

kittonii. The same assemblage, but with a predominance of *Aulacodiscus kittonii*, has been recorded from Kawerua, Northland (Sharma 1975). At the end of a bloom in the surf zone on the west coast beaches, mounds of detergent-like foam may accumulate in blanketing clouds. Thus, blooms of surf-zone benthic diatoms are commonly responsible for the sea foam. In particular, *Attheya armatus* has a remarkable ability to accrete sand and clay particles and to form sticky aggregates that foam on the shore (Lewin & Norris 1970; Crawford et al. 1994). This species is not planktonic, but benthic, dwelling in the sand.

Another possible source of the sea foam at Piha is bull kelp (*Durvillaea antarctica*). Mass die-offs of bull kelp occurred on Auckland's west coast in 1995 and 1998. Microscopic examination of the September 2014 Piha foam revealed an abundance of brown, cellular detritus particles which could well have been sloughings from *Durvillaea*. Very few unicellular algae were detected, though the detritus may represent sticky diatom aggregates.

As to the environmental effects of the foam, it was apparent at south Piha during the Bot Soc visit that intertidal sea life was unusually sparse. Foam may well have affected invertebrates (Fig. 4), and also seaweeds, which were noticeably absent over large areas. Toxic effects of water foams have been well documented (Schilling & Zessner 2011).



Fig. 3. Sea foam, Taitomo Island, south Piha. Photo: Mike Wilcox, 20 Sep 2014.



Fig. 4. Sea foam overlying a colony of mussels (*Xenostrobus pulex*) at The Gap, Photo: Josh Salter, 20 Sep 2014.

References

- Cassie Cooper, V. 1996: *Microalgae*. Riverside Books, Hamilton.
- Crawford, R.M.; Gardner, C.; Medlin, L.K. 1994: The genus *Attheya* I. A description of four new taxa, and the transfer of *Gonioceros septentrionalis* and *G. armatum*. *Diatom Research* 9 (1): 27-51.
- Lewin, J.; Norris, R.E. 1970: Surf-zone diatoms of the coasts of Washington and New-Zealand (*Chaetoceros armatum* T.West and *Asterionella* spp.). *Phycologia* 9: 143-149.
- Schilling, K.; Zessner, M. 2011: Foam in the aquatic environment. *Water Research* 45: 4355-4366.
- Sharma, P. 1975: A note on the algal bloom at Kawerua coast, North Island, New Zealand. *Tane* 21: 55-58.

***Wittrockiella salina* in Auckland – a green alga at the crossroads**

M.D. Wilcox

Introduction

Since 2005 I have been studying the marine algae of Auckland, recording their occurrence, habitats and distribution. The goal is to compile a comprehensive account of Auckland's seaweeds, supported by herbarium specimens and field observations. A large range of habitats has been surveyed covering the main harbours (Waitemata, Mahurangi, Whangateau, Manukau and Kaipara), the west coast shores, the

east coast shores, and the Hauraki Gulf Islands. Observations and collections have ranged from subtidal rocky reefs and channels (thanks to the efforts of various SCUBA divers) to the intertidal rocky shores and mudflats.

Of all the 550 or so species of marine algae we have in Auckland waters, one stands out for its specialised high-intertidal brackish habitat which is at the

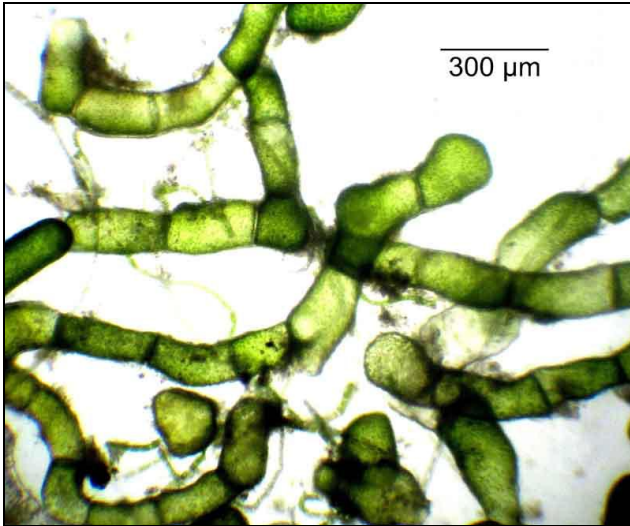


Fig. 1. *Wittrockiella salina*, specimen from North Head, 10 Sep 2014, AK 354593.

crossroads of land and sea, of freshwater and saltwater. This species is the crust-forming, filamentous green alga, *Wittrockiella salina*, and the purpose of this note is to put it on the map, figuratively and literally.

