

ANTILLEAN CYANOPHYCEAE FROM SALT-PANS AND MARINE LOCALITIES

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I. CYANOPHYCEAE FROM SALT-PANS IN BONAIRE AND CURAÇAO

A number of samples from salt-pans collected by J. Rooth in Bonaire and by Miss T. M. Emeis in Curaçao were handed over to the author for identification. Frémy (1941) has published a list of *Cyanophyceae* collected by Wagenaar Hummelinck in Bonaire, Klein Bonaire and Curaçao in 1930 and 1932. Among the last mentioned collection there were samples from the same salt-pans in Bonaire, where also J. Rooth did his collecting. It is interesting to compare both results.

Dr Fr. Drouet had the kindness to procure some identifications for this part as well as for part II.

COLLECTIONS FROM SALT-PANS ON THE WEST COAST OF BONAIRE BY J. ROOTH

Only during the very scarce rain spells fresh water is added to the salt-pans. Sea-water enters by means of subterranean communication and by percolating, the salt-pans being situated below sea level. As a rule the water is rather clear. It is usually set in movement by trade winds.

Salt-pan of Slagbaai, north-west coast of Bonaire, temp. during IX 1959—VIII 1960 22—35° C, depth down to 1 m:

Boca Slagbaai, seaside, floating, 56.4 g Cl/l, 13 VII 1960; chlorinity during IX 1959—VIII 1960 36—85 g Cl/l: *Coccochloris elabens* (abundant), *Phormidium subsalsum* (according to Dr Drouet agreeing with the type; rather numerous).

Inland side of salt-pan, floating, 117.8 g Cl/l, 13 VII 1960; chlorinity during IX 1959—VIII 1960 76—143 g Cl/l: *Coccochloris elabens* (chiefly), *Phormidium subsalsum* (very scarce).

Inland side of salt-pan, growing on stones, 117.8 g Cl/l, 13 VII 1960; chlorinity during IX 1959—VIII 1960 76—143 g Cl/l: *Coccochloris elabens* (chiefly), *Phormidium subsalsum* (rather scarce).

Goto, Saliña Grandi, salt-lake, north-west coast of Bonaire, temp. during IX 1959—VIII 1960 21—35° C, depth generally down to 1 m, but in some parts down to 10—15 m:

South-west side, floating and growing on stones, 84.0 gr Cl/l, 13 VII 1960; chlorinity during IX 1959—VIII 1960 77—90 g Cl/l: *Coccochloris elabens* (scarce), *Entophysalis deusta* (numerous), *Spirulina subsalsa* (rather numerous), *Spirulina labyrinthiformis* (rather numerous).

South-east side, floating and growing on stones, 84.9 gr Cl/l, 13 VII 1960; chlorinity during IX 1959—VIII 1960 77—90 g Cl/l: *Coccochloris elabens* (numerous), *Entophysalis deusta* (rather numerous), *Phormidium subsalsum* (rather numerous), *Spirulina subsalsa* (abundant), *Spirulina labyrinthiformis* (abundant).

North side, floating and growing on stones, 85.5 g Cl/l, 13 VII 1960; chlorinity during IX 1959—VIII 1960 70—88 g Cl/l: *Coccochloris elabens* (abundant), *Entophysalis deusta* (rather numerous), *Phormidium subsalsum* (very scarce), *Spirulina subsalsa* (numerous), *Spirulina labyrinthiformis* (numerous).

Pekelmeer, a long-stretched salt-lake, south-west coast of Bonaire, and environment, temp. during IX 1959—VIII 1960 21—35° C, depth down to 1 m:

West shore, south of Witte Pan, floating and growing on stones, 82.5 g Cl/l, 15 VII 1960; chlorinity during IX 1959—VIII 1960 51—118 g Cl/l: *Coccochloris elabens* (numerous), *Johannesbaptistia pellucida* (numerous), *Gomphosphaeria apomina* (very scarce), *Entophysalis deusta* (very numerous), *Schizothrix lardacea* (abundant), *Microcoleus chthonoplastes* (rather numerous), *Lyngbya aestuarii* (rather numerous), *Spirulina subsalsa* (scarce).

West shore, between Witte Pan and Oranje Pan, floating and growing on stones, 82.7 g Cl/l, 15 VII 1960; chlorinity during IX 1959—VIII 1960 60—124 g Cl/l: *Coccochloris elabens* (numerous), *Anacystis dimidiata* (rather scarce), *Johannesbaptistia pellucida* (rather numerous), *Entophysalis deusta* (numerous), *Lyngbya aestuarii* (numerous), *Lyngbya semiplena* (rather numerous), *Spirulina subsalsa* (scarce).

Near Oranje Pan, south of Pekelmeer, floating and growing on stones, about 80 g Cl/l, 15 VII 1960: *Coccochloris elabens* (numerous), *Entophysalis deusta* (abundant), *Microcoleus chthonoplastes* (numerous), *Lyngbya semiplena* (abundant), *Spirulina labyrinthiformis* (scarce).

Willemsoog, between Oranje Pan and Pekelmeer, hole in the bottom, where sea-water is supplied, floating and growing on stones, usually 20—21 g Cl/l, can increase up to 59 g Cl/l, 15 VII 1960: *Coccochloris elabens* (scarce), *Entophysalis deusta* (scarce), *Lyngbya semiplena* (abundant), *Spirulina subsalsa* (scarce).

East shore of Pekelmeer, hole in the bottom where sea-water is supplied, near colony of flamingos, growing on stones, 41.5 g Cl/l, 22 VII 1960: *Coccochloris elabens* (numerous), *Anacystis dimidiata* (scarce), *Entophysalis deusta* (numerous), *Entophysalis conferta* (on *Lyngbya aestuarii*, numerous), *Lyngbya aestuarii* (abundant), *Lyngbya semiplena* (scarce).

