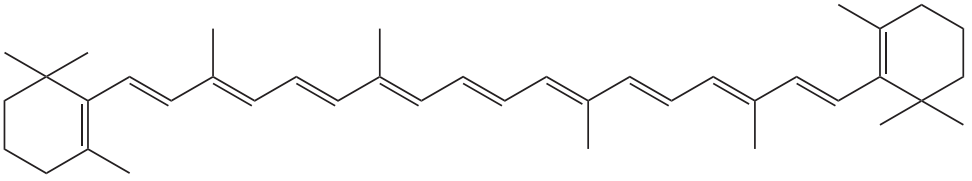
2 Carotenes

β,β-Carotene

Recommended abbreviation: ββ-Car (ββ)

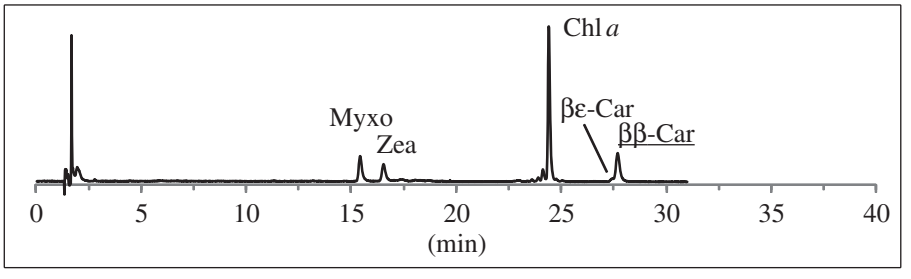
IUPAC: β,β-Carotene (trivial name: β-Carotene)

Molecular formula: $C_{40}H_{56}$ **Molecular weight**: 536.87

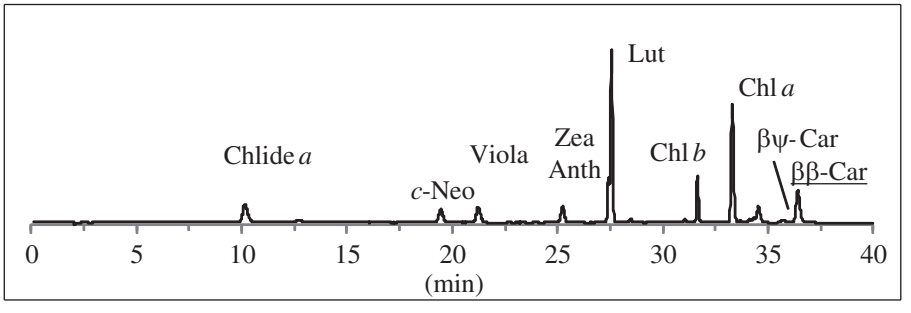


Biological occurrence	Dominant pigment in chlorophytes, prasinophytes, mesostigmatophytes, rhodophytes and one group of dinoflagellates. Minor in all other algal groups. Also present in plants (notably carrots) [78]
Source culture	*Pavlova lutheri* (Pavlovophyceae)
Alteration products	*Cis*-isomers
Biosynthetically related to	Cantha, Asta, Zea, Viola, Neo, Diato, Diadino, Allo etc.
Occurs together with	

HPLC chromatogram of *Synechococcus* sp. (system 1)



HPLC chromatogram of *Dunaliella salina* (system 2)

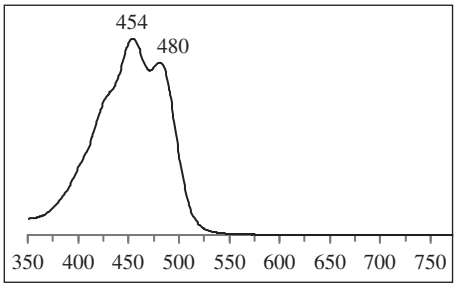


UV-Vis spectra (see also reference spectra below)

