

## SHORT COMMUNICATION

### A new record of *Percursaria percura* (Ulvaceae, Ulvales) on the North Island, New Zealand

SJ Pratt<sup>a</sup>, CJ Lundquist<sup>b\*</sup>, W Nelson<sup>c</sup> and CEC Gemmill<sup>a</sup>

<sup>a</sup>Department of Biological Sciences, University of Waikato, Hamilton, New Zealand; <sup>b</sup>National Institute of Water and Atmospheric Research Ltd (NIWA), Hamilton, New Zealand; <sup>c</sup>National Institute of Water and Atmosphere Research Ltd (NIWA), Wellington, New Zealand

(Received 2 May 2012; accepted 30 August 2012)

The filamentous green alga *Percursaria percura* (Ulvaceae, Ulvales) was recorded for the first time on the North Island of New Zealand at Ōmokoroa Estuary, Tauranga Harbour. This species is previously known within New Zealand from only two records, both from the South Island. In Tauranga Harbour, this species was restricted to anoxic estuarine sediments where mangrove forests had been mulched, and mulch left in situ. *Percursaria percura* was found intertwined with *Ulva* spp. and *Rhizoclonium* spp. Surveys of other North and South Island estuaries suggest that this alga, although occurring as part of nuisance green algal blooms in Tauranga Harbour, has only colonized human-impacted locations, and has not yet been observed in 'natural' estuarine ecosystems in New Zealand. As this species was found intertwined with other mat-forming filamentous green algae, it can easily be misidentified in the field, leading to both over- and under-reporting of species occurrence.

**Keywords:** *Percursaria percura*; Ulvaceae; Tauranga Harbour; mangrove; macroalgal blooms; New Zealand

#### Introduction

Here we report a new record of the macroalgal species *Percursaria percura* (C. Agardh) Rosenv. (Ulvaceae) at Ōmokoroa Estuary, Tauranga Harbour, North Island, New Zealand. *Percursaria percura* has previously been recorded only twice in New Zealand waters from South Island localities. Laing (1927, 1932) recorded it from Kaikorai, Dunedin, but this record was questioned by Naylor (1954) as no authenticated voucher was found in Laing's herbarium. *Percursaria percura* has also been found from highly modified hypersaline lagoons and channels adjacent to Lake Grassmere, Marlborough (Adams 1994). Based on the few records available for this species, it is currently difficult to determine whether it is an

uncommon or cryptic indigenous species or an introduced non-indigenous species.

The genus *Percursaria* Bory (Ulvaceae) is monotypic and is comprised currently of the single recognized species *P. percura* (Guiry & Guiry 2012). The species is widely distributed globally with extensive representation throughout the coastal margins of the Pacific and Atlantic oceans (Garbary et al. 1985; South 1984; Wynne 1986), usually in sheltered bays and inlets in the upper intertidal region (Londry et al. 2005). *Percursaria percura* is a filamentous green alga that forms dense, bright green clumped mats on the substrate. While this alga is virtually indistinguishable in the field from other filamentous green algae such as *Rhizoclonium* spp., it is readily identified in the

\*Corresponding author. Email: [c.lundquist@niwa.co.nz](mailto:c.lundquist@niwa.co.nz)

laboratory with the aid of a compound microscope.

The first documented record of *P. percursea* on the North Island of New Zealand was at Ōmokoroa Estuary, Tauranga Harbour, in April 2010 (Table 1). Large patches (>1 ha) of filamentous green algae were also observed colonizing disturbed substrates where mangroves were removed in four other estuaries in Tauranga Harbour (Waikareao, Waikaraka, Te Puna and Matua estuaries); however, *P. percursea* has not yet been documented at these sites. All putative records have been associated with localized disturbances due to deposition of post-removal mulched mangrove (*Avicennia marina* subsp. *australasica* (Walp.) J.Everett). Large seasonal blooms of filamentous green algae, similar in timing to blooms of other Ulvaceae such as sea lettuce (*Ulva* sp.) and other filamentous green algae such as *Rhizoclonium* spp. (Cladophoraceae), have formed at most mangrove clearing sites; these blooms are probably fuelled by high nutrient availability at these disturbed sites, although in situ nutrient release associated with mangrove mulchate has not been quantified.

### Distribution and habitat

*Percursaria percursea* presence in the North Island of New Zealand was confirmed from three collections at Ōmokoroa Estuary, Tauranga Harbour, made in 2010 and 2012. The locality is described as an upper intertidal mudflat of the greater Tauranga Harbour (Table 1). The site is inundated with harbour water twice daily for <6 h per tidal cycle.

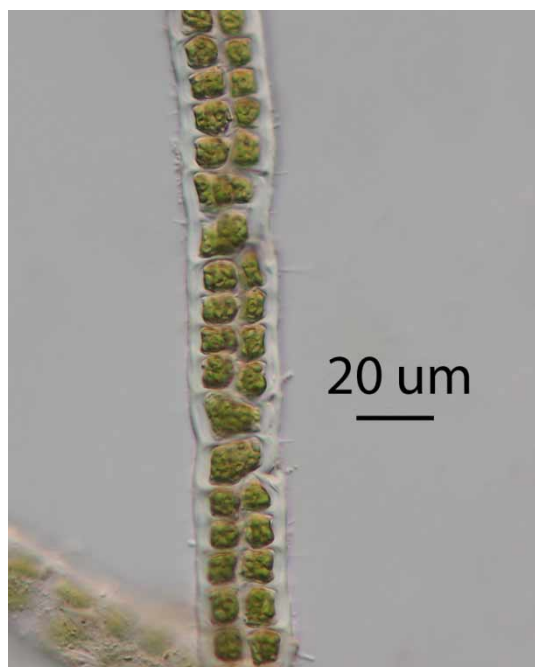
We observed *P. percursea* only on the highly anoxic (oxic layer generally <5 mm deep) mangrove mulchate along with Ulvaceae and other filamentous green algae. These multispecies macroalgal blooms (C. J. Lundquist, NIWA, pers. obs.), including *P. percursea*, *Rhizoclonium* spp. and *Ulva* spp., were found in highest abundance in spring months. Large patches of filamentous green algae were recorded in Ōmokoroa in 2010, and sub-samples confirmed the presence of *P. percursea*, and did not confirm presence of other filamentous green algae such as *Rhizoclonium* spp. Detailed sampling in 2012 found macroalgal blooms to be comprised of multispecies aggregations at all locations, suggesting that the large patches of filamentous green algae observed in 2010 were likely to also be multispecies aggregations.