South-east of second station mentioned from Pekelmeer, bottom (mud and salt), 15 VII 1960: *Coccochloris elabens* (numerous), *Entophysalis deusta* (rather numerous), *Phormidium subsalsum* (rather scarce).

COLLECTIONS FROM SALT-PANS ON THE NORTH-WEST COAST OF CURAÇAO BY T. M. EMEIS

Salt-pan of San Nicolaas, along a large inland bay, Santa Martha, with a two months old communication with the sea, bottom, salinity circa 66‰ after heavy rains, 5 XII 1960, before the rains circa 86‰: *Entophysalis deusta* (scarce), *Microcoleus chthonoplastes* (rather scarce), *Lyngbya aestuarii* (scarce), *Lyngbya semiplena* (rather scarce), *Spirulina subsalsa* (rather scarce).

Salt-pans of Cas Abau, near the coast, with a layer of strong brine near the bottom, temp. on the bottom up to more than 45° C, on the surface 26—36° C, 5 XII 1960:

Cas Abau 2, salinity circa 46‰ after heavy rains, but usually circa 175‰: *Entophysalis deusta* (rather numerous), *Spirulina subsalsa* (very scarce), *Spirulina labyrinthiformis* (very scarce).

Cas Abau 2, bottom, salinity circa 200‰: *Entophysalis deusta* (rather numerous), *Spirulina subsalsa* (very scarce), *Spirulina labyrinthiformis* (very scarce).

Cas Abau 3, bottom, salinity circa 275‰: *Coccochloris elabens* (rather numerous).

ANNOTATED LIST OF SPECIES *)

CHROOCOCCALES

Chroococcaceae Naegeli

Coccochloris elabens (Bréb.) Drouet & Daily (see p. 51) — cells cylindrical or elliptic-cylindrical, more or less truncate or rounded at both ends, 3—4 μ in diam. and $1\frac{1}{2}$ — $2\frac{1}{2}$ (rarely 3) times as long as diameter, or 2—6 μ in diam. and 2—4 times as long as diameter, in amorphous or cylindrical, gelatinous colonies, and, in the last case, cells often in regular rows (agreeing with the figure of *Dzensia salina* Woron. in Hof & Frémy, p. 150—151, fig. 3, brought to the synonymy of *Coccochloris elabens* in Drouet & Daily, p. 29), colonies mostly diffluent.

Anacystis dimidiata (Kütz.) Drouet & Daily, p. 70 — *Ill.*: Drouet & Daily, fig. 100—107; Koster, fig. 6—8; Umezaki, pl. 1 fig. 3.

Ecology: in fresh, brackish, and marine waters.

Distribution: cosmopolitan.

Johannesbaptistia pellucida W. R. Taylor & Drouet; Drouet & Daily, p. 85 — *Ill.*: Drouet & Daily, fig. 182—184; Koster, fig. 9—10; Umezaki, pl. 1 fig. 4.

Ecology: in shallow, fresh, brackish, and salt waters.

Distribution: Europe, North, Central, and South America, Malaysia.

Gomphosphaeria aponina Kütz. (see p. 51).

Chamaesiphonaceae Borzi

Entophysalis deusta (Menegh.) Drouet & Daily (see p. 51) — cells often in dense pulvinate colonies (agreeing with *Aphanocapsa litoralis* Hansg. in Hof & Frémy, p. 154, fig. 6, considered a synonym of *Entophysalis deusta* in Drouet & Daily, p. 103, or single or binate.

Entophysalis conferta (Kütz.) Drouet & Daily (see p. 51).

HORMOGONALES

Oscillatoriaceae Kirchner

Schizothrix lardacea (Cesati) ex Gomont, 15, p. 311; Geitler, p. 1085; Frémy, 1934, p. 78 — *Ill.*: Gomont, 15, pl. 8 fig. 8, 9; Geitler, fig. 693a, b; Frémy, 1934, pl. 20 fig. 3— one or few trichomes in a sheath, trichomes 2—2.5 μ wide, cells 2— $2\frac{1}{2}$ times as long as wide.

Ecology: on moist rocks, walls, stones, soil, sometimes on sea-shores.

Distribution: cosmopolitan.

Microcoleus chthonoplastes (Mert.) Thuret ex Gomont, 15, p. 353; Geitler, p. 1133; Frémy, 1934, p. 67 — *Ill.*: Gomont, 15, pl. 14, fig. 5—8; Geitler, fig. 739; Frémy, 1934, pl. 17 fig. 7; Umezaki, pl. 5 fig. 2.

Ecology: on soil, in brackish and marine waters, brines, on sea-shores.

Distribution: cosmopolitan.

Lyngbya aestuarii (Mert.) Liebm. ex Gomont, 16, p. 127; Geitler, p. 1052; Frémy, 1934, p. 104 — *Ill.*: Gomont, 16, pl. 3 fig. 1, 2; Geitler, fig. 666; Frémy, 1934, pl. 27; Koster, fig. 42—46; Umezaki, pl. 8 fig. 1.

Ecology: in brackish and marine waters, brines, on sea-shores, in thermal, sometimes fresh waters, on stones, logs, soil, or floating.

* The ecological and geographical data are borrowed from the references cited.

Distribution: cosmopolitan.

Lyngbya semiplena (Ag.) J. Ag. ex Gomont (see p. 54).

Phormidium subsalsum Gomont, Bull. Soc. bot. de France 46, 1899, p. 38; Geitler, p. 1024; Frémy, 1934, p. 95 — *Ill.*: Gomont, 1899, pl. I fig. 15—16; Frémy, 1934, pl. 24 fig. 6— trichomes usually slightly, but occasionally spirally curved, 5—6 μ wide, apical cell thickened. Recently Drouet (1962, p. 204) has pointed out that *Phormidium subsalsum* Gomont has to be considered a synonym of *Microcoleus vaginatus* (Vauch.) Gomont ex Gomont. Which is the correct name of this species has still to be sorted out.