Wittrockiella

There are currently seven species of *Wittrockiella*:

- *W. amphibia* (Collins) Boedeker & Hansen (including *W. paradoxa* Wille) from Pacific Northwest USA (Washington, Oregon, California), eastern North America, and Europe (Brodie et al. 2007, Boedeker & Hansen 2010).
- *W. calcicola* (Fritsch) Boedeker (formerly *Cladophorella calcicola* Fritsch) from semi-terrestrial moist limestone sites in Europe (Boedeker et al. 2012).
- *W. fritschii* (A.K.Islam) Boedeker (formerly *Cladophorella fritschii* A.K.Islam) from Bangladesh (Boedeker et al. 2012).
- *W. lyallii* (Harv.) C.Hoek, Ducker & Womersley from southern New Zealand and Chile (van den Hoek et al. 1984, Boedeker et al. 2010, Nelson 2013).
- *W. netzahualpillii* (Galicía & Novelo) Boedeker (formerly *Cladophorella netzahualpillii* Galicía & Novelo) from brackish water wells in Mexico (Boedeker et al. 2012).
- *W. salina* V.J.Chapm. from New Zealand and Australia (van den Hoek et al. 1984). A freshwater form, *Wittrockiella salina* var. *kraftii* Skinner & Entwisle, has been described from the base of a waterfall on Lord Howe Island, Australia (Skinner & Entwisle 2004), but was not recorded there by Kraft (2007). Christian Boedeker rediscovered it in 2012, noting that it

was a genuine freshwater species, occurring in forest well away from the sea.

- *W. sundarbanensis* (A.K.Islam) Boedeker (formerly *Cladophorella sundarbanensis* A.K.Islam) from mangrove forests in Bangladesh (Boedeker et al. 2012).

Wittrockiella has been assigned to the family Pithophoraceae in the order Cladophorales (see Boedeker et al. 2012, Nelson 2013), but has alternatively been retained in Cladophoraceae (Broady et al. 2012).

Discovery of *Wittrockiella salina*

Chapman (1949) described this species from a population growing in the shade of overhanging rocks near the high watermark of spring tides, Stanmore Bay, Whangaparaoa Peninsula. The Stanmore Bay holotype specimen (AK 167050) is preserved at the Auckland Museum. Chapman (1949) emphasized that it is a minute, microscopic plant and easily overlooked. I visited the Stanmore Bay site in June 2012 and found it still growing there. Evidently, Chapman just observed a small, inconspicuous patch, and makes no reference to it growing in extensive crusts, as it does at many sites in Auckland. Its main microscopic features are the highly variable size and shape of the individual cells (Fig. 1) which are characteristically bulging, and the common occurrence of hair-like processes. Auckland samples generally have filaments around 3 mm long and 200 µm wide.

The type was at one time temporarily lost so a neotype was designated: V.W.Lindauer N.Z. Exsicc. No. 331, Uruti Bay, Russell, 6 Dec 1948, ADU 17848 (van den Hoek et al. 1984), and AK 30307, AK 295618, WELT A001131, WELT A020775, and BM 001045910: on stones, piles and other surfaces, high intertidal, muddy, brackish (Nelson & Adams 1987).

Chapman (1956) also described *Cladophorella marina* V.J.Chapm., from crevices in clay banks, Orongo Bay, Russell (V.W.Lindauer 9091, 8 Jan 1948, AK 167051–holotype; AK 338787) but it has subsequently been widely regarded as just a synonym of *Wittrockiella salina* (van den Hoek et al. 1984; Womersley 1984; Nelson & Adams 1987; Adams 1994). However, several specimens in the Auckland Museum from Northland, labelled as this alga (including AK 338787) have the habitat and appearance of the tight-mat, crevice-dwelling form of *Microdictyon mutabile*. Other specimens, e.g. V.W.Lindauer N.Z. Exsicc. No. 154, Matauri Bay, 21 Sep 1940, treated as *Wittrockiella salina* (Adams 1994; Nelson & Phillips 1996), had earlier been identified as *Cladophora velutina* or *Cladophora membranacea* var. *repens*, and may be better placed in *Cladophora albida*. *Cladophorella marina*



Fig. 2. *Wittrockiella salina* colony at base of cliff below a freshwater seep, Kakamatua Bay, Manukau Harbour, 21 Aug 2009, AK 306508.



