lanceolate, protracted rostrate apices
length 16–40 µm, width 4.0–4.5 µm
sternum narrow, almost not widening from the apices towards the central area
central area large, unilateral, often buttressed
striae parallel to weakly radiate, 15-17 in 10 µm
spines absent

(Van de Vijver et al., 2023)

Fragilaria landnama **Van de Vijver & Iris Hansen in VdVijver et al. (2023)**

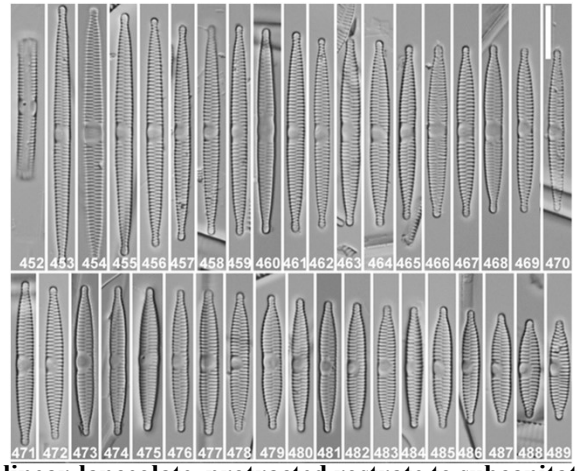


Diatom community is typical for colder, fast-flowing, more alkaline rivers with higher trophic levels..

So far only found in ICELAND

(Van de Vijver et al., 2023)

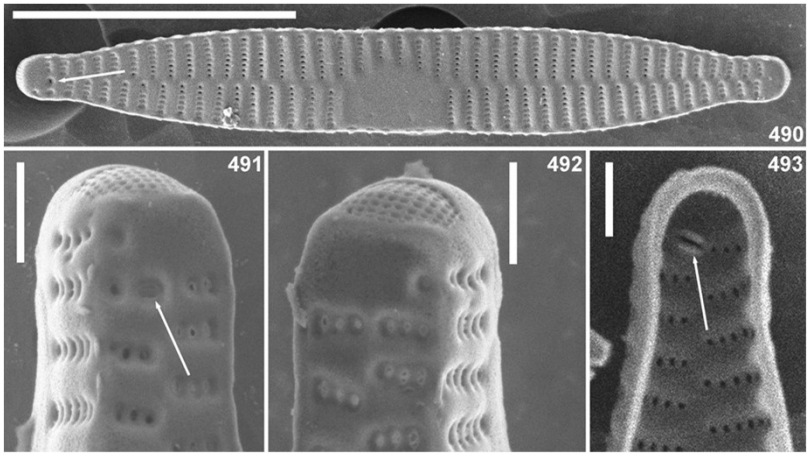
Fragilaria thingvellirensis **Van de Vijver & G.S.Jónsson in VdVijver et al. (2023)**



valves linear to linear-lanceolate, protracted rostrate to subcapitate apices
length 18–50 µm, width 3.0–4.0 µm
sternum narrow, linear not widening towards the central area
central area large, unilateral, often buttressed
striae parallel to weakly radiate, 16-17 in 10 µm
continuous series of relatively large, narrow, marginal spines present

(Van de Vijver et al., 2023)

Fragilaria thingvellirensis **Van de Vijver & G.S.Jónsson in VdVijver et al. (2023)**

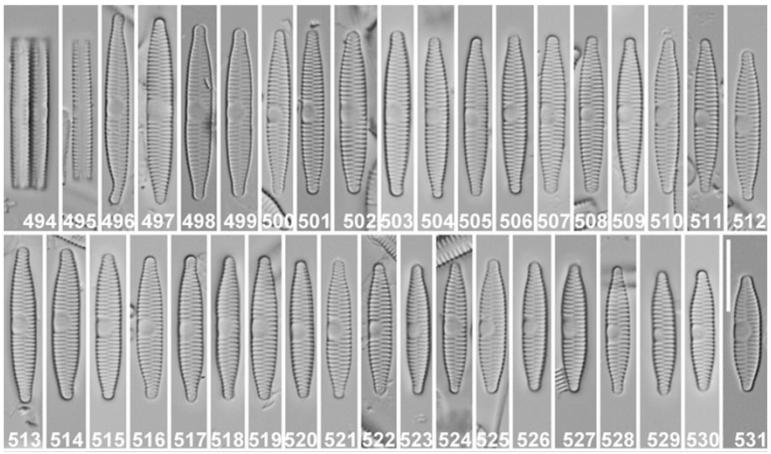


Observed in the plankton of a large Icelandic lake

So far only found in ICELAND

(Van de Vijver et al., 2023)

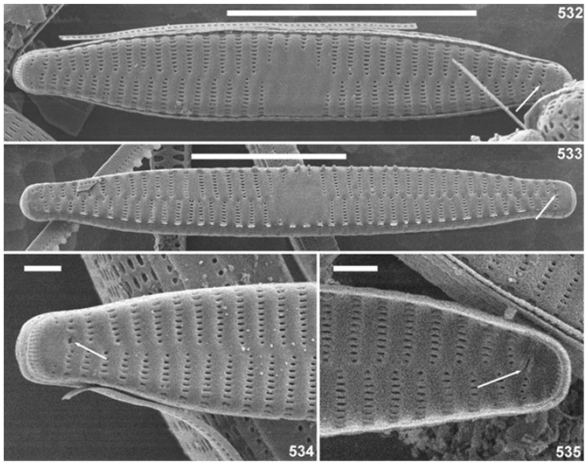
Fragilaria vandekerckhoveana Van de Vijver in VdVijver et al.



valves linear to weakly linear-lanceolate, broadly rounded to rostrate apices
length 16–28 µm, width 3.0–4.0 µm
sternum very narrow, linear not widening towards the central area
central area large, unilateral, clearly depressed on one side
striae parallel to weakly radiate, 18-19 in 10 µm
spines usually absent, very rarely (<1%) present

(Van de Vijver et al., 2023)

Fragilaria vandekerckhoveana Van de Vijver in VdVijver et al. (2023)



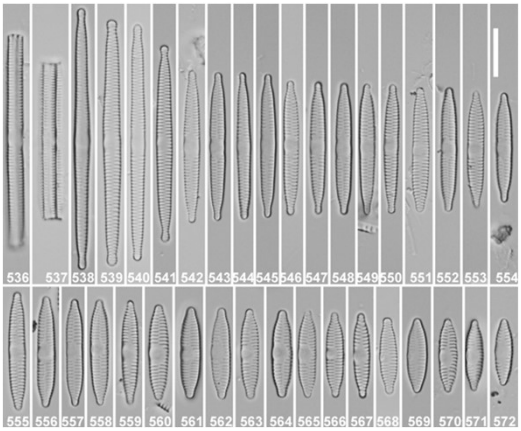
Associated diatom flora points to points to rather alkaline, eutrophic conditions with a high electrolyte content. Most taxa seen occur up to the β-α-mesosaprobic level.

Observed in historic material from Scotland (UK)

(Van de Vijver et al., 2023)

Fragilaria vaucheriaefalsa

Van de Vijver, Kusber & D.M.Williams in VdVijver et al. (2023)



valves linear to linear-lanceolate, weakly protracted, (sub-)rostrate apices
length 16–55 µm, width 3.0–4.0 µm
sternum narrow, weakly widening towards the central area
central area large, forming transverse hyaline area
striae parallel to weakly radiate, 14-16 in 10 µm
continuous series of small but distinct, conical marginal spines present

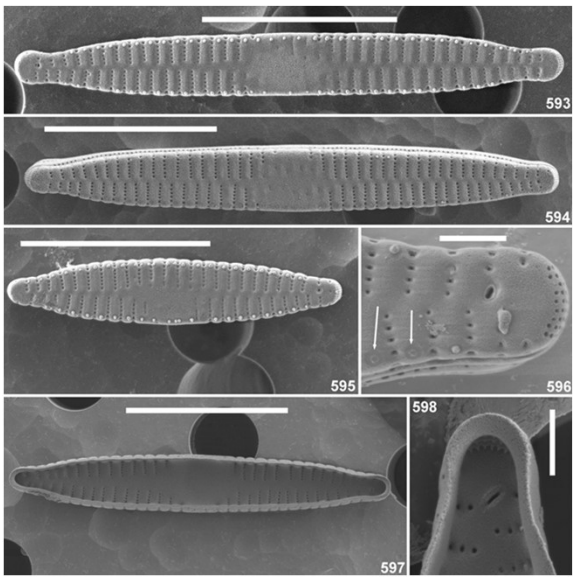
(Van de Vijver et al., 2023)

Fragilaria vaucheriaefalsa

Van de Vijver, Kusber & D.M.Williams in VdVijver et al. (2023)

Associated diatom flora points to more oligo- to mesotraphic and rather eutrophic conditions. The composition also points to more alkaline (even calcium-bicarbonate), mesosaprobic conditions.