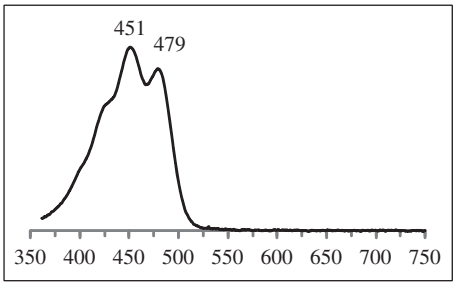
Solvent	λ_{max} (nm)	Band ratio (% III:II)	Ref.
Acetone	(427), *454*, 480	21	[96]
Diethyl ether	(430), *447*, 476	5	[133]
Ethanol (see Remarks)	(428), *451*, 480	27	[86]
Hexane	(425), *451*, 477	29	[96]
Methanol (see Remarks)	(429), *449*, 475	25	[160]
Recommended specific absorption coefficient *d* (L g^{-1} cm^{-1})		259 (at 453 nm, hexane) [103] 250 (at 454 nm, acetone) [96]	

Reference spectra

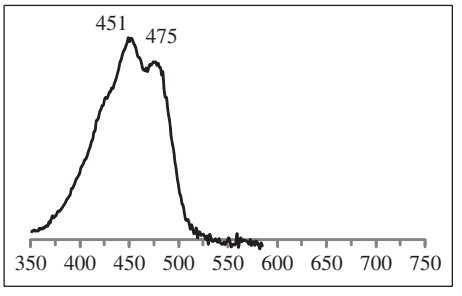
In acetone



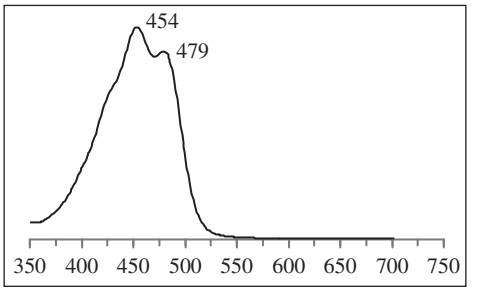
In hexane



In HPLC solvent system 1



In HPLC solvent system 2



Mass spectra

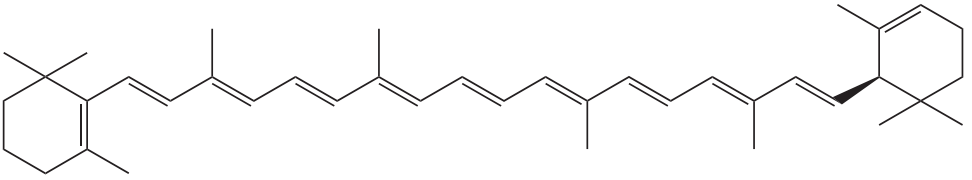
Ionization technique	Mass analyser type	Diagnostic ions (m/z, rel. intensity)	Ref.
EI	Magnetic sector	536 $[M]^+$ (44), 444 $[M-92]^+$ (15), 430 $[M-106]^+$ (4), 119 (72), 109 (22), 91 (45), 83 (23), 69 (100)	[144]
Remarks	To aid dissolving in alcohol, first dissolve in a drop or two of hexane		

β,ε-Carotene

Recommended abbreviation: βε-Car (βε)

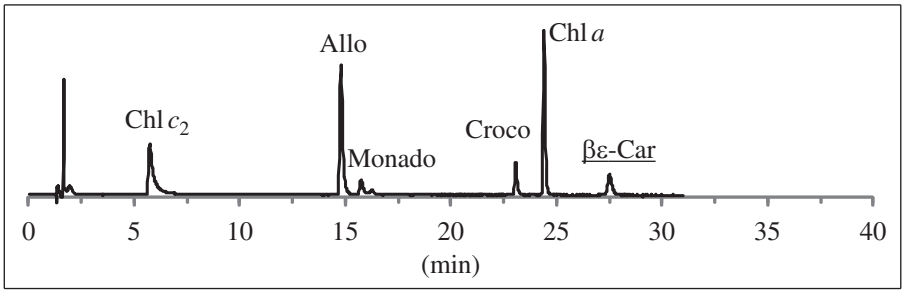
IUPAC: (6′*R*)-β,ε-Carotene (trivial name: α-carotene)