Fig. 3. *Wittrockiella salina* with *Ulva intestinalis* below a freshwater waterfall above the beach, south Piha, 20 Sep 2014, AK 354583.



Fig. 4. Site of *Wittrockiella salina* below stormwater outfall, Murrays Bay, North Shore, 25 July 2013, AK 345203.

(subsequently considered to be *Wittrockiella salina*) was reported by Beanland and Woelkerling (1982) to be common on mangrove pneumatophores in the Spencer Gulf, South Australia, and with cell widths of 140-250 μ m.

Adams (1994) stated that *Wittrockiella salina* was virtually unknown in the field in New Zealand, and rarely present in herbaria, and Nelson (2013) does not include it in her illustrated guide. However, *Wittrockiella lyallii* is well known from southern New Zealand (Catlins, Fiordland, Stewart Island, Chatham Island, Snares) (Boedeker et al. 2010). For instance, it is abundant in Doubtful Sound, Fiordland, where it favours south-facing shores, forming dark green crusts where there is freshwater seepage and shade from overhanging vegetation (Boyle et al. 2001).

***Wittrockiella salina* V.J.Chapm. var. *salina* in Auckland**

This alga is distinctly high-tidal and euryhaline (brackish) in its occurrence, favouring shaded rocks where there is freshwater seepage. It occurs at all seasons, in suitable habitats. Colonies may be as much as 0.3 m² in area and up to 2 cm thick. The most typical habitat is the high-tidal base of shaded, steeply-sloping or vertical sandstone or conglomerate cliffs with intermittent freshwater from natural seeps (Figs. 2 and 3) or stormwater pipes (Fig. 4). Associates include other euryhaline green algae such as *Rhizoclonium riparium*, *Ulva intestinalis*, *U. compressa* and *U. procera*. On a sea cliff at south Piha, *Wittrockiella salina* occurs below a waterfall with *Ulva intestinalis* and the freshwater filamentous algae *Zygnema* and *Spirogyra*. Populations on shaded sandstone banks at Kakamatua Bay, Manukau Harbour, are semi-terrestrial, with mosses such as *Fissidens leptocladus* and a cyanobacterium, *Nostoc* sp., sometimes associated with it (Fig. 2). It grows as firm, brittle, crunchy, dark-green crusts, often with long hyaline hairs. The habitat and robustness of some of the Manukau Harbour colonies resemble that of *Wittrockiella lyallii*, which is distributed in southern New Zealand and southern South America (Adams 1994; Boedeker, Ramírez & Nelson 2010). However, *W. lyallii* has much larger cells (c. 500- 600 μ m wide), and lacks hairs, and Christian Boedeker (Victoria University of Wellington) has confirmed from gene sequences that the Manukau populations are *W. salina*.

Populations at Goat Island Bay and Mathesons Bay, Leigh, are on greywacke rock at the edges of small freshwater creeks as they enter beaches. A report of *Wittrockiella salina* on Kaikoura Island, Great Barrier (Wilcox 2007) needs to be retracted, as the high-tidal green turfing alga mentioned was actually *Microdictyon mutabile*.

Wittrockiella salina var. *salina* is reported as occurring in Tasmania, South Australia, Victoria and

New South Wales as turfs or crusts, as in Auckland, but may also occur as 'moss balls' floating on top of the water in saline lagoons, and on mangrove pneumatophores (Beanland & Woelkerling 1982, van den Hoek et al. 1984, Womersley 1984). In Auckland, except for one collection from Tuff Crater on basalt lava, *Wittrockiella salina* has not been found on mangroves or in salt marshes, nor on wood, and nor has the moss-ball form been found in New Zealand.

There are just four collections of *Wittrockiella salina* from outside Auckland (Russell, Ahipara, Nelson, Chatham Islands), while 35 gatherings have been made in Auckland (Fig. 5). Although this may seem to indicate that Auckland is the stronghold for the species, the disparity is more than likely just because the author's collecting was concentrated here and that it has not been looked for, recognised and collected from many other places.