Observed in historic material from Scotland and England (UK)



(Van de Vijver et al., 2023)

Comparison table *F. vaucheriae* group

	Fragilaria vaucheriae	*Fragilaria rinoi*	*Fragilaria truncata*	*Fragilaria catenarinoi*	*Fragilaria kellyana*
original reference	Kützing 1833	Delgado et al. 2016	Greville 1827	this study	this study
Figures	1–58	59–164	165–337	338–374	375–412
colonies	no	no	no	short, ribbon-shaped	no
length (µm)	12–50	6–28	15–35	15–40	8–55
width (µm)	3.5–4.5	4.5–6.0	3.5–4.0	3.5–5.0	(3.5)4.0–4.5(5.0)
valve outline	linear in longer valves to linear-lanceolate in smaller specimens with almost parallel to (in smaller specimens) weakly convex margins	linear in the longest valves, but most valves lanceolate to elliptic-lanceolate with clearly convex margins	linear in longer valves to linear-lanceolate in smaller specimens	almost strictly linear in longer specimens, becoming weakly linear-lanceolate in the smaller specimens	linear to weakly linear-lanceolate with parallel margins
apices	clearly protracted, rostrate to sub-capitate	protracted, rostrate, not (sub-)capitate	weakly protracted, rostrate to sub-capitate	clearly but shortly protracted, rostrate	clearly protracted, rostrate to weakly subcapitate
sternum	very narrow but distinct, gradually widening from apices to central area	narrow at the apices, gradually widening towards the central area	narrow but distinct, linear	variable in width ranging from very narrow to moderately broad, gradually widening from the apices towards the central area	narrow, gradually widening from the apices towards the central area
central area	unilateral with broad hyaline zone (rarely depressed or inflated) at one side of the sternum and only very weakly shortened striae at opposite site.	large, unilateral with hyaline zone at one side of the sternum and moderately to strongly shortened striae at opposite site with valves possessing broad central area extending from one margin to another, rarely present	large, usually unilateral with broad hyaline zone (rarely depressed or inflated) at one side of the sternum and clearly shortened striae at opposite site, in larger valves, central area expanded forming a large, transverse hyaline zone	large, spanning the entire valve width in larger valves becoming unilateral, with broad, hyaline zone on one side and weakly to distinctly shortened striae on the opposite side	large, unilateral, with broad, often depressed hyaline zone on one side and weakly to distinctly shortened striae on the opposite side
ghost striae	occasionally present	absent	absent	occasionally present	absent
striae in 10 µm	12–13	14–16	13–14	9–14	14–16
rimoportulae per valve	1	1	1	1	1
spines	Short, conical, non-linking marginal spines	absent, papillae occasionally present	Continuous series of very short, blunt, marginal spines present	large, very irregularly shaped, spines present, entirely surrounding the valve margin linking neighboring valves	Large, irregularly shaped, triangular marginal spines present

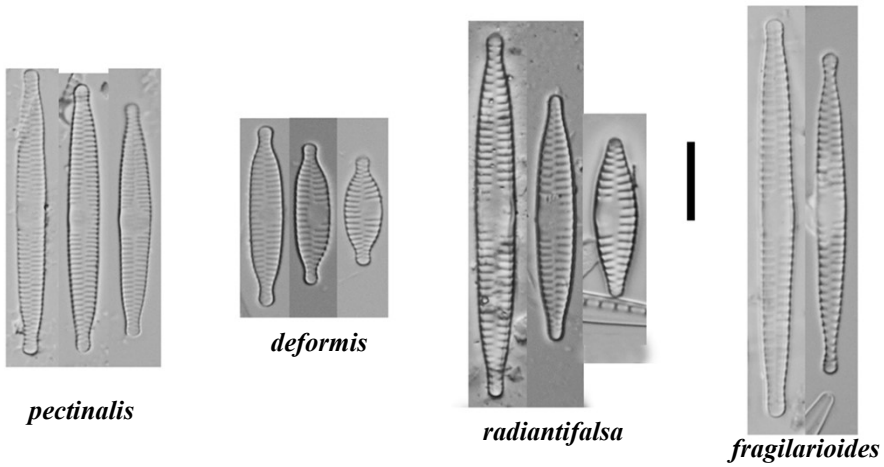
(Van de Vijver et al. 2023)

Comparison table *F. vaucheriae* group

	Fragilaria landnama	*Fragilaria thingvellirensis*	*Fragilaria vandekerckhoveana*	*Fragilaria vaucheriaefalsa*	*Fragilaria vaucheriaerobusta*
original reference	this study	this study	this study	this study	this study
Figures	413–451	452–493	494–535	536–598	599–685
colonies	no	no	no	no	no
length (µm)	16–40	18–50	16–28	18–50	12–55
width (µm)	4.0–4.5	3.0–4.0	3.0–4.0	3.0–4.0	4.0–5.0
valve outline	distinctly lanceolate to occasionally linear-lanceolate with convex margins	linear to linear lanceolate with parallel to weakly convex margins	linear to weakly linear-lanceolate with almost parallel margins	linear to linear lanceolate with parallel to weakly convex margins	linear to weakly linear-lanceolate with almost strictly parallel margins, smallest valves with more lanceolate valve outline
apices	clearly protracted, rostrate, only very rarely weakly subcapitate	clearly protracted, rostrate to subcapitate	weakly protracted, broadly rounded and shortly rostrate to subrostrate	clearly protracted, rostrate to subcapitate	weakly protracted, broadly rounded, rostrate to subrostrate.
sternum	narrow, almost not widening from the apices towards the central area	narrow, linear not widening near the central area	very narrow, linear, not widening towards the central area	narrow, linear not widening near the central area	narrow, almost not widening near the central area
central area	large, unilateral, often buttressed with broad, depressed hyaline zone on one side and weakly to distinctly shortened striae on the opposite side, occasionally, central area almost entirely spanning the valve width	large, unilateral, often buttressed, with broad, often depressed hyaline zone on one side and weakly to distinctly shortened striae on the opposite side, occasionally, central area almost entirely spanning the valve width	area large, unilateral, with broad, often depressed hyaline zone on one side and weakly to distinctly shortened striae on the opposite side	large, unilateral, often buttressed, with broad, often depressed hyaline zone on one side and weakly to distinctly shortened striae on the opposite side, occasionally, central area almost entirely spanning the valve width	large, strictly unilateral, with broad, often depressed hyaline zone on one side and weakly to distinctly shortened striae on the opposite side
ghost striae	absent	absent	ocassionally present	absent	ocassionally present
striae in 10 µm	15–17	16–17	18–19	16–17	15–16
rimoportulae per valve	1	1	1	1	1
spines	absent	continuous series of relatively large, narrow, marginal spines present	usually absent, rarely valves with large, triangular marginal spines present, running almost from apex to apex, but absent at the apices	continuous series of relatively large, narrow, marginal spines present	small in the type population, irregularly shaped, well-developed in conspecific populations

(Van de Vijver et al. 2023)

5. Some minor problems solved



Fragilaria pectinalis (O.F.Müller) Lyngbye 1819

Basionym: ***Conferva pectinalis*** **O.F.Müller 1788**

- **Cells never forming ribbon-like colonies, occasionally 2 cells linked**
- **Valves linear, sometimes narrowly linear-lanceolate**
- **Apices subcapitate to subrostrate**
- **Length 20-35 µm, width 3.5-5.0 µm**
- **sternum narrow**
- **Central area unilateral, forming a small, rounded fascia**
- **Striae alternate, parallel throughout, 14-15 in 10 µm**
- **Small spines present**

Original description

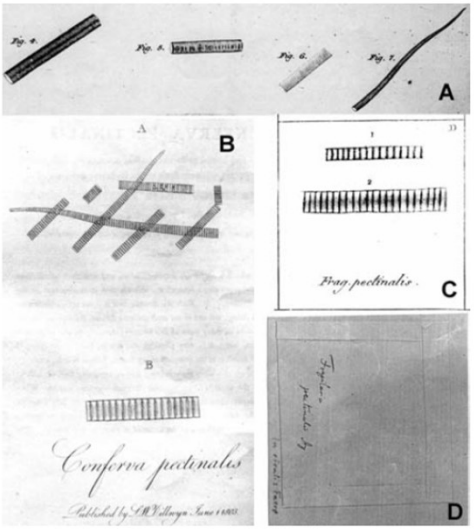


Fig. 1. A, *Conferva pectinalis*, reproduced from Müller (1788, figs. 4–7). B, *Conferva pectinalis*, reproduced from Dillwyn (1802 in 1802-1809, Pl. 24, figs. A, B). C, *Fragilaria pectinalis*, reproduced from Lyngbye (1819, Tab. 63, Fig. D1, 2). D, The envelope labelled "*Fragilaria pectinalis* Ag." housed in C.