Molecular formula: $C_{40}H_{56}$ **Molecular weight:** 536.87

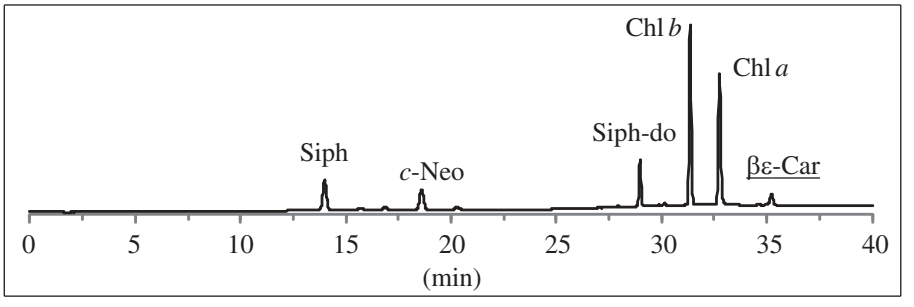


Biological occurrence	Minor or trace pigment in chlorophytes, prasinophytes, cryptophytes, some dinoflagellates, cyanobacteria
Source culture	*Chroomonas salina* (cryptomonad)
Alteration products	*Cis*-isomers
Biosynthetically related to	Lut, Loro, Siph
Occurs together with	Lut, Zea, Viola, Anth, Neo, Allo, Croco, Monado

HPLC chromatogram of *Chroomonas salina* (system 1)



HPLC chromatogram of *Codium fragile* (system 2)

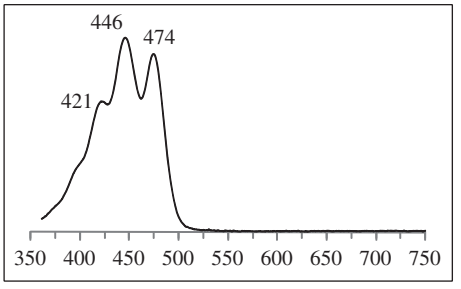


UV-Vis spectra (see also reference spectra below)

Solvent	λ_{max} (nm)	Band ratio (% III:II)	Ref.
Acetone	(424), *448*, 476	56	[96]
Ethanol (see remarks)	423, *444*, 473	61	[86]
Hexane	423, *446*, 474	71	[57]
Methanol (see remarks)	(422), *442*, 471	61	[160]
Recommended specific absorption coefficient *d* (L g^{-1} cm^{-1})		270 (at 446 nm, hexane) [57] 270 (at 448 nm, acetone) [96]	

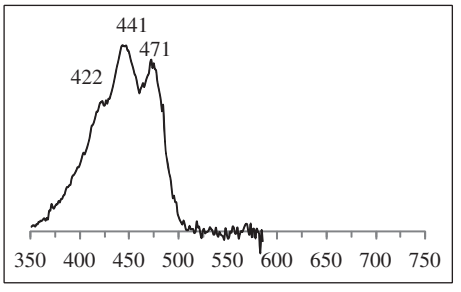
Reference spectra

In hexane

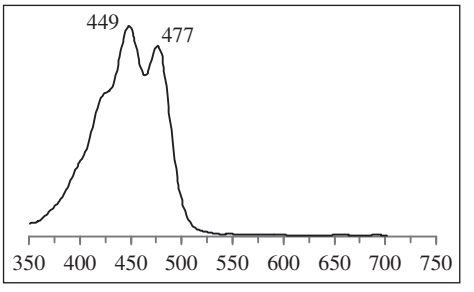


For spectrum in acetone, see [109]

In HPLC solvent system 1



In HPLC solvent system 2



Mass spectra

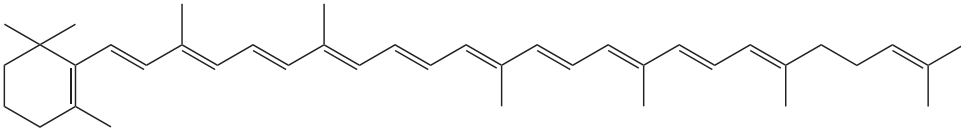
Ionization technique	Mass analyser type	Diagnostic ions (m/z, rel. intensity)	Ref.
EI	Magnetic sector	536 $[M]^+$ (100), 480 $[M-56]^+$ (2), 444 $[M-92]^+$ (25), 430 $[M-106]^+$ (18), 388, 378, 374	[144]
Remarks	To aid dissolving, add a drop or two of hexane before adding the alcohol		

β,ψ-Carotene

Recommended abbreviation: βψ-Car (βψ)