Herbarium specimens from Auckland

Waitemata Harbour: Tuff Crater, Northcote, mangroves, *M.D. Wilcox 2126*, 8 Nov 2008, AK 307569; Soldiers Bay, *M.D. Wilcox 4436*, 21 Sep 2011 (sample sent to Christian Boedeker), AK 328861, WELT A031117; Paremoremo, Sanders Reserve, *M.D. Wilcox 4468*, 21 Nov 2011, AK 329962; Greenhithe, *M.D. Wilcox 4566*, 18 Jan 2012, AK 330228; North Head, Torpedo Bay, *M.D. Wilcox 4665*, 20 Aug 2012, AK 332905; Herne Bay, Bella Vista Reserve foreshore, *M.D. Wilcox 4804*, 7 Jan

2013, AK 337024; North Head, Torpedo Bay, *M.D. Wilcox 5260*, 10 Sep 2014, AK 354593.

East Coast Bays to Weiti River: Murrays Bay, below stormwater pipe outflow near wharf, *M.D. Wilcox 5082*, 25 Jul 2013, AK 345203.

Whangaparaoa Peninsula to the Matakana River, including Mahurangi Harbour and Kawau Bay: Stanmore Bay, *V.J. Chapman*, 1948, AK 167050 (type); Tindalls Beach, *V. Cassie (Cooper)*, 9 Jun 1985, AK 337433; Manly, Polkinghorne Bay, *M.D. Wilcox 4537*, 28 Feb 2012, AK 330632; Stanmore Bay, *M.D. Wilcox 4599*, 27 June 2012, AK 334180; Arkles Bay, *M.D. Wilcox 5052*, 18 Jul 2013, AK 345197; Fishermans Rock, *M.D. Wilcox 5198*, 2 Feb 2014, AK 350634.

Northern Rodney – Tawharanui Peninsula to Te Arai Point: Goat Island Beach, on sides of creek channel, forming a thick turf, *I. Novaczek*, 28 Aug 1988, Leigh Lab Herbarium; Whangateau Harbour, near Big Omaha Wharf, *M.D. Wilcox 4431a*, 31 Aug 2011, AK 328489, WELT 031450; Mathesons Bay, creek, *M.D. Wilcox 4453*, 25 Oct 2011, AK 329937, WELT A031472; Whangateau Harbour, near Big Omaha Wharf, *M.D. Wilcox 4518*, 4 Dec 2011, AK 330249, WELT 032272; Leigh, Goat Island Bay, Whakatuwhenua Stream, *M.D. Wilcox 4671*, 23 Aug 2012, AK 334168; Whangateau Harbour, near Big Omaha Wharf, *M.D. Wilcox*, 31 Aug 2012, WELT A031450.

Inner Hauraki Gulf – Eastern Beach to Orere Point and Miranda on the Firth of Thames: Howick, *M.D. Wilcox 5243*, 30 Jul 2014, AK 353913.