TAXON 55 (1) • February 2006: 193–199 Tuji & Williams • Typifications in *Conferva* and *Fragilaria*

NOMENCLATURE

Edited by John McNeill, Scott A. Redhead & John H. Wiersema

Typification of *Conferva pectinalis* O. F. Müll. (*Bacillariophyceae*) and the identity of the type of an alleged synonym, *Fragilaria capucina* Desm.

Akihiro Tuji[1,2] & David M. Williams[2]

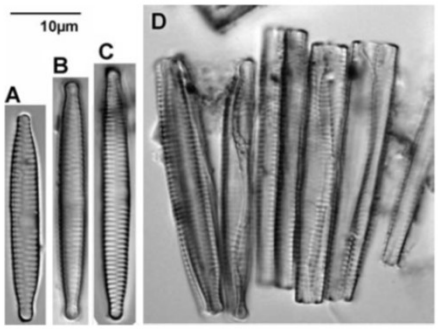
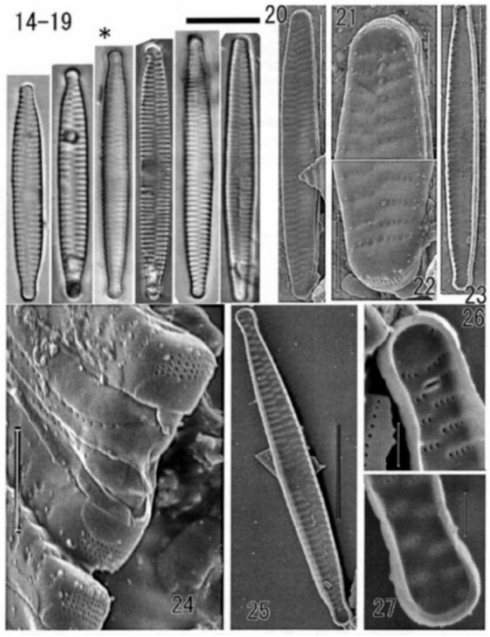


Fig. 4. *Conferva pectinalis*; B, epitype specimen (designated here). A–C, other valves; D, sibling frustules in girdle view, possibly dissociated from a colony. Specimens from original Dillwyn material, BM 101152.

Fragilaria pectinalis

(Tuji & Williams 2006)

Type material



NINETEENTH INTERNATIONAL DIATOM SYMPOSIUM 2006
Listvyanka, Russia (Y. Likhoshway, ed.), pp. 125–139
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Examination of types in the *Fragilaria pectinalis–capitellata* species complex

Akihiro Tuji*

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Department of Botany, Natural History Museum, Cromwell Road, London SW7 5BD, U.K.

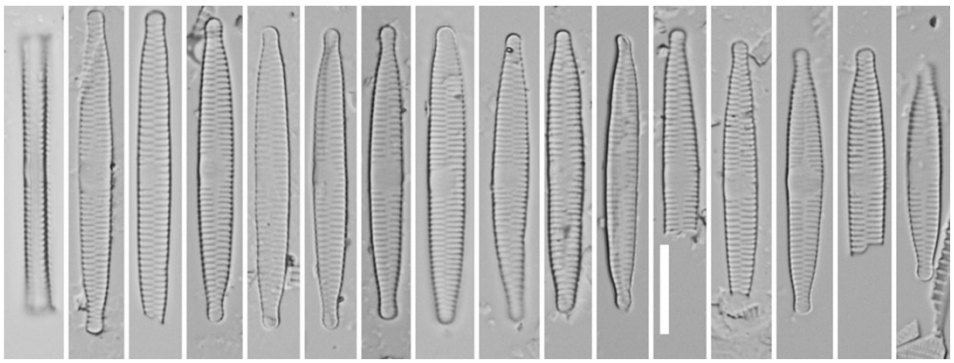
Fragilaria pectinalis

***Conferva pectinalis* O.F.Müller**
Epitype and isoepitype material

(Tuji & Williams 2008)

Type material

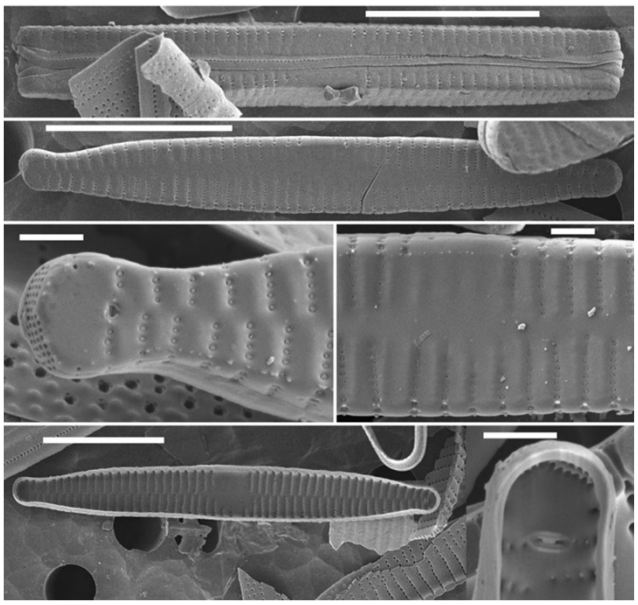
Fragilaria pectinalis



***Conferva pectinalis* O.F.Müller**
Epitype and isoepitype material

Type material

Fragilaria pectinalis

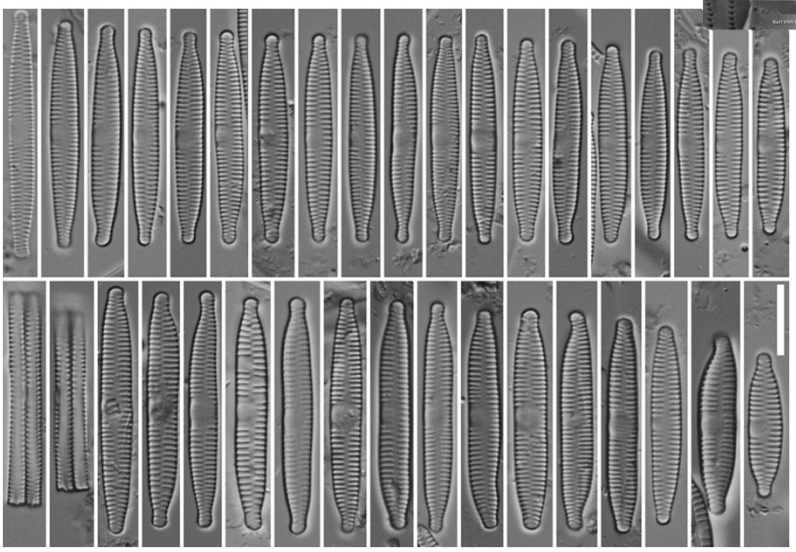


***Conferva pectinalis* O.F.Müller - Epitype and isoepitype material**

NOT type material

Verified and confirmed populations

Fragilaria pectinalis



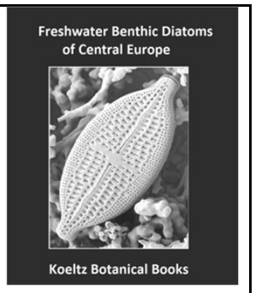
Kleine Nete, Belgium

Lower series = teratologic valves (frequent)

(Van de Vijver et al. 2020)

Other populations

Fragilaria* X *pectinalis



Figs 5-7: ***Fragilaria pectinalis*** (O.F. Müller) Lyngbye

Lange-Bertalot et al. 2017, p. 275, plate 10, figs 5-7

Fresh material: Cells often form band-like colonies. Outline: Girdle view: Frustules linear-rectangular. Valve: Linear, sometimes narrowly linear-lanceolate. Ends: Subrostrate to subcapitate.

Dimensions: Length 28-37 µm, width 3.5-4 µm. Striae: 14-15/10 µm, usually interrupted at the centre by a unilateral Central area.