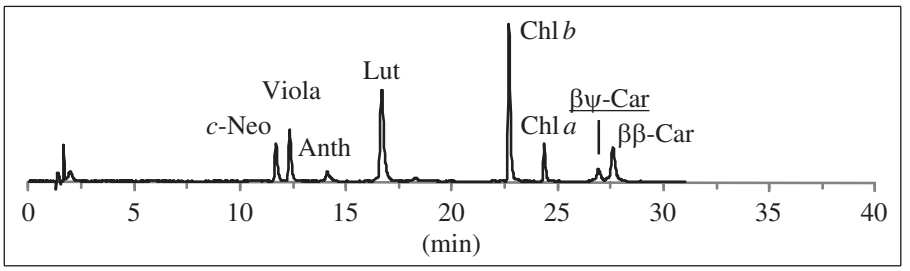
IUPAC: β,ψ-Carotene (trivial name: γ-carotene)

Molecular formula: $C_{40}H_{56}$ **Molecular weight:** 536.87

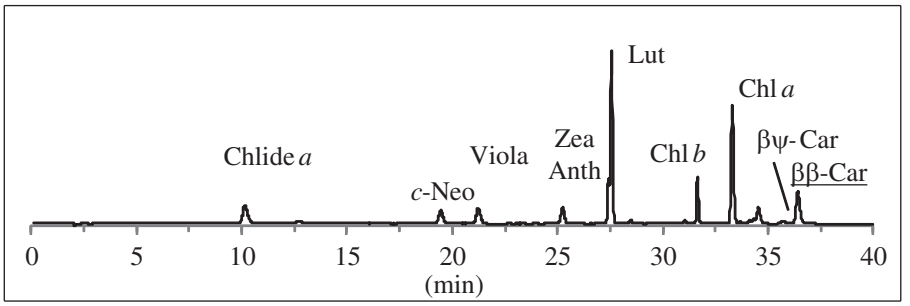


Biological occurrence	Occasionally found in some chlorophytes and prasinophytes, dinoflagellates Pigment Type 3 and mesostigmatophytes
Source culture	*Dunaliella tertiolecta* (chlorophyte)
Alteration products	*Cis*-isomers
Biosynthetically related to	Lyco, ββ-Car, βε-Car (biosynthetic precursor of ββ-Car and βε-Car)
Occurs together with	

HPLC chromatogram of *Dunaliella tertiolecta* (system 1)



HPLC chromatogram of *Dunaliella salina* (system 2)



UV-Vis spectra (see also reference spectra below)

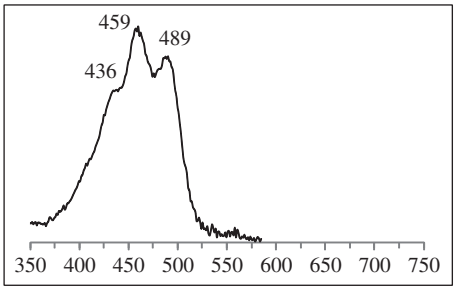
Solvent	λ_{max} (nm)	Band ratio (% III:II)	Ref.
Acetone	(439), *461*, 491	n.d.	[66]
Cyclohexane	439, *464*, 496	59	[69]
Ethanol (see remarks)	(440), *460*, 489	23	[83]
Recommended specific absorption coefficient *d* (L g^{-1} cm^{-1})		276 (at 462 nm, hexane) [181] 319 (at 459 nm, petroleum ether) [126]	

Reference spectra

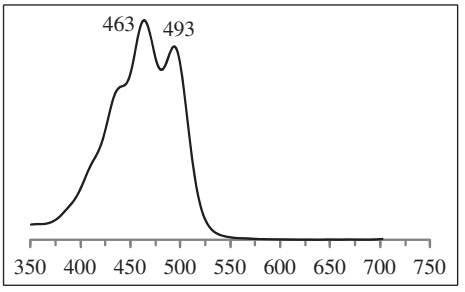
For spectrum in acetone, see [109]

For spectrum in hexane, see [109]