Ecology: in fresh water, infrequently in brackish and marine waters.

Distribution: cosmopolitan.

Spirulina subsalsa Oersted ex Gomont (see p. 55)—windings touching each other, 5 μ in diam.

Spirulina labyrinthiformis (Menegh.) ex Gomont (see p. 56)—windings touching each other, 3 μ in diam.

COMPARISON WITH FREMY'S RECORD OF SPECIES FOUND GROWING IN THE SAME SALT-PANS IN BONAIRE (COLL. P. WAGENAAR HUMMELINCK, 1930—1932)

Salt-pan of Slagbaai. No similar species recorded from 1930—1932 and 1960. The chlorinity of the station in 1930—1932 was much lower than that of the stations in 1960.

Goto, Saliña Grandi. Similar species recorded from 1930—1932 and 1960: *Entophysalis deusta* (syn.: *Entophysalis granulosa* Kütz., *Gloeocapsa crepidinum* Thuret, *Aphanocapsa litoralis* Hansg., *Pleurocapsa entophysalis* Setch. & Gardn., *Myxosarcina salina* Frémy), *Spirulina subsalsa*.

Pekelmeer. Similar species recorded from 1930—1932 and 1960: *Anacystis dimidiata* (syn.: *Chroococcus turgidus* (Kütz.) Nägeli), *Entophysalis deusta*, *Microcoleus chthonoplastes*, *Lyngbya aestuarii*, *Lyngbya semiplena*, *Spirulina subsalsa*, *Spirulina labyrinthiformis*.

II. MARINE CYANOPHYCEAE OF THE WINDWARD ISLANDS

Three collections of marine *Cyanophyceae* from Anguilla, St. Martin, St. Barts, Saba, St. Eustatius, Barbuda, and Grenada, islands of the Windward Group, made by W. F. R. Suringar (1885), P. Wagenaar Hummelinck (1949, 1955), and M. Vroman (1958), were studied. Feldmann has given a short review of the investigations concerning the marine *Cyanophyceae* of the Antilles, up to 1958.

The material here studied is preserved in the Rijksherbarium, Leiden; that collected by M. Vroman also in the Botanical Laboratory of the Free University, Amsterdam.

ST. JOHN

Bay south of Cruz Bay, 18 VI 1955, *Wagenaar Hummelinck 1408—7*: *Dichothrix fucicola*.

Turner Bay, east, Chiton-zone, 18 VI 1955, *Wagenaar Hummelinck 1407—17*: *Dichothrix fucicola*.

ANGUILLA

North Sandy Ground (rocky beach, sandy reef; tidal belt and lower), 19 VI 1949, *Wagenaar Hummelinck 1142—20*: *Dichothrix fucicola*.

Salt-pond of Sandy Ground (ditch; *Ruppia*), 46 g Cl/l, 16 VI 1949, *Wagenaar Hummelinck 1144—2*: *Spirulina subsalsa*.

ST. MARTIN

Cupecoy Bay, flat stones before sandy beach (littoral and sublittoral belts), 16 V 1958, *Vroman St. M.* 22—16, *St. M.* 22—17: *Dichothrix fucicola*, *Hydrocoleum lyngbyaceum*, in its sheaths *Lyngbya rivulariarum*.

Cupecoy Bay, west of the bay, rocky coast, Lowland formation, weather-worn, very sharp rocks, high littoral belt, 16 V 1958, *Vroman St. M.* 23—4: *Dichothrix fucicola*.

Maho Bay, between Burgeux Bay and Mullet Pond Bay, littoral belt, rather high on the rocks, 9 V 1958, *Vroman St. M.* 12—15, *St. M.* 12—16: *Dichothrix fucicola*, *Hydrocoleum lyngbyaceum*, in its sheaths *Lyngbya rivulariarum*.

Same locality, in little rock pool, about high-tide mark, 9 V 1958, *Vroman St. M.* 12—18: *Dichothrix fucicola*, *Phormidium valderianum*, *Spirulina labyrinthiformis* (scarce).

Burgeux Bay, western part of the bay, rocky coast, littoral belt, 7 V 1958, *Vroman St. M.* 10—35, *St. M.* 10—36, *St. M.* 10—37, *St. M.* 10—38: *Rivularia polyotis*, *Hormothamnion enteromorphoides*, *Hydrocoleum lyngbyaceum*, in its sheaths *Lyngbya rivulariarum* and *Spirulina labyrinthiformis*.

Little Bay, east side of Kay Bay Hill, rocky coast (littoral and upper sublittoral belts), 28 IV 1958, *Vroman St. M.* 1—37, *St. M.* 1—38: *Dichothrix fucicola*, *Symploca hydroides*.

Little Bay, west side of peninsula with Fort Amsterdam, coast of dolerite rocks (littoral and upper sublittoral belts), 29 IV 1958, *Vroman St. M.* 2—24, *St. M.* 2—26: *Coccochloris stagnina*, *Scytonema myochrous* (fairly scarce), *Lyngbya semiplena*, *Lyngbya lutea* on *Wrangelia argus* (det. M. Vroman), *Spirulina subsalsa* (fairly scarce).

Little Bay, eastern part, boulders before the beach (much whirling sand), 30 IV 1958, *Vroman St. M.* 4—23, *St. M.* 4—24: *Hydrocoleum lyngbyaceum*, in its sheaths *Lyngbya rivulariarum* and *Spirulina labyrinthiformis*.

Little Bay, eastern side of beach, rocks, quaternary coral limestone (littoral and sublittoral belts), 30 IV 1958, *Vroman St. M.* 5—21: *Dichothrix fucicola*.

Great Bay, Point Blanche Bay (rocks, sand; low-tide and lower zone), 26 VI 1949, *Wagenaar Hummelinck 1125 A—1*: *Dichothrix fucicola*.