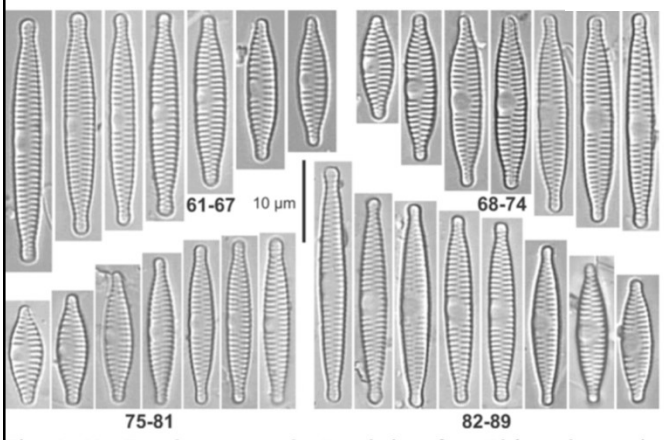
Other populations

Fragilaria X *pectinalis*

Cryptogamie, Algologie, 2015, 36 (3): 271-289

Taxonomy and ecology of *Fragilaria microvaucheriae* sp. nov. and comparison with the type materials of *F. uliginosa* and *F. vaucheriae*

Carlos E. WETZEL* & Luc ECTOR



France

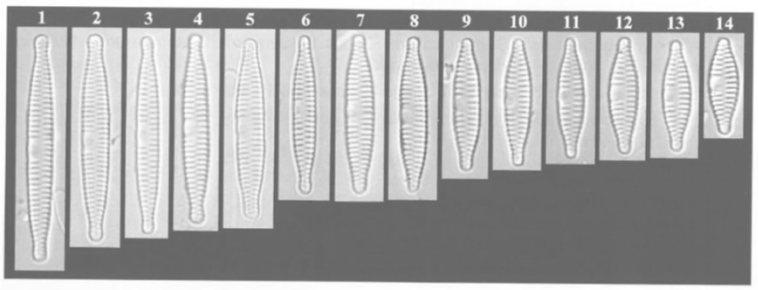
Figs 61-89. *Fragilaria pectinalis*. Populations from Rhône-Alpes region (France). **61-67.** Drôme River at Livron-sur-Drôme (04.07.2007), **68-74.** Romanche River at Le Bourg d'Oisans (04.04.2007), **75-81.** Eygues River at Saint-Maurice-sur-Eygues (28.06.2011), **82-89.** Beaume River at Rosières (18.05.2011).

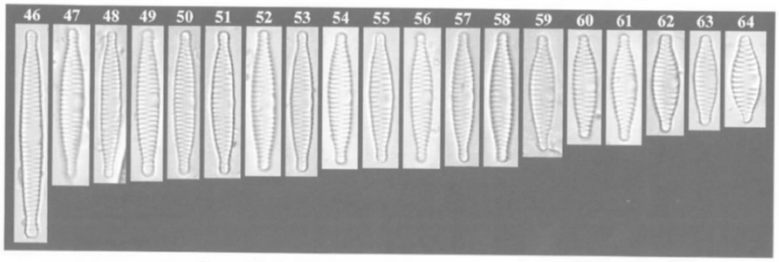
Wetzel & Ector (2015)

Other European populations

Fragilaria X *pectinalis*

France





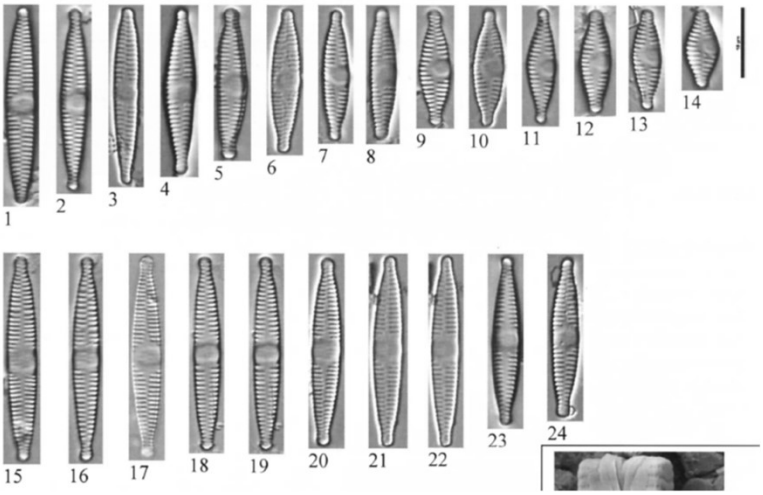
Figures 46 à 64 : rivière l'Eygues à Saint Maurice (06117100 : 28.06.2011)

(Bey & Ector 2013)

Other European populations

Fragilaria X pectinalis

France



Figs 1-27 : Le Méchet à Saint-Prix 2013

(Peeters & Ector 2017)

Ecology

Fragilaria X pectinalis

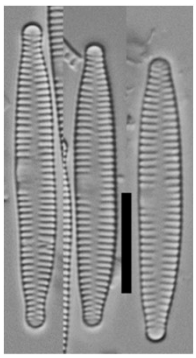
<u>Bey & Ector (2013)</u>
- **observed in rivers with good water quality**
- **ecology not clear however**

<u>Wetzel & Ector (2015)</u>
- **preference for hard water**
- **relatively good water quality**
- **poorly mineralized rivers**
- **low to medium conductivity (38-499 µS/cm)**
- **high nitrate concentrations**

<u>Lange-Bertalot et al. (2017)</u>
- **difficult to assess**

<u>Peeters & Ector (2017)</u>
- **ecology not defined**

Can be confused with



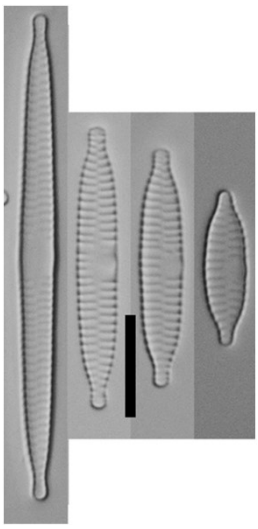
***Fragilaria pectinalis* has**

less protracted apices

very parallel margins

higher stria density

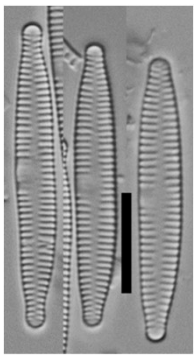
clear spot in central area



F. pectinalis
L 20-35 µm
W 3.5-5 µm
S 14-15 in 10 µm

F. vaucheriae
L 14-50 µm
W 4-5 µm
S 11-14 in 10 µm

Can be confused with



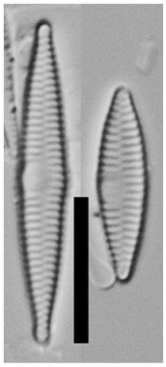
***Fragilaria pectinalis* has**

lanceolate valves

smaller dimensions

lower stria density

less protracted apices



F. pectinalis
L 20-35 µm
W 3.5-5 µm
S 14-15 in 10 µm

F. perminuta
L 7.5-32 µm
W 3-3.5 µm
S 18-20 in 10 µm

Fragilaria deformis (W.Smith) Van de Vijver & Ector 2020

Basionym: ***Synedra deformis*** **W.Smith 1853**
Synonym: ***Fragilaria candidagilae*** **Almeida et al. 2015**

- **Cells solitary, never producing ribbon-like colonies**
- **Valves rectangular, linear to elliptical (smaller) with parallel margins**
- **Strongly capitate apices**
- **Length 13-29 µm, width 4.5-5.0 µm**
- **sternum narrow**
- **Central area unilateral, very wide fascia**
- **Striae alternate, parallel in the middle, slightly radiate near the apices, 14-16 in 10 µm**
- **Spines absent**

Original description

Fragilaria deformis

A SYNOPSIS

OF THE

BRITISH DIATOMACEÆ;

WITH REMARKS

ON THEIR

STRUCTURE, FUNCTIONS AND DISTRIBUTION;

AND INSTRUCTIONS FOR

COLLECTING AND PRESERVING SPECIMENS.

BY

WILLIAM SMITH, F.L.S.,

THE PLATES

BY

TUFFEN WEST,

IN TWO VOLUMES.
VOL. II.

LONDON:
PRINTED FOR SMITH AND BECK, 6 COLEMAN STREET, CITY;
PUBLISHED BY JOHN VAN VOORST, PATERNOSTER ROW.
1856.

no image

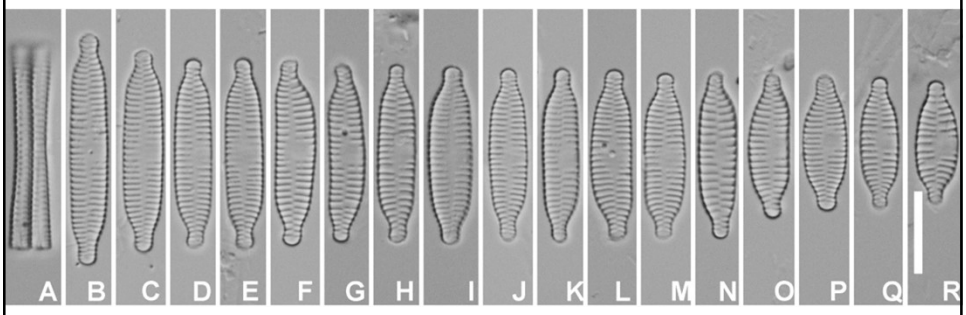
60. **Synedra deformis,** n. sp. Frustules direct; nodule obsolete; valve linear or linear-elliptical, suddenly constricted towards the produced and often distorted extremities; striæ 36 in ·001″. Length ·0005″ to ·0008″. Breadth of valve ·0002″. v.v.