In HPLC solvent system 1



In HPLC solvent system 2



Mass spectra

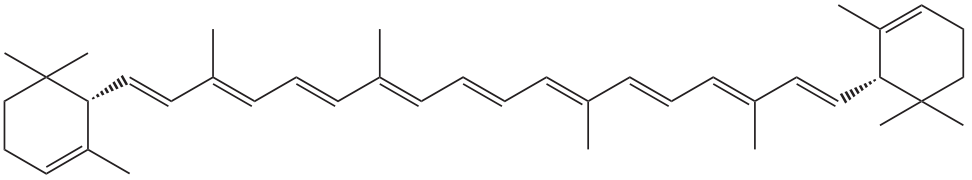
Ionization technique	Mass analyser type	Diagnostic ions (m/z, rel. intensity)	Ref.
EI	Magnetic sector	536 $[M]^+$ (100), 467 $[M-69]^+$ (8), 444 $[M-92]^+$ (20), 430 $[M-106]^+$ (25), 407 (m*, M → M-69)	[30]
Remarks	To aid dissolving, add a drop or two of hexane before adding the alcohol		

ε,ε-Carotene

Recommended abbreviation: εε-**Car** (ε)

IUPAC: (6*S*,6′*S*)-ε,ε-Carotene (trivial name: ε-carotene)

Molecular formula: $C_{40}H_{56}$ **Molecular weight:** 536.87

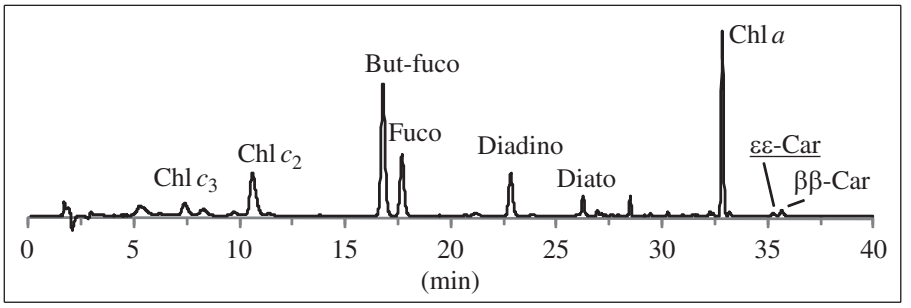


Biological occurrence	Significant pigment in pelagophytes but not always present (see Chapter 1). Occasional traces in cultures of chlorophytes, diatoms, cryptomonads and prasinophytes Pigment Type 3
Source culture	*Pelagococcus subviridis* (chrysophyte)
Alteration products	*Cis*-isomers
Biosynthetically related to	Lyco
Occurs together with	

HPLC chromatogram (system 1)

NO DATA AVAILABLE

HPLC chromatogram of *Pelagomonas calceolata* (system 2)

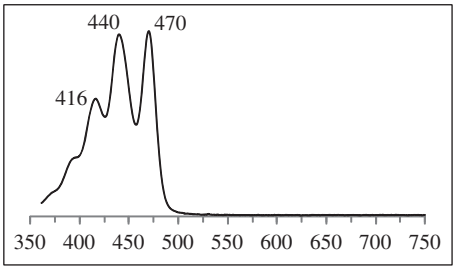


UV-Vis spectra (see also reference spectra below)

Solvent	λ_{max} (nm)	Band ratio (% III:II)	Ref.
Cyclohexane	416, 440, 470	n.d.	[157]
95% Ethanol	417, *440*, 470	96	[36]
Hexane	415, 439, *469*	101	[23]
Recommended specific absorption coefficient *d* (L g^{-1} cm^{-1})		312 (at 440 nm, petroleum ether)	[143]

Reference spectra

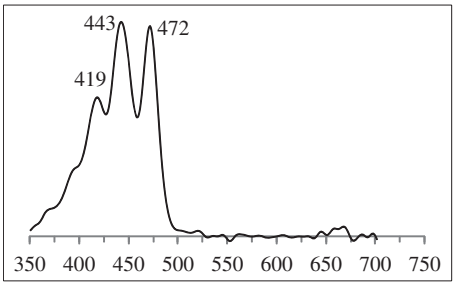
In hexane



In HPLC solvent system 1

NO DATA AVAILABLE

In HPLC solvent system 2



Mass spectra

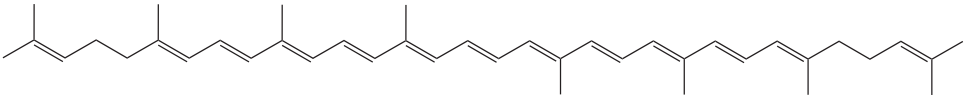
Ionization technique	Mass analyser type	Diagnostic ions (m/z, rel. intensity)	Ref.
EI	Magnetic sector	536 $[M]^+$ (100), 480 $[M-56]^+$ (5), 444 $[M-92]^+$ (28), 430 $[M-106]^+$ (8), 388 $[M-92–56]^+$ (30)	[143]
Remarks	Opposite stereochemistry than βε-Car and Lut [23, 46]		