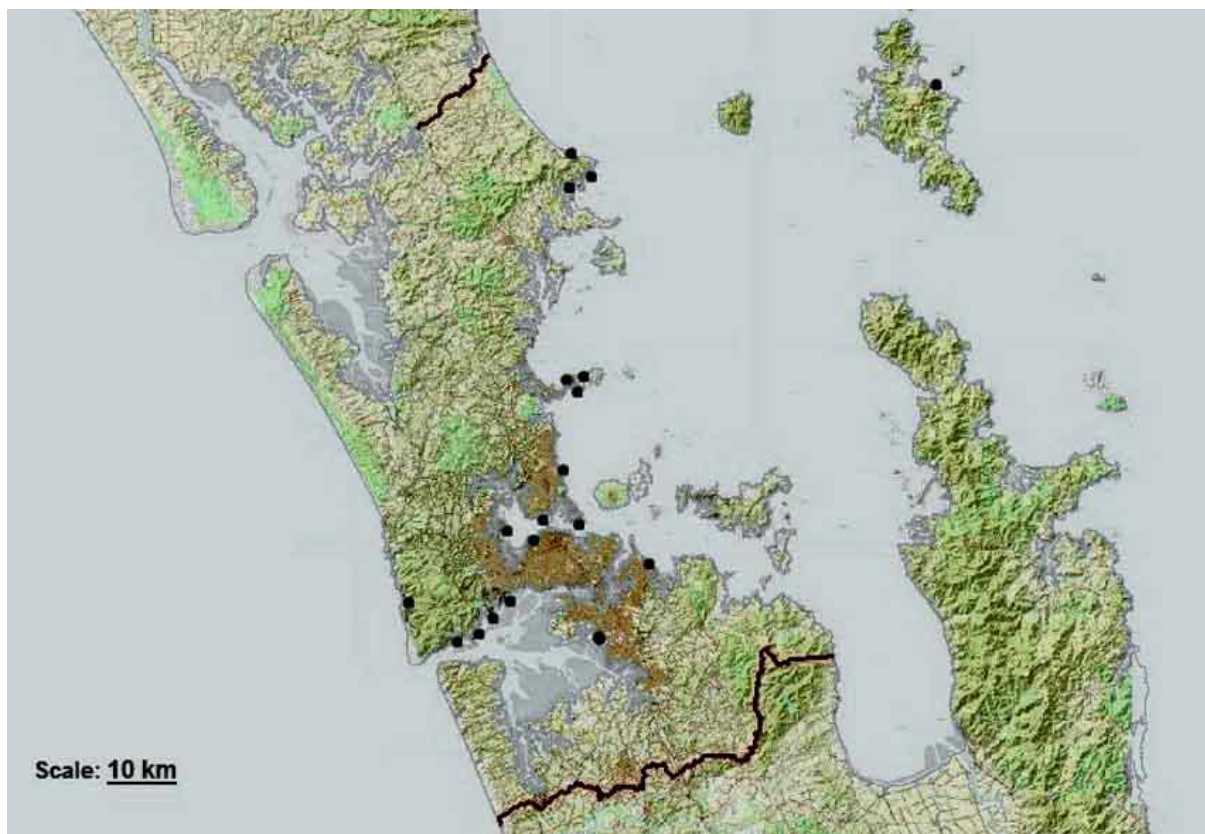


Fig. 5. Distribution of *Wittrockiella salina* in Auckland based on herbarium collections.

Outer Hauraki Gulf Islands: Great Barrier Island, Awana, south, freshwater seepage, *M.D. Wilcox 4923*, 17 Jan 2013, AK 337343.

West Coast–Manukau Heads to Muriwai: Piha, *M.D. Wilcox 5275*, 20 Sep 2014, AK 354583.

Manukau Harbour: Kakamatua Bay, *M.D. Wilcox 2040*, 16 May 2007, AK 307571; Kakamatua Bay, *M.D. Wilcox 3583*, 21 Aug 2009, AK 306508; Kakamatua Bay, *M.D. Wilcox 4073*, 28 Jun 2010, AK 315004; Kakamatua Bay, *M.D. Wilcox 4074*, 28 Jun 2010, AK 315009; Kakamatua Bay, *M.D. Wilcox 4077*, 28 Jun 2010, AK 315007; Kakamatua Bay, *M.D. Wilcox 4214*, 31 Aug 2010 (sample sent to Christian Boedeker, Leiden), AK 316819, WELT A032063; Kakamatua Bay, *M.D. Wilcox 4345*, 5 Mar 2011 (sample sent to Christian Boedeker), AK 326458, WELT 031054; Weymouth, *M.D. Wilcox 4568*, 10 Feb 2012, AK 330356; Waikowhai, *M.D. Wilcox 4624*, 13 July 2012, AK 336782; Cornwallis, *M.D. Wilcox 4627*, 14 July 2012, AK 336793; Green Bay, *M.D. Wilcox 4642*, 27 July 2012, AK 336794; Bokel Bay, Laingholm, *M.D. Wilcox 4990*, 7 Apr 2013, AK 340376; Taumatara Point, Laingholm, *M.D. Wilcox 4991*, 7 Apr 2013, AK 340382; Cornwallis, *M.D. Wilcox 5193*, 2 Feb 2014, AK 350635.

Chapman (1956) also records it from Orewa, Te Haruhi Bay (Whangaparaoa Peninsula), Palm Beach (Waiheke Island), and from Whangaparapara (Great

Barrier Island), but herbarium specimens have not been found.

Herbarium specimens from other parts of New Zealand

North Island: Bay of Islands, Russell, Orongo Bay, in culvert, *V.W. Lindauer 9013*, 23 Dec 1947, AK 338666; Bay of Islands, Russell, Uruti Bay, on sunny side of culvert, with small muddy stream near HWM, *V.W. Lindauer 331*, 6 Dec 1948, AK 30307, AK 295618, WELT A020775, WELT A001131; Ahipara, Shipwreck Bay, freshwater seeps at base of cliffs, *M.D. Wilcox 5141*, 12 Oct 2013, AK 346025.

South Island: Nelson, Tasman Bay, Stillwater Point, *W.A. Nelson*, 10 Jul 1991, WELT A019876; Nelson, Tasman Bay, Coquille Point, *C. Boedeker & G.C. Zuccarello*, 27 Feb 2011, WELT A031144.