Great Bay, Point Blanche Bay, rock pool, together with *Lophosiphonia cristata* (det. M. Vroman), 5 VI 1955, *Wagenaar Hummelinck 1399—3*: *Dichothrix penicillata*.

Great Bay, east side of peninsula with Fort Amsterdam, dolerite coast, rocks, littoral belt, 2 V 1958, *Vroman St. M.* 7—20: *Symploca hydroides*.

Great Bay, eastern part, upper littoral belt, 14 V 1958, *Vroman St. M.* 21—12: *Dichothrix fucicola* (very scarce), *Hydrocoleum lyngbyaceum*, in the sheaths of both species *Lyngbya rivulariarum*.

Great Bay, near Little Bay Hotel, sublittoral belt, 22 V 1958, *Vroman St. M.* 24—15, *St. M.* 24—17: *Lyngbya majuscula*, *Lyngbya lutea*.

Guanabay, littoral belt, fairly high on the rocks of the Point Blanche formation, 13 V 1958, *Vroman St. M.* 18—21, *St. M.* 18—22: *Hydrocoleum lyngbyaceum*, in its sheaths *Lyngbya rivulariarum*, *Symploca hydroides*.

Guanabay, quaternary coral lime-stone, spray zone, 13 V 1958, *Vroman St. M.* 17—28: *Hydrocoleum lyngbyaceum* (scarce), *Spirulina subsalsa* (scarce), together with *Polysiphonia ferulacea* (det. M. Vroman).

Oysterpond (littoral and upper sublittoral belts, to a depth of c. 40 cm, shape of coast very variable: rocks, quaternary coral lime-stone, mangroves, sandy bottom), 12 V 1958, *Vroman St. M.* 15—24: *Entophysalis conferta*, epiphytic on *Lyngbya majuscula*.

Oysterpond, on rocks of the Point Blanche formation, upper sublittoral belt, 12 V 1958, *Vroman St. M.* 14—35: *Lyngbya majuscula*.

Mouth Piece Bay, epiphytic on *Cymodocea manatorum* (det. M. Vroman), 23 V 1958, *Vroman St. M.* 27—11: *Symploca hydroides*.

Mouth Piece Bay, sublittoral belt, 23 V 1958, *Vroman St. M.* 28—18: *Lyngbya majuscula*.

Baie de la Grande Case, diorite coast (littoral and upper sublittoral belts), 26 V 1958, *Vroman St. M.* 33—19: *Hydrocoleum glutinosum*, in its sheaths *Lyngbya rivulariarum*.

Baie de la Grande Case, on diorite boulders, sublittoral belt, 26 V 1958, *Vroman St. M.* 34—33: *Lyngbya lutea*.

Baie de la Grande Case, sublittoral belt (sandy bottom with *Cymodocea manatorum* and *Thalassia testudinum* (det. M. Vroman), 26 V 1958, *Vroman St. M.* 35—17: *Dichothrix penicillata*, *Lyngbya lutea*.

Same locality, on *Dictyota*, 26 V 1958, *Vroman St. M.* 35—6: *Dichothrix fucicola*.

Flamingo Pond, 27 VI 1955, *Wagenaar Hummelinck* 1132a—3: *Coccochloris elabens*, *Entophysalis deusta*, *Spirulina subsalsa*.

ST. BARTS

Grande Saline, pool in ditch, 34 g Cl/l, 3 VI 1949, *Wagenaar Hummelinck* 1122—1, 1122—2: *Gomphosphaeria aponina*, *Lyngbya semiplena*.

SABA

Foot of Parish Hill, south-west point of Saba, littoral belt, big boulders before a boulder beach, 28 V 1958, *Vroman Saba* 7—10: *Hydrocoleum lyngbyaceum*, in its sheaths *Lyngbya rivulariarum*.

ST. EUSTATIUS

West side, beach, IV—V 1885, *Suringar s.n.*: *Hydrocoleum lyngbyaceum*, in its sheaths *Lyngbya rivulariarum* and *Spirulina labyrinthiformis*.

West coast, IV—V 1885, *Suringar s.n.*: *Dichothrix fucicola*, *Hydrocoleum lyngbyaceum*, *Hydrocoleum glutinosum*, in its sheaths *Lyngbya rivulariarum* and *Spirulina labyrinthiformis*.

Near Sugarloaf, boulder coast, littoral belt, exposed, 21 V 1958, *Vroman St. Eust.* 5—20: *Lyngbya semiplena*, epiphytic on *Polysiphonia ferulacea* (det. M. Vroman), *Spirulina labyrinthiformis* (scarce).

Boekaniers Bay, boulders with a dense algal vegetation, littoral belt, *Vroman St. Eust.* 1—16, *St. Eust.* 1—17: *Calothrix parietina* (fairly scarce), *Calothrix confervicola* (scarce), *Symploca muscorum*, *Lyngbya semiplena*.

Corre Corre Bay, quiet, shallow water behind coral reef, 20 V 1958, *Vroman St. Eust.* 3—19: *Lyngbya lutea* on *Gelidiella acerosa* (det. M. Vroman), *Vroman St. Eust.* 3—26: *Calothrix parietina* (scarce), *Phormidium papyraceum*.

Concordia Bay, IV—V 1885, *Suringar s.n.*: *Hydrocoleum glutinosum*, in its sheaths *Lyngbya rivulariarum*.

Concordia Bay, boulders before sandy beach, littoral belt (much whirling sand), 20 V 1958, *Vroman St. Eust.* 4—1: *Lyngbya majuscula*, on *Codium*.

BARBUDA

Two Feet Bay, surf-swept terrace, 10 VII 1955, *Wagenaar Hummelinck* 1395 C—32: *Hydrocoleum lyngbyaceum*.

GRENADA

Lagoon St. George, jetty, 24 I 1955, *Wagenaar Hummelinck* 1391—4: *Lyngbya majuscula*.