Fresh water. Lewes, Sussex, March 1853, *W. Sm.*

(Smith 1856)

Type material

Fragilaria deformis

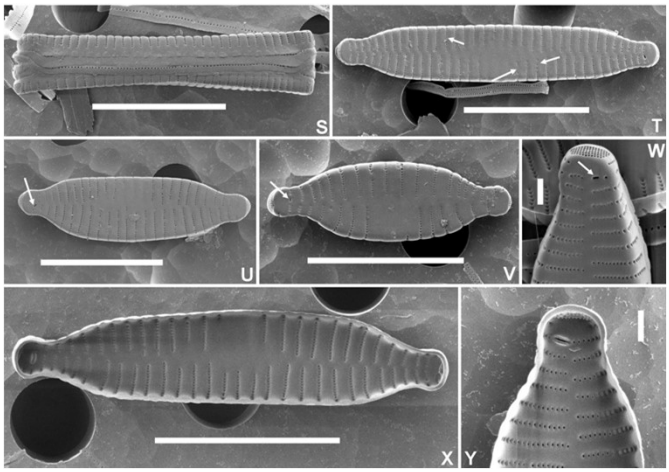


***Synedra deformis* W.Smith**
Sussex, Lewes, P. Mill Pond, UK

(Van de Vijver et al. 2020)

Type material

Fragilaria deformis



***Synedra deformis* W.Smith**
Sussex, Lewes, P. Mill Pond, UK

(Van de Vijver et al. 2020)

Fragilaria candidagilae = F. deformis

Phytotaxa 231 (1): 001–018
www.mapress.com/phytotaxa/
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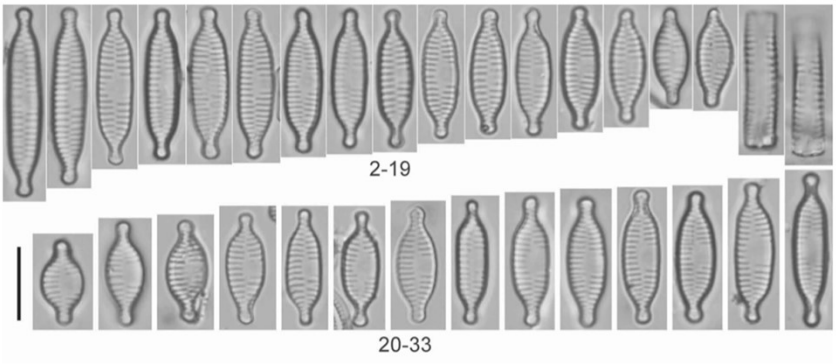
Article

PHYTOTAXA

http://dx.doi.org/10.11646/phytotaxa.231.1.1

Examination and comparison of *Fragilaria candidagilae sp. nov.* with type material of *Fragilaria recapitellata, F. capucina, F. perminuta, F. intermedia* and *F. neointermedia* (Fragilariales, Bacillariophyceae)

CRISTINA DELGADO[1], M. HELENA NOVAIS[2], SAÚL BLANCO[3] & SALOMÉ F.P. ALMEIDA[1]



Description:—Valves linear-lanceolate to elliptical, with strongly capitate apices (Figs 2–17). Frustules rectangular in girdle view with interruption of striation in the middle portion due to absence of striae (Figs 18, 19, 37). Valve dimensions (n=30): Length 13.0–25.8, width 4.5–5.0, striae density 12–14 in 10 µm. Striae alternate, punctuate and parallel in the central part to slightly radiate near the ends (Figs 34–39). Striae are continuous from the valve face onto the mantle (Figs 37 and 39). Central area unilaterally expanded from the axial area to the valve face margin. Siliceous plaques are present along the valve mantle edge (Figs 37, 39). Narrow axial area (Figs 2–33). Striae uniseriate, composed of round areolae (7 areolae in 1 µm) on both valves (Figs 34–39). Each valve has two apical pore fields (APF) that are of the ocellulimbus type and made up of 6 to 7 rows, each composed of 8 to 14 poroids (Fig. 39). Frequently isolated, cells without spines and rimoportulae occur near the poles, one per valve (Fig. 34–36, 38). Girdle bands open with perforations (Figs 36, 37). A rimoportula is present and might vary from apically oriented (Fig. 34) to almost transapical orientation (Figs 35–36). Siliceous depositions on outer areolar openings in the form of rounded floating disks cover almost all the areolae openings (Figs 34, 38). Inner areolar openings without siliceous depositions (Figs 35, 36).

(Delgado et al. 2015)

Other European populations

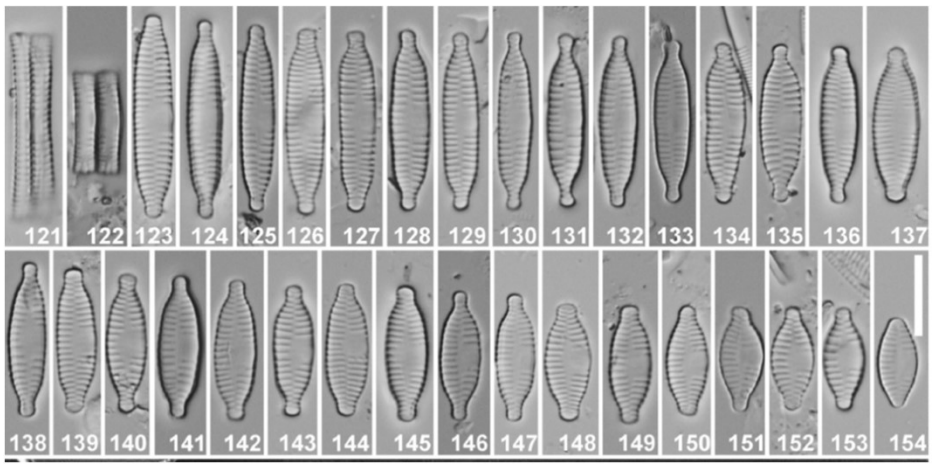
Fragilaria deformis

Diatom Research, 2021
https://doi.org/10.1080/0269249X.2021.1942221

Taylor & Francis

***Fragilaria subrecapitellata* (Fragilariaceae, Bacillariophyta), a new diatom species from Switzerland**

BART VAN DE VIJVER [1,2], JOACHIM HÜRLIMANN[3], DAVID M. WILLIAMS [4], ZLATKO LEVKOV [5], CARLOS E. WETZEL [6] & LUC ECTOR [6]



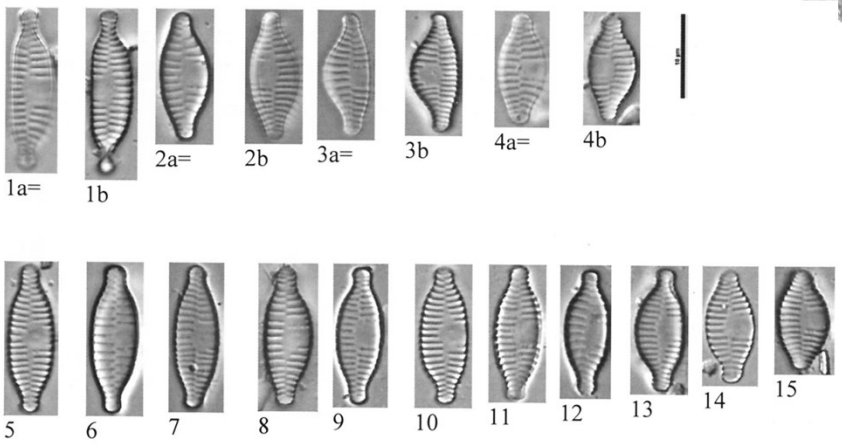
Figs 121–157. *Fragilaria deformis* Van de Vijver & Ector. LM and SEM images taken from Nadelburg, Austria (sample Grunow 118).

Van de Vijver et al. (2021)

Other European populations

Fragilaria deformis (as *F. candidagilae*)

France



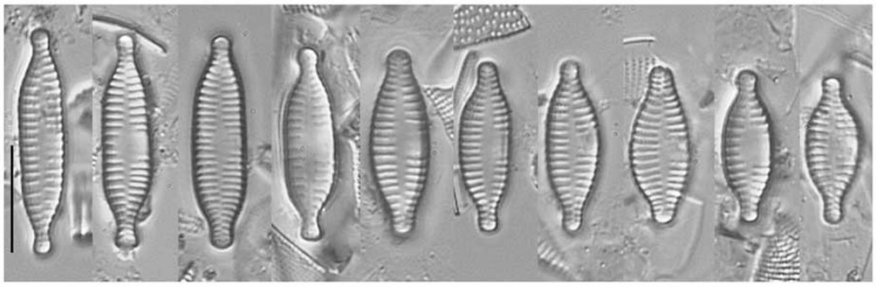
Figs 1-15 : Le Vrin à la Ferté Loupière 2010

(Peeters & Ector 2017)

Other European populations

Fragilaria deformis (as *F. candidagilae*)