### Morphology

We observed mats, both fresh and rehydrated, under  $\times 400$  magnification on a compound microscope; this was the minimum magnification at which we could make reliable determinations. The thalli of *P. percursea* are generally unbranched, biseriate filaments (Londry et al. 2005; Guiry & Guiry 2012) (Fig. 1). The filaments are also typically contorted in appearance. The filament cells are square to slightly elongate, typically 10–25  $\mu\text{m}$  wide  $\times$  10–40  $\mu\text{m}$  in length (Guiry & Guiry 2012). The two rows of cells are more or less symmetrical, with each cell containing a single parietal chloroplast (Londry et al. 2005). It is not uncommon for filaments to become uniseriate for short lengths (Bliding 1963; Londry et al. 2005). The life history of this species

**Table 1** Collection sites of *Percursaria percursea* at Ōmokoroa Estuary, Tauranga Harbour, Bay of Plenty, North Island, New Zealand.

| Sample ID | Date collected   | GPS coordinates          | Det.      | Voucher      |
|-----------|------------------|--------------------------|-----------|--------------|
| ASK204    | 10 November 2010 | 37°39.006'S 176°02.235'E | W. Nelson | WELT A032066 |
| ASK205    | 10 November 2010 | 37°39.006'S 176°02.235'E | W. Nelson | WELT A032067 |
| SJP15     | 23 January 2012  | 37°39.056'S 176°02.310'E | S. Pratt  | WAIK 22539   |



**Figure 1** Low-light photomicrograph of a biserial filament of *Percursaria percura* (not stained). Sample SJP15, Ōmokoroa Estuary, Tauranga Harbour, Bay of Plenty, North Island, New Zealand.

alternates between isomorphic gametophytes and sporophytes (Bliding 1963). The species is capable of both asexual and sexual reproduction, producing quadriflagellated zoospores and biflagellated anisogametes, respectively.

*Percursaria percura* can be easily distinguished under  $\times 40$  magnification from other filamentous green algae and Ulvaceae with which it often co-occurs, due to its biserial filaments; *Rhizoclonium* has uniseriate filaments with square to rectangular-shaped cells and *Ulva* spp. have two layers of cells (Guiry & Guiry 2012).

### Discussion

This record of *P. percura* from the North Island of New Zealand adds to the current records of the distribution of this species both in New Zealand and internationally. We refer to the species as non-indigenous given its restricted

distribution records which are all associated with sites that have been modified by human activity, however, it is possible that this species is a cryptic and uncommon indigenous species that has evaded detection until recently.

The origin(s) of the population of *P. percura* at Ōmokoroa is unknown at this time and monitoring should continue to estimate the extent and frequency of occurrence of this species. Small-scale sampling of macroalgal blooms associated with mangrove removals at selected sites in Auckland and Whangamatā harbours, as well as other sites within Tauranga Harbour (Waikaraka, Waikareao, Te Puna and Welcome Bay estuaries) has not found any *P. percura* present. Extensive field sampling in Auckland estuaries in unmodified habitats did not detect this species, and it was not recorded in a national survey of soft sediment habitats in Whāngārei, Otago and Kaipara harbours, though *Ulva* spp. and *Rhizoclonium* spp. were recorded in all harbours (Neill et al. 2012). Elsewhere *P. percura* is generally found within upper tide-pools and salt marshes (Londry et al. 2005). We observed *P. percura* only in association with highly anoxic substrate, generally as part of multispecies blooms with Ulvaceae and other filamentous green algae. This environmental condition is associated with the human modification of the harbour through consented mangrove removal by mulching. In Tauranga Harbour, mangrove management has occurred as a response to increasing mangrove distributions, which are linked to changes in land-based inputs to the harbour (Green et al. 2003). Mangroves in Tauranga Harbour have increased substantially from  $<20$  ha aerial coverage in 1943 to c. 550 ha in 2001 (Park 2004).

*Percursaria percura* is not recognized as a nuisance species in the worldwide literature, in comparison with *Ulva* spp. that form extensive blooms in European and North American estuaries, as well as extensive blooms in Tauranga Harbour (de Winton et al. 1998). Because macroalgal blooms often require management action to mitigate smothering of benthic

communities and anoxic conditions, it is likely that the presence of macroalgal blooms on mangrove removal may be delaying return of these managed areas to a healthy ecosystem state (e.g. oxic layer reinstated and macrofauna re-establishment).

Accurate identification of *P. percursa* requires microscopic examination as this species can easily be mistaken for other filamentous green algae (and vice versa) in the field. Care must be taken to tease apart the mats that commonly consist of tangled filaments of multiple species. Ecologists must be cautious in this regard if their surveys are to be accurate. Identification of *P. percursa* and *Rhizoclonium