ANNOTATED LIST OF SPECIES *)

CHROOCOCCALES

Chroococcaceae Naegeli

Coccochloris stagnina Sprengel; Drouet & Daily, p. 15 — *Ill.*: Drouet & Daily, fig. 145—163; Koster, fig. 1—2; Umezaki, pl. 1 fig. 1.

St. Martin: *Vroman St. M.* 2—24—cells 4.5 μ in diam.

Ecology: in fresh waters, in aerial localities, occasionally in brackish and marine waters.

Distribution: cosmopolitan; collected in St. Eustatius, 1949.

Coccochloris elabens (Bréb.) Drouet & Daily, p. 28 — *Ill.*: Drouet & Daily, fig. 164—169; Geitler, fig. 65; Koster, fig. 3.

St. Martin: *Wagenaar Hummelinck 1132a—3.*

Ecology: in fresh, brackish, and marine waters.

Distribution: cosmopolitan; collected in Barbuda, 1955.

Gomphosphaeria aponina Kütz.; Drouet & Daily, p. 98 — *Ill.*: Drouet & Daily, fig. 178—180; Umezaki, pl. 1 fig. 7.

St. Barts: *Wagenaar Hummelinck 1122.*

Ecology: in shallow fresh, brackish, and marine waters.

Distribution: cosmopolitan.

Chamaesiphonaceae Borzi

Entophysalis deusta (Menegh.) Drouet & Daily, p. 103 — *Ill.*: Drouet & Daily, fig. 185—194, 247—250; Koster, fig. 16; Umezaki, pl. 2 fig. 1.

St. Martin: *Wagenaar Hummelinck 1132a—3.*

Ecology: on rocks, shells, wood, and soil, in brackish and marine waters.

Distribution: cosmopolitan.

Entophysalis conferta (Kütz.) Drouet & Daily, p. 111 — *Ill.*: Drouet & Daily, fig. 196—215; Koster, fig. 11—13, Umezaki, pl. 2 fig. 2.

St. Martin: *Vroman St. M.* 15—24; Saba: *Vroman Saba 3—12*—cells 3 μ in diam.

Ecology: epiphytic on larger marine algae, also endophytic, in brackish and marine waters.

Distribution: cosmopolitan; collected in St. Martin, 1949.

HORMOGONALES

Scytonemataceae Rabenh.

Scytonema myochrous (Dillw.) Ag. ex Born. & Flah., 5, p. 104; Gardner, p. 300; Geitler, p. 780; Frémy, 1934, p. 171 — *Ill.*: Geitler, fig. 49, 501, 502.

St. Martin: *Vroman St. M.* 2—24—filaments 23—32 μ in diam., sheaths brown, divergently lamellate, false branches geminate, trichomes 14—18 μ in diam.

Ecology: on moist soil, walls, rocks, in fresh waters, rarely on sea-shores.

Distribution: cosmopolitan; collected in Anguilla, 1949.

Rivulariaceae Rabenh.

Calothrix parietina (Naeg.) Thuret ex Born. & Flah., 3, p. 366; Fan, p. 159 — *Ill.*: Geitler, fig. 380; Frémy, 1934, pl. 37; Fan, fig. 1; Chapman, fig. 12 n. 4.

St. Eustatius: *Vroman St. Eust.* 1—16—sheaths thick, basal part of trichomes 10—12 μ

* The ecological and geographical data are borrowed from the references cited.

in diam., cells nearly as long as diameter or shorter, one heterocyst at the base; *Vroman St. Eust.* 3—26—basal part of trichomes 9 μ in diam.

Ecology: on soil, stones, rocks, or wood, in fresh and brackish waters, sometimes on sea-shores, far above high-tide mark, spray zone, or upper part of littoral belt.

Distribution: cosmopolitan; collected in Anguilla, St. Martin, and St. Eustatius, 1949.

Calothrix confervicola (Roth) Ag. ex Born. & Flah., 3, p. 349; Fan, p. 169 — *Ill.*: Geitler, fig. 376; Frémy, 1934, pl. 35 fig. 1; Fan, fig. 6; Umezaki, pl. 16, fig. 2.

St. Eustatius: *Vroman St. Eust.* 1—16—trichomes 12 μ in diam., 1—5 heterocysts at the base, cells 3—4 μ long.

Ecology: epiphytic on marine algae.

Distribution: Europe, Canada, N. America, Brazil, Japan, Australia.

Rivularia polyotis (J. Ag.) ex Born. & Flah., 3, p. 360; Taylor, p. 54; Geitler, p. 647; Frémy, 1934, p. 156; Umezaki, p. 103 — *Ill.*: Taylor, pl. 2 fig. 9; Geitler, fig. 411; Frémy, 1934, pl. 46; Chapman, fig. 12 n. 2, 3; Umezaki, pl. 20 fig. 2.

St. Martin: *Vroman St. M.* 10—37—thallus aggregate, hemispheric, often confluent, olivaceous, 3—4 mm in diam., filaments easily separated, sheaths distinct, fairly thick, trichomes 9 μ in diam., cells somewhat constricted at the basal part, basal cells 1—2 times as long as diameter, higher cells half as long as diameter. Agreeing well with *Euactis pulchra* Cramer in Rabenhorst, Algen n. 1449, cited by Bornet and Flahault among the synonyms of *Rivularia polyotis*.

Ecology: on muddy stones, rocks, marine algae, and phanerogams, sea-shores, near high-tide mark.

Distribution: Europe, Morocco, Atlantic coast of N. America, Antilles, Bermuda, Bahamas, New Zealand, S. Australia.

Dichothrix fucicola (Kütz.) ex Born. & Flah., 3, p. 379; Taylor, p. 53; Geitler, p. 585; Gardner, p. 307; Frémy, 1939, p. 38; Drouet, 1942, p. 110; Feldmann, p. 35 — *Ill.*: Taylor, pl. 2 fig. 15; Frémy, 1939, fig. 5.