Scotland



Comerton Burn, Newtyle; Boyndie Burn, Aberdeenshire, Scotland

DIATOM FLORA OF BRITAIN AND IRELAND

Ecology

Fragilaria deformis

Delgado et al. (2016) as *F. candidagilae*

- epilithic species
- neutral-alkaline pH (7.0–8.3)
- poorly mineralized rivers
- low to medium conductivity (89.9–457.0 µS/cm)
- low nitrates (< 1.5mg/l) & nitrites (0.1 mg/l)
- low ammonium (0.1 mg/l)

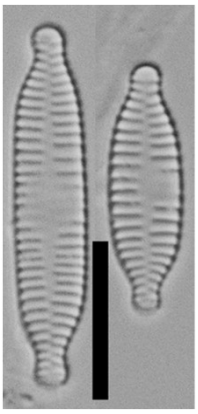
Lange-Bertalot et al. (2017) (as *F. recapitellata*)

- larger rivers
- up to eutrophic conditions
- alpha-mesosaprobic

Van de Vijver et al. (2020)

- circumneutral to alkaline
- eutrophic
- α-mesosaprobic conditions

Can be confused with



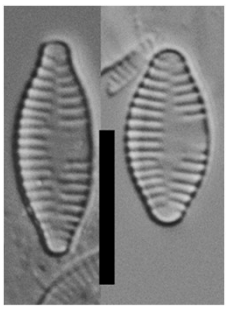
F. deformis
L 13-29 µm
W 4.5-5 µm
S 14-16 in 10 µm

***Fragilaria deformis* has**

less regular valve outline

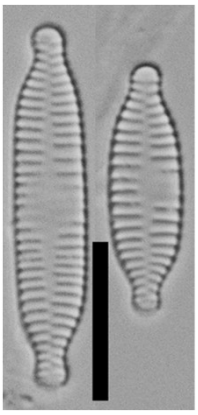
parallel margins

elongated, protracted apices



F. rinoi
L 9-24 µm
W 4-5.5 µm
S 14-16 in 10 µm

Can be confused with

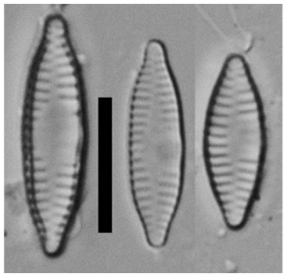


Fragilaria deformis has

lower stria density

less regular valve outline

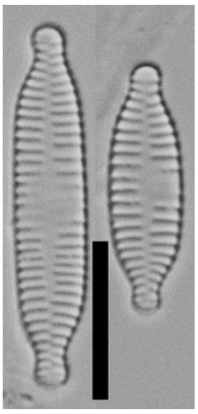
elongated, protracted apices



F. deformis
L 13-29 µm
W 4.5-5 µm
S 14-16 in 10 µm

F. microvaucheriae
L 6-24 µm
W 2.5-4.0 µm
S 15-16 in 10 µm

Can be confused with

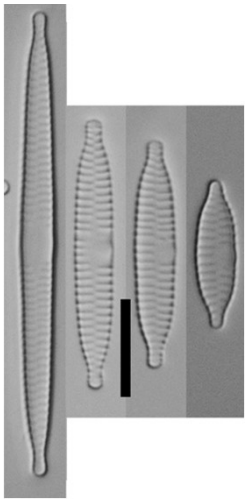


Fragilaria deformis has

higher stria density

less regular valve outline

shorter valves



F. deformis
L 13-29 µm
W 4.5-5 µm
S 14-16 in 10 µm

F. vaucheriae
L 14-50 µm
W 4-5 µm
S 11-14 in 10 µm

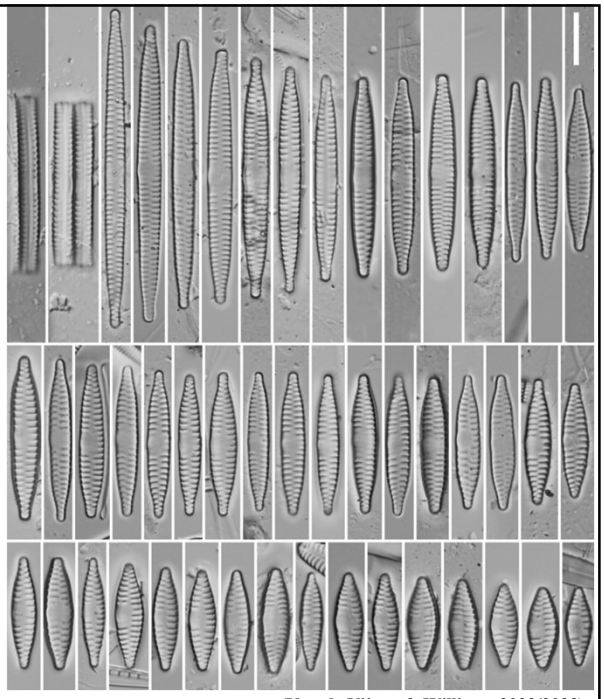
Fragilaria radiantifalsa Van de Vijver & D.M.Williams 2022/2023

To exclude as synonym: *Fragilaria radians (*Kützing) D.M.Williams & Round sensu Krammer & Lange-Bertalot 1991

- **cells solitary or joined in pairs**
- **valves linear to weakly lanceolate (larger specimens), distinctly lanceolate to rhombic-lanceolate (smaller valves)**
- **apices protracted, rostrate (large specimens) to cuneately rounded (smaller valves)**
- **length 15-55 µm, width 4.0-6.0 µm**
- **sternum narrow, linear**
- **central area very large, asymmetrical, often buttressed**
- **striae alternate, parallel throughout, 10-11 in 10 µm**
- **spines rudimentary or flattened**

Type population

Fragilaria radiantifalsa

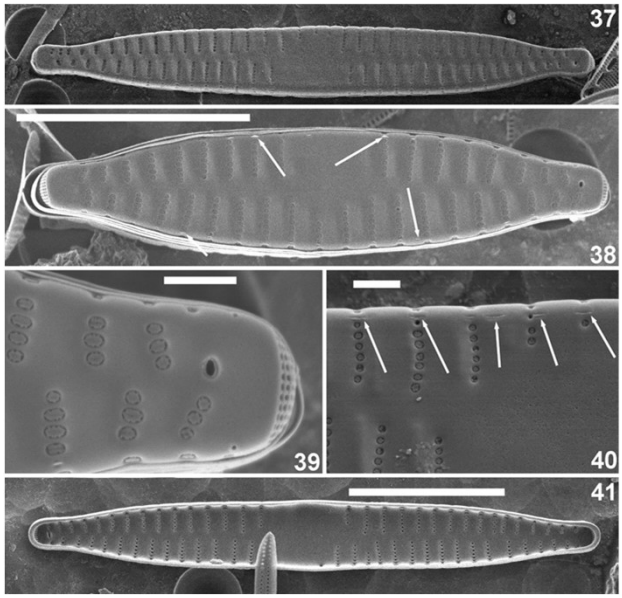


sample APM19-003
Kanaal Gent-Oostende, Lievegem (Belgium)
coll. date 12 IV 2019
leg. Vlaamse Milieu Maatschappij

(Van de Vijver & Williams 2022/2023)

Type population

Fragilaria radiantifalsa

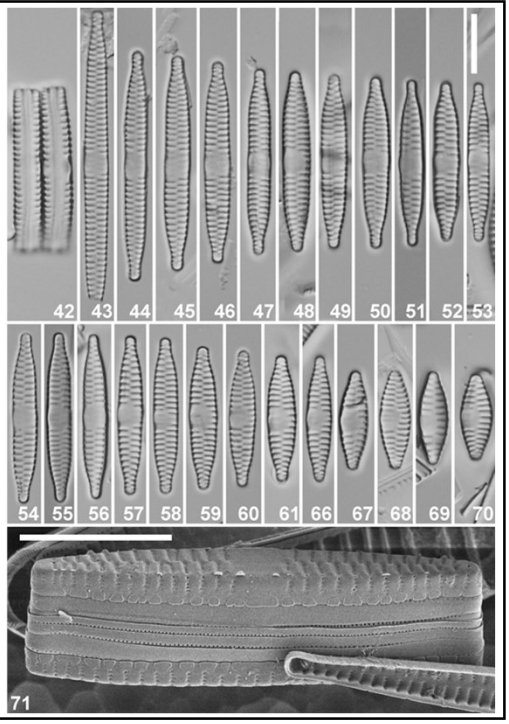


sample APM19-003
Kanaal Gent-Oostende,
Lievegem (Belgium)
coll. date 12 IV 2019
leg. Vlaamse Milieu Maatschappij

(Van de Vijver & Williams 2022/2023)