ψ,ψ-Carotene (Lycopene)

Recommended abbreviation: Lyco (Ly)

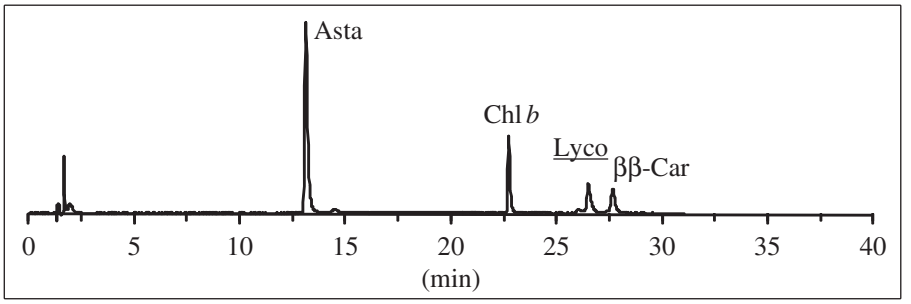
IUPAC: ψ,ψ-Carotene

Molecular formula: $C_{40}H_{56}$ **Molecular weight:** 536.87



Biological occurrence	Minor or trace pigment in mesostigmatophytes (also characteristic of tomatoes)
Source culture	*Mesostigma viride* (mesostigmatophyte)
Alteration products	*Cis*-isomers
Biosynthetically related to	The biosynthetic precursor to all carotenoids
Occurs together with	

HPLC chromatogram of mixed standards (system 1)



HPLC chromatogram (system 2)

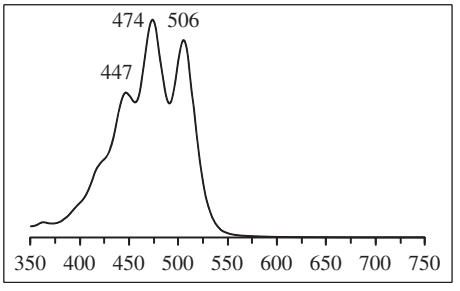
NO DATA AVAILABLE

UV-Vis spectra (see also reference spectra below)

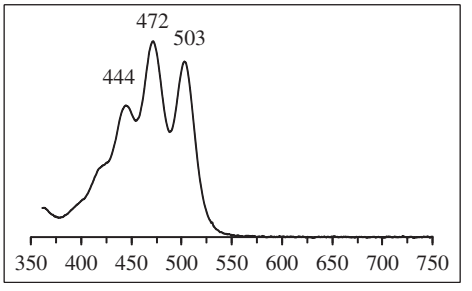
Solvent	λ_{max} (nm)	Band ratio (% III:II)	Ref.
Acetone	448, *474*, 506	84	[2]
Ethanol	443, *472*, 502	n.d.	[113]
Hexane	448, *473*, 504	n.d.	[14]
Recommended specific absorption coefficient d **(L g^{-1} cm^{-1})**		347 (at 473 nm, hexane) [181] 345 (at 474 nm, acetone) [2]	

Reference spectra

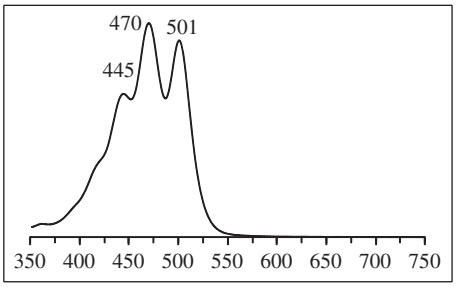
In acetone



In hexane



In HPLC solvent system 1



In HPLC solvent system 2

NO DATA AVAILABLE

Mass spectra

Ionization technique	Mass analyser type	Diagnostic ions (m/z, rel. intensity)	Ref.
EI	Magnetic sector	536 $[M]^+$ (22), 467 $[M-69]^+$ (4), 444 $[M-92]^+$ (2), 430 $[M-106]^+$ (4), 109 (19), 91 (47), 69 (100)	[55]
Remarks	Mesostigmatophytes are found in freshwater environments		