Chatham Islands: Turanga Rock, *W.A. Nelson*, 9 Mar 1987, WELT A018584.

Acknowledgements

Many thanks for advice and assistance to Dr Christian Boedeker, Post-doctoral researcher, School of Biological Sciences, Victoria University of Wellington, and world authority on *Wittrockiella*. The base distribution map (Fig. 5) is from the Auckland Council ALGGi database.

References

- Adams, N. M. 1994: *Seaweeds of New Zealand*. Canterbury University Press.
- Beanland, W.R.; Woelkerling, W.J. 1982: Studies on Australian mangrove algae: II. Composition and geographical distribution of communities in Spencer Gulf, South Australia. *Proceedings of the Royal Society of Victoria* 94: 89-106.
- Boedeker, C.; Hansen, G.I. 2010: Nuclear rDNA sequences of *Wittrockiella amphibia* (Collins) comb.nov. (Cladophorales, Chlorophyta) and morphological characterization of the mat-like growth form. *Botanica Marina* 53: 351-356.
- Boedeker, C.; Ramirez, M.E.; Nelson, W.A. 2010: *Cladophoropsis brachyartrus* from southern South America is a synonym of *Wittrockiella lyallii* (Cladophoraceae, Chlorophyta), previously regarded as endemic to New Zealand. *Phycologia* 49(6): 525-536.
- Boedeker, C.; O'Kelly, C.J.; Star, W.; Leliaert, F. 2012: Molecular phylogeny and taxonomy of the *Aegagropila* clade (Cladophorales, Ulvophyceae), including the description of *Aegagropilopsis* gen. nov. and *Pseudocladophora* gen. nov. *Journal of Phycology* 48(3): 808-825.
- Boyle, M.C.; Jillett, J.B.; Mladenov, P.V. 2001: Intertidal communities in Doubtful Sound, New Zealand; changes over time. *New Zealand Journal of Marine & Freshwater Research* 35: 663-673.
- Broady, P.A.; Flint, E.A.; Nelson, W.A.; Cassie Cooper, V.; De Winton, M.D.; Novis, P.M. 2012: Phyla Chlorophyta and Charophyta: green algae. Pp 347-381 in Gordon, D.P. (ed.) 2012. *New Zealand Inventory of Biodiversity Vol. 3. Kingdoms Bacteria, Protozoa, Chromista, Plantae, Fungi*. Canterbury University Press, Christchurch.
- Brodie, J.; Maggs, C.A.; John, D.M. (eds.) 2007: *Green seaweeds of Britain and Ireland*. British Phycological Society.
- Chapman, V.J. 1949: Some new species and forms of marine algae from New Zealand. *Farlowia*, 3 (4): 495-498.
- Chapman, V.J. 1956: The marine algae of New Zealand. Part 1. Myxophyceae and Chlorophyceae. *Journal of the Linnean Society of London* 55(360): 333-501.
- Kraft, G.T. 2007. *Algae of Australia. Marine benthic algae of Lord Howe Island and the southern Great Barrier Reef, 1. Green algae*. Canberra & Melbourne: Australian Biological Resources Study & CSIRO Publishing.
- Nelson, W. 2013: *New Zealand seaweeds. An illustrated guide*. Te Papa Press, Wellington.
- Nelson, W.A.; Adams, N.M. 1987. Marine algae of the Bay of Islands area. List of species. *National Museum of New Zealand Misc. Series* No. 16.
- Nelson, W.A.; Phillips, L. 1996: The Lindauer Legacy – current names for the Algae Nova-Zelandicae Exsiccatae. *New Zealand Journal of Botany* 34: 553-582.
- Skinner, S.; Entwisle, T.J. 2004: Non-marine algae of Australia: 6. Cladophoraceae (Chlorophyta). *Telopea* 10(3): 731-748.
- van den Hoek, C.; Ducker, S.C.; Womersley, H.B.S. 1984: *Wittrockiella salina* Chapman (Cladophorales, Chlorophyceae), a mat and ball forming alga. *Phycologia* 23: 39-46.
- Wilcox, M.D. 2007: Seaweeds of Kaikoura Island. *Kaka Comments, Motu Kaikoura Trust Supporters' Newsletter* 3: 5-6.
- Womersley, H.B.S. 1984. *The marine benthic flora of southern Australia Part I*. Adelaide: South Australian Government Printing Division.