Other European populations

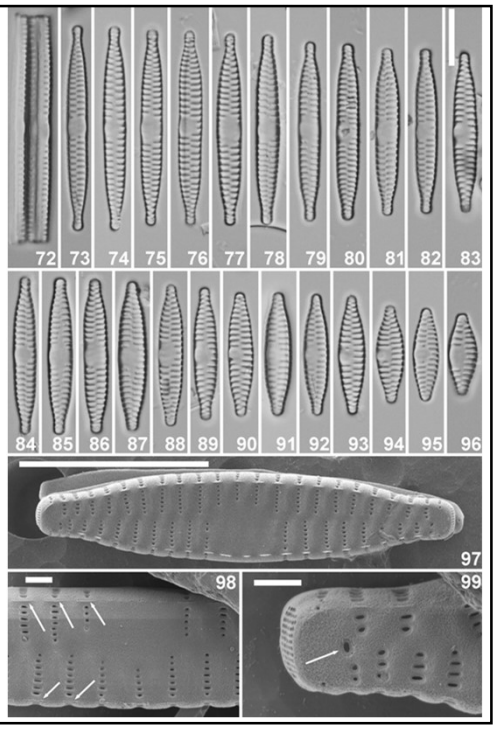
Fragilaria radiantifalsa



Walke Arnott sample 146
Loch Leven near Kinross
(Scotland, UK)
Coll. date 7 X 1854

Other European populations

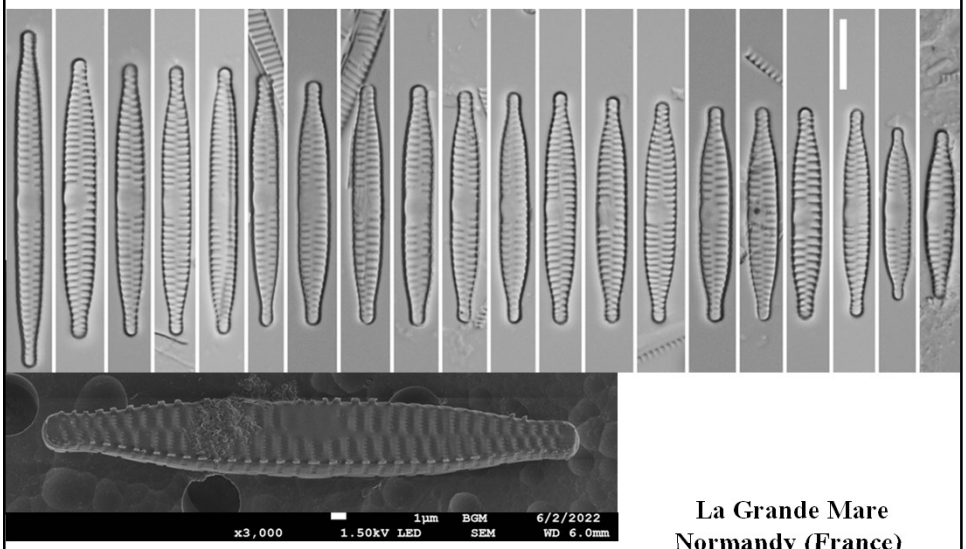
Fragilaria radiantifalsa



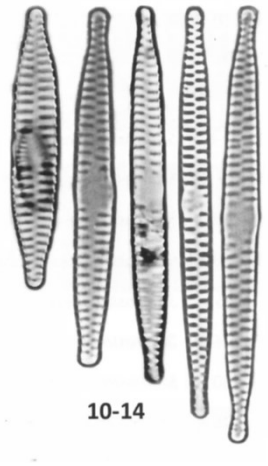
Walke Arnott sample 307
Kinross near the lake
(Scotland, UK)
Coll. date 3 XI 1855

Other European populations

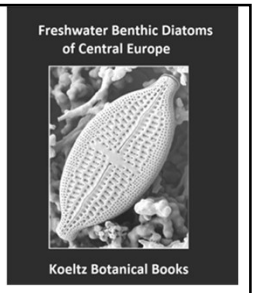
Fragilaria radiantifalsa



La Grande Mare
Normandy (France)
Leg. Servanne Quiniou



Fragilaria radiantifalsa



as *F. radians*

Lange-Bertalot et al. 2017, p. 273, plate 10, figs 10-14

Figs 10-14: ***Fragilaria radians*** (Kützing) Williams et Round

Fresh material: Cells form radial tufts on filamentous algae. Outline: Valve: Linear, tapering from the centre to drawn out subcapitate Ends.

Dimensions: Length 35-55 µm, width 3.5-4.5 µm at the centre, 2-2.5 µm at the ends. Striae: Relatively coarse, 9-11/10 µm, alternate (not opposite). Puncta: Not resolvable with LM.

Ecology

Fragilaria radiantifalsa

Lange-Bertalot et al. (2017)

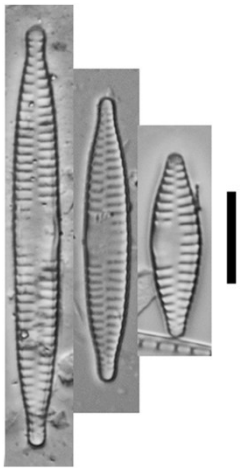
- **not well understood**
- **found in lakes on carbonate substrate**
- **often together with *F. capucina*, *F. perminuta*, *F. austriaca***

Van de Vijver & Williams (2022/2023)

The species composition in the type slide points to eutrophic, alkaline conditions in electrolyte-enriched lakes and rivers

- **high conductivity values (almost 1000 µS/cm)**
- **alkaline pH (7.8)**
- **high TN (6.5 mg/l) and moderately high TP (0.4 mg/l) values**
- **high Cl^{-1} (114 mg/l) and $SO4^{-2}$ values (96 mg/l)**
- **typical for low water quality**

Can be confused with



Fragilaria radiantifalsa has

lower stria density

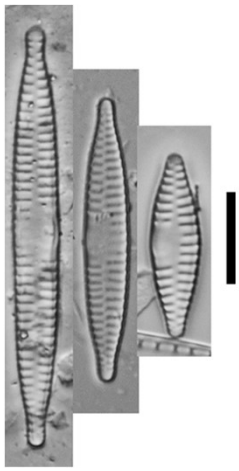
shorter valves
(lower L/W ratio)

well-developed
central area

F. radiantifalsa
L 15-55 µm
W 4.0-6.0 µm
S 10-11 in 10 µm

F. amphicephaloides
L 40-75 µm
W 2-3 µm
S 10-14 in 10 µm

Can be confused with

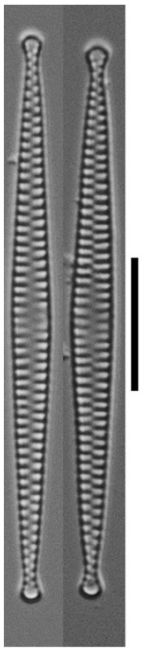


Fragilaria radiantifalsa has

lower stria density

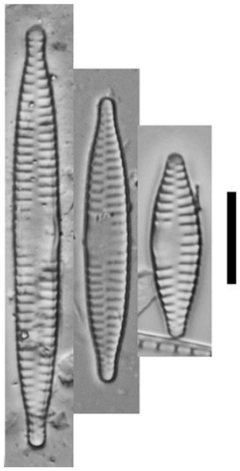
parallel valve margins

well-developed
central area



F. radiantifalsa
L 15-55 µm
W 4.0-6.0 µm
S 10-11 in 10 µm

F. austriaca
L 25-63 µm
W 3-4 µm
S 12-15 in 10 µm



F. radiantifalsa
L 15-55 µm
W 4.0-6.0 µm
S 10-11 in 10 µm

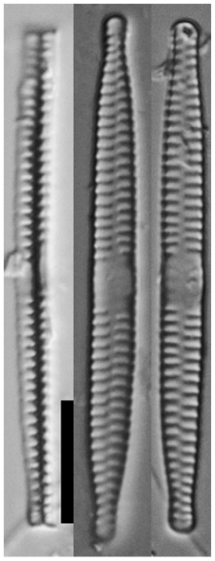
Can be confused with

***Fragilaria radiantifalsa* has**

smaller valves always distinctly (rhombic-) lanceolate

broader valves

no colonies observed



F. fragilarioides
L 35-45 µm
W 3.5-4 µm
S 10-11 in 10 µm

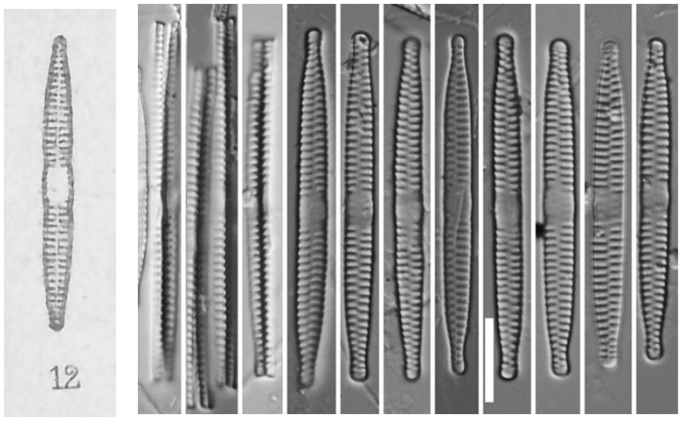
Fragilaria fragilarioides (Grunow) Cholnoky 1963