St. John: *Wagenaar Hummelinck* 1407—17, 1408—7; Anguilla: *Wagenaar Hummelinck* 1142—20; St. Martin: *Wagenaar Hummelinck* 1125 A—1; *Vroman St. M.* 1—38, *St. M.* 5—21, *St. M.* 10—36, *St. M.* 12—5, *St. M.* 12—18, *St. M.* 21—12, *St. M.* 23—4, *St. M.* 35—6; St. Eustatius: *Suringar s.n.*—thallus pulvinate, velvety, aggregate, penicillate, olivaceous, 5 mm high, filaments fasciculate, straight, erect, much falsely branched, sheaths thick, lamellose, yellow-brown, gelatinous, basal part of trichomes 15—23 μ in diam., heterocysts basal and 1—4 intercalary in a row, basal ones hemispheric to subconical with rounded angles, intercalary ones rectangular to oblong, lower cells disc-shaped, higher ones as long as diameter or slightly longer or shorter. Agrees well with the type, *Schizosiphon fucicola* Kützing (L). The diameter of the basal part of the trichomes appears to be 13—19 μ in the type. Bornet and Flahault mention a trichome diameter of 17—22 μ .

Ecology: on rocks or sandy soil, rarely on larger marine algae, sea shores, in littoral belt.

Distribution: Antilles, Bahamas, Florida, Bermuda Islands.

This species seems to have a restricted area, which is unusual among the *Cyanophyceae*. The very near species *D. penicillata* is reported from a somewhat wider area.

Dichothrix penicillata Zanard. ex Born. & Flah., 3, p. 379; Taylor, p. 53; Geitler, p. 585; Gardner, p. 307; Drouet, 1942, p. 110.

St. Martin: *Wagenaar Hummelinck* 1399—1—basal part of trichomes 14—18 μ in diam., heterocysts basal and 1—2 intercalary; *Vroman St. M.* 35—17—basal part of trichomes 12—15 μ in diam.

Ecology: on marine phanerogams and larger algae, on coral-rocks and reefs, sea-shores, in littoral belt.

Distribution: Red Sea, Gulf of Mexico, Antilles, Florida, Marshall Is.

Microchaetaceae Lemmermann

Hormothamnion enteromorphoides Grunow *ex* Born. & Flah., 7, p. 260; Taylor, p. 28; Geitler, p. 677; Frémy, 1939, p. 44; Drouet, 1942, p. 109; Feldmann, p. 36; Umezaki, p. 79 — *Ill.*: Taylor, pl. 2 fig. 3; Geitler, fig. 436; Frémy, 1939, fig. 7; Umezaki, pl. 12 fig. 4.

St. Martin: *Vroman St. M.* 10—35—thallus gelatinous, subplumose, filaments flexuous, sheaths at first thin, afterwards wide, finally diffluent, containing 1—many trichomes, trichomes moniliform, slightly attenuate to the ends, 6—8 μ in diam., cells barrel-shaped, $\frac{1}{2}$ —1 time as long as diameter, apical cell hemispheric or obtuse-conical, heterocysts more or less square, 9 μ in diam., as long as diameter or slightly longer.

Ecology: on sand, mud, rocks, larger marine algae, or free floating, in quiet, shallow, marine water, on sea shores, in lower littoral and upper sublittoral belt.

Distribution: Canary Islands, Mexico, Florida, Antilles, Pacific Islands, Japan, Viet-Nam, India, Malay Arch., Mauritius.

Oscillatoriaceae Kirchner

Hydrocoleum lyngbyaceum Kütz. *ex* Gomont, 15, p. 337; Taylor, p. 43; Geitler, p. 1150; Gardner, p. 289; Frémy, 1934, p. 73; Frémy, 1939, p. 19; Drouet, 1942, p. 116; Feldmann, p. 29; Umezaki, p. 27 — *Ill.*: Gomont, pl. 12 fig. 8—10; Taylor, pl. 1 fig. 17; Geitler, fig. 757; Frémy, 1934, pl. 19 fig. 1; Chapman, fig. 6 n. 5—7; Umezaki, pl. 3 fig. 4.

St. Martin: *Vroman St. M.* 4—23, *St. M.* 4—24, *St. M.* 10—36, *St. M.* 10—38, *St. M.* 12—16, *St. M.* 17—28, *St. M.* 18—21, *St. M.* 21—2, *St. M.* 22—17; St. Eustatius: *Suringar s.n.*; Saba: *Vroman Saba* 7—10; Barbuda: *Wagenaar Hummelinck 1395 C—32*. Thallus pulvinate, caespitose, gelatinous, brown (*Vroman St. M.* 21—12), filaments erect-radiating, flexuous, sheaths thick, partly distinct, partly diffluent, trichomes usually 14—16 μ , but also 9—11 μ (*Vroman St. M.* 22—17, *Wagenaar Hummelinck 1395 C—32*) or 14—18 μ (*Suringar s.n.*) and 16—18 μ (*Vroman St. M.* 21—12) in diam., slightly attenuate at the apex, cells 2—3 μ long, apical cell lens-shaped or rounded, with thickened membrane.

Ecology: in quiet marine waters, on marine phanerogams and larger algae, rocks, stones, piles, wood, sand, mud, sea-shores, in littoral belt, *Lichina* zone.

Distribution: cosmopolitan.

Hydrocoleum glutinosum (Ag.) *ex* Gomont, 15, p. 339; Geitler, p. 1150; Frémy, 1934, p. 73; Frémy, 1939, p. 20; Drouet, 1942, p. 116; Feldmann, p. 29; Umezaki, p. 28 — *Ill.*: Frémy, 1934, pl. 19 fig. 2; Umezaki, pl. 3 fig. 5.

St. Martin: *Vroman St. M.* 33—19; Saba: *Vroman Saba* 3—14, *Saba* 3—15; St. Eustatius: *Suringar s.n.* Thallus mucous, sheaths thick, lamellate, diffluent, filaments more or less flexuous, trichomes 15—18 μ in diam., slightly attenuate at the apex, cells 2—3 μ in diam., apical cell rounded-subconical or more or less lens-shaped, with thickened membrane.

Ecology: on rocks, stones, mud, sand, larger algae, sea-shores, in rock pools, littoral belt, on high-tide mark, in quiet, salt and brackish waters.

Distribution: Europe, Canary Is., N. America, Antilles, Japan, Malay Arch., Mauritius.

Whether *H. lyngbyaceum* and *H. glutinosum* can actually be separated as two distinct species has still to be investigated. The diameter of the trichomes of some of the above

mentioned specimens of *H. lyngbyaceum* is intermediate, when compared with Gomont's key. Umezaki considers the character of the sheaths to be a good one. In *H. glutinosum* the sheaths are entirely diffluent, in *H. lyngbyaceum*, however, they may be diffluent too, although they may be distinct just as well. According to Gomont there is some difference in the colour of the thallus. Frémy (1939, p. 20) considers this a good character to separate both species, together with the diameter of the trichomes and the more or less mucous thallus.

Symploca hydroides Kütz. ex Gomont, 16, p. 106; Geitler, p. 1119; Frémy, 1934, p. 81; Frémy, 1939, p. 22; Drouet, 1942, p. 118; Umezaki, p. 55 — *Ill.*: Gomont, pl. 2 fig. 1—4; Geitler, fig. 724; Umezaki, pl. 9 fig. 1; Frémy, 1934, pl. 21 fig. 3.

St. Martin: *Vroman St. M.* 1—37, *St. M.* 7—20, *St. M.* 18—22, *St. M.* 27—11; Saba: *Vroman Saba* 1—15, *Saba* 3—2. Thallus gelatinous, pulvinate, forming thick cushions, false branches rare, filaments flexuous, elongated, sheaths thin, trichomes only torulose sometimes at the upper part, 5.5—9 μ in diam., cells about as long as diameter or somewhat longer, at the apical part somewhat shorter, apical cell rounded or somewhat flat.

Ecology: on rocks, stones, sand, larger algae, sea-shores, in littoral belt, in quiet, salt waters.

Distribution: Europe, N. America, Antilles, Japan, New-Caledonia, Malay Arch., Ceylon.

Symploca muscorum (Ag.) Gom. ex Gomont, 16, p. 110; Geitler, p. 1122; Frémy, 1934, p. 82; Frémy, 1939, p. 23 — *Ill.*: Gomont, pl. 2 fig. 9; Geitler, fig. 730; Frémy, 1934, pl. 22 fig. 2.

St. Eustatius: *Vroman, St. Eust.* 1—17—filaments sparsely branched, very flexuous, trichomes 6—8 μ in diam., cells as long as diameter or somewhat longer, apical cell rounded.

Ecology: on moist soil among mosses, on decayed leaves, on sand among trees, on soil among *Salicornia*, also floating, usually in fresh, rarely in brackish and marine waters.

Distribution: cosmopolitan.

Lyngbya majuscula (Dillw.) Harvey ex Gomont, 16, p. 131; Taylor, p. 44; Geitler, p. 1060; Gardner, p. 275; Frémy, 1934, p. 106; Frémy, 1939, p. 28; Drouet, 1942, p. 118; Feldmann, p. 32; Umezaki, p. 54 — *Ill.*: Gomont, pl. 3 fig. 3, 4; Taylor, pl. 1 fig. 19; Geitler, fig. 672, c, d; Frémy, 1934, pl. 28, fig. 1; Chapman, fig. 4 n. 9; Umezaki, pl. 8 fig. 3.

St. Martin: *Vroman St. M.* 12—18, *St. M.* 14—35, *St. M.* 15—24, *St. M.* 24—17, *St. M.* 28—18; Saba: *Vroman Saba* 3—2, *Saba* 3—12; St. Eustatius: *Vroman St. Eust.* 4—1; Grenada: *Wagenaar Hummelinck* 1391—4. Filaments more or less flexuous or nearly straight, sheaths usually thick, lamellate, sometimes thin, outside rough, trichomes 18—45 μ in diam., cells 2—4 μ long, apical cell rounded, rounded-truncate or somewhat lens-shaped, with more or less thickened membrane.

Ecology: on rocks, sand, mud, coral, larger algae and marine phanerogams, roots of *Rhizophora*, sea-shores, in upper littoral belt, or free floating.

Distribution: cosmopolitan.

Lyngbya semiplena (Ag.) J. Ag. ex Gomont, 19, p. 138; Geitler, p. 1061; Gardner, p. 276; Frémy, 1934, p. 108; Drouet, 1936, p. 26; Frémy, 1939, p. 29; Umezaki, p. 51 — *Ill.*: Gomont, pl. 3 fig. 7—11; Geitler, fig. 672 a; Frémy, 1934, pl. 28 fig. 3; Chapman, fig. 4 n. 10; Koster, fig. 50; Umezaki, pl. 7 fig. 4.

St. Martin: *Vroman St. M.* 2—24; St. Barts: *Wagenaar Hummelinck* 1122; St. Eustatius: *Vroman St. Eust.* 1—16, *St. Eust.* 5—20. Filaments flexuous, sheaths fairly thin, trichomes very shortly attenuate at the apex, 5—10 μ in diam., cells 1.5—2.5 μ long, apical cell

rounded or rounded-depressed-conical, or somewhat lens-shaped, with thickened membrane.

Ecology: on rocks, mud, larger algae, bridges, sea-shores, in littoral or supralittoral belt, rock pools, salt-marshes, in brackish waters.

Distribution: cosmopolitan.

Lyngbya lutea (Ag.) Ag. *ex* Gomont, 16, p. 141; Geitler, p. 1057; Gardner, p. 275; Frémy, 1934, p. 109; Frémy, 1939, p. 30; Umezaki, p. 50 — *Ill.*: Gomont, pl. 3 fig. 12, 13; Geitler, fig. 670 a; Frémy, 1934, pl. 28 fig. 4; Koster, fig. 47; Umezaki, pl. 7 fig. 3.

St. Martin: *Vroman St. M.* 2—26, *St. M.* 24—15, *St. M.* 34—33, *St. M.* 35—17; Saba: *Vroman Saba* 3—4; St. Eustatius: *Vroman St. Eust.* 3—19. Thallus gelatinous, filaments flexuous, intertwined, usually turning bluish with ClZnJ, sheaths thin, trichomes 4.5—6 μ in diam., cells as long as diameter or slightly longer or shorter, apical cell rounded or flattened-rounded, with thickened membrane.

Ecology: on rocks, walls, stones, posts, larger algae, sea-shores, in littoral and supralittoral belt, rock pools, in brackish and thermal waters.

Distribution: Europe, N. Africa, Canary Islands, N. America, Anrilles, Japan, New Zealand, S. Australia.

Lyngbya rivulariarum Gomont, 16, p. 148; Geitler, p. 1048; Frémy, 1934, p. 112; Umezaki, p. 46 — *Ill.*: Frémy, 1934, pl. 29 fig. 6; Umezaki, pl. 7 fig. 1.

St. Martin: *Vroman St. M.* 4—23, *St. M.* 4—24, *St. M.* 10—36, *St. M.* 10—38, *St. M.* 12—16, *St. M.* 18—21, *St. M.* 21—12, *St. M.* 22—17, *St. M.* 33—19; Saba: *Vroman Saba* 3—14, *Saba* 3—15, *Saba* 7—10; St. Eustatius: *Suringar s.n.* Filaments flexuous, spirally curved to nearly straight, sheaths very thin, filaments 1—1.5 μ in diam., cells as long as diameter, apical cell obtuse.

Ecology: in and sometimes on the sheaths of gelatinous marine *Cyanophyceae* (*Rivularia*, *Dichothrix*, *Hydrocoleum*), according to Dr Drouet (*in lit.*) not occurring in fresh water.

Distribution (as far as known): Europe, N. America, Japan.

Phormidium valderianum Gomont, 16, p. 167; Geitler, p. 1011; Gardner, p. 279; Frémy, 1934, p. 87 — *Ill.*: Gomont, pl. 4 fig. 20; Geitler, fig. 645 c; Frémy, 1934, pl. 23 fig. 2.

St. Martin: *Vroman St. M.* 12—18—thallus gelatinous, tough, 0.5 cm. high, 3.5—5 cm in diam., filaments flexuous, densely intricate, sheaths thin, diffuent, trichomes 2 μ in diam., cells twice as long as diameter, not constricted at the cross-walls, apical cell rounded. Agrees with *Leptothrix zonata* Cesati in Rabenhorst, Algen n. 577, cited by Gomont as a synonym of *Phormidium valderianum* Gomont.

Ecology: on stones and moist rocks, usually in fresh, often in brackish and salt waters, also in thermal waters.

Distribution: cosmopolitan.

Phormidium papyraceum (Ag.) *ex* Gomont, 16, p. 173; Geitler, p. 1011; Frémy, 1934, p. 90; Frémy, 1939, p. 24 — *Ill.*: Gomont, pl. 5 fig. 3, 4; Geitler, 650 a, b; Frémy, 1934, pl. 23 fig. 27; Chapman, fig. 5 n. 1.

St. Eustatius: *Vroman St. Eust.* 3—26—filaments very flexuous, sheaths thin, afterwards diffuent, trichomes 3 μ diam., cells 2 μ long, apical cells rounded or conical-rounded.

Ecology: on moist stones, rocks, walls, wood, soil, in fresh, thermal, brackish and salt waters, on sea-shores, highest tide-mark, spray zone.

Distribution: cosmopolitan.

Spirulina subsalsa Oersted *ex* Gomont, 16, 253; Taylor, p. 46; Geitler, p. 927; Frémy, 1934, p. 134; Umezaki, p. 66 — *Ill.*: Gomont, pl. 7 fig. 32; Taylor, pl. 1 fig. 12; Geitler, fig. 593 a; Frémy, 1934, pl. 31 fig. 24; Umezaki, pl. 10 fig. 9.

Anguilla: *Wagenaar Hummelinck* 1144—2; St. Martin: *Wagenaar Hummelinck* 1132a—3; *Vroman St. M.* 2—24, *St. M.* 17—28. Windings touching each other, 3—4 μ wide, filaments 1.5—2 μ in diam.

Ecology: on mud, roots of *Rhizophora*, sponges, or floating among other algae, in quiet, brackish, salt, also fresh and thermal waters, on sea-shores, in lower littoral belt.

Distribution: cosmopolitan.

Spirulina labyrinthiformis (Menegh.) ex Gomont, 16, p. 255; Geitler, p. 928, Frémy, 1934, p. 134; Umezaki, p. 67 — *Ill.*: Frémy, 1934, pl. 31 fig. 25; Umezaki, pl. 10 fig. 10.

St. Martin: *Vroman St. M.* 4—24, *St. M.* 10—36, *St. M.* 12—18, *St. M.* 24—17; Saba: *Vroman Saba* 3—14, *Saba* 3—15; St. Eustatius: *Suringar s.n.*; *Vroman St. Eust.* 5—20. Windings touching each other, 2.5—3 μ wide, filaments 1 μ in diam.

Ecology: in the sheaths of *Hydrocoleum*, among other algae, on roots of *Rhizophora*, on sponges, in quiet, salt, brackish or thermal waters.

Distribution: Europe, Africa, Mexico, Antilles, Japan, India.

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