Basionym: *Synedra rumpens* var. *fragilarioides* Grunow in Van Heurck 1881
Synonyms: *Synedra vaucheriae* var. *distans* Grunow in Van Heurck 1881, *Fragilaria rumpens* var. *fragilarioides* (Grunow) A.Cleve 1953, *Fragilaria capucina* var. *fragilarioides* (Grunow) Ludwig & Flores 1997, *Fragilaria distans* (Grunow) Bukhtiyarova 1995

- **Cells forming ribbon-like colonies**
- **Valves linear, tapering to apices**
- **Apices protracted, capitate to subcapitate**
- **Length 30-45 µm, width 3.5-4.0 µm**
- **Sternum narrow, linear**
- **Central area well-developed, often swollen fascia, ghost striae present**
- **Striae alternate, parallel throughout, 10-11 in 10 µm**
- **Spines present (forming colonies)**

Original description

Fragilaria fragilarioides



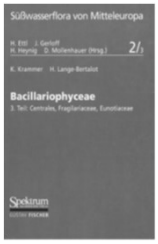
Type material Collection Grunow 30484

12. S. RUMPENS VAR ? FRAGILARIOIDES GRUN.*
Ayant 10 à 10 1/2 stries en 0,01 mm.

(Grunow in Van Heurck 1881)

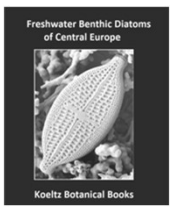
Fragilaria fragilarioides

Synonym of *Fragilaria radiantifalsa ("radians")* ?



1.9 distans/fragilarioides-Sippen (Fig. 109: 16; Fig. 113: 16–21)
Synedra vaucheriae var. *distans* Grunow in Van Heurck 1881; *Synedra rumpens* var. *fragilarioides* Grunow in Van Heurck 1881

Schalen wie bei var. *vaucheriae* sensu stricto, durchschnittlich jedoch längere, lineare Schalen, Str. durchschnittlich noch weiter gestellt, um 10/10 µm (vgl. aber auch *radians*- und *amphicephala*-Sippen).
Ökologischer Schwerpunkt infolge von Abgrenzungsproblemen noch nicht genauer bekannt, jedenfalls nicht in stärker mit Abwasser belasteten Flüssen.
Diese Sippen bleiben bezüglich ihres Variabilitätsspektrums noch genauer zu untersuchen.



■ ***Fragilaria radians*** (Kützing) Will… Round… 987

Plate 10: 10-14

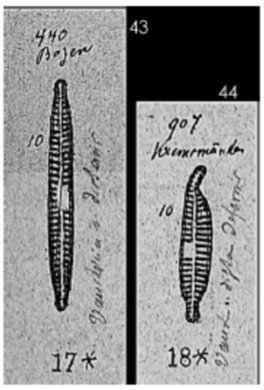
Syn. *Fragilaria capucina radians* morphotype s… ammer et Lange-Bertalot 1991, *Fragilaria distans/fragilarioides*-populations sensu Krammer et … talot 1991, *Fragilaria capucina distans* morphotype sensu Krammer et Lange-Bertalot 1991

Syn. (?) *Synedra vaucheriae* var. *distans* Grun… in Van He… 81

X

***Fragilaria radiantifalsa* = NO colonies**
***Fragilaria fragilarioides/distans* = colonies**

Synedra vaucheriae var. *distans* Grunow in van Heurck, *Synopsis des diatomées de Belgique pl. 40. f. 17.* 1881.
Type: slide 440 in Grunow collection (not located).



Figs. 43, 44. Van Heurck's annotated book plate 40 figs 17 and 18 in Van Heurck (1881). 17. *Synedra vaucheriae* var. *distans* Grunow. 18. *Synedra vaucheriae* var. *deformis* Grunow.

Bull. Natl. Mus. Nat. Sci., Ser. B, 39(1), pp. 1–9, February 22, 2013

Examination of Types in the *Fragilaria vaucheriae–intermedia* Species Complex

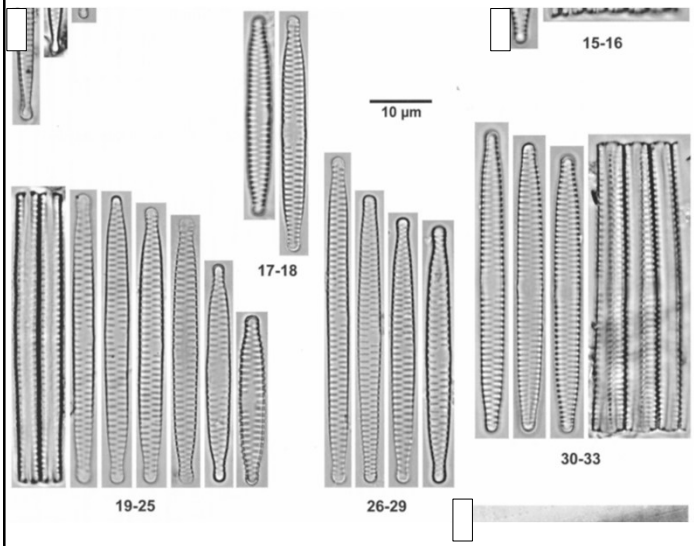
Akihiro Tuji[1]* and David M. Williams[2]

In Van Heurck's annotated copy of *Synopsis des diatomées de Belgique* (GVHS: Plate 40 Fig. 17 from Van Heurck, 1881), Grunow registered '440' for this taxon (Fig. 43). However, no slide has been found with that number. The illustration Van Heurck (1881, Plate 40, Fig. 17) provided agrees with the current concept of *F. vaucheriae*, hence *Synedra vaucheriae* var. *distans* should be considered a synonym of *F. vaucheriae*.

Material found!
No synonym with *F. vaucheriae*!
Formation of colonies!

Other European populations

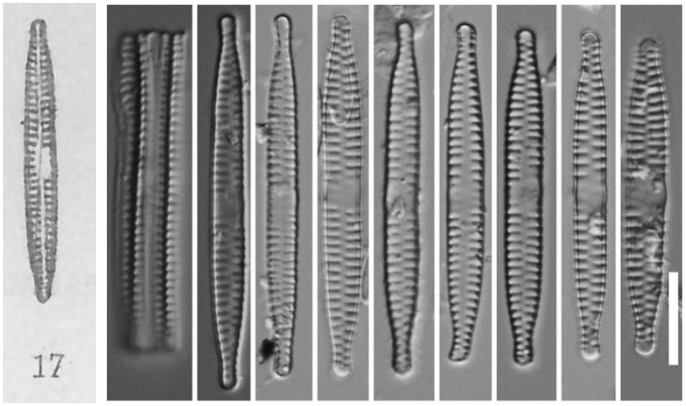
Germany ***Fragilaria fragilarioides***



Identified as *Fragilaria distans*

(Reichardt 2018)

Fragilaria distans is a younger (heterotypic) synonym



17. S. VAUCHERIAE VAR DISTANS GRUN.* 10 stries en 0,01 mm.

Type material
Collection Grunow 440

Grunow in Van Heurck (1881)

New combination at species level:
***Fragilaria fragilarioides* (Grunow) Cholnoky 1963**
***Fragilaria distans* (Grunow) Bukhtiyarova 1995**

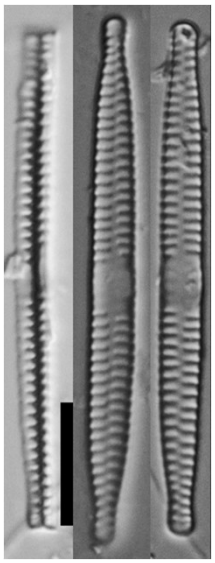
Ecology

Fragilaria fragilarioides

Van de Vijver et al. (2022)

Type slide dominated by *Gomphonema parvulum, G. italicum, Nitzschia amphibia, N. paleacea* and *Rhoicosphenia abbreviata.*

According to Lange-Bertalot et al. (2017), the species composition in the type slide is typical for meso- to eutrophic, β-α-mesosaprobic conditions with higher electrolyte contents.



F. fragilarioides
L 35-45 µm
W 3.5-4 µm
S 10-11 in 10 µm

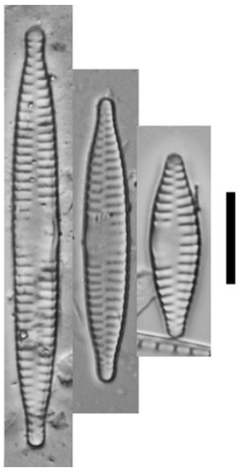
Can be confused with

***Fragilaria fragilarioides* has**

narrower valves

colonies!

smaller valves linear, not lanceolate



F. radiantifalsa
L 15-55 µm
W 4.0-6.0 µm
S 10-11 in 10 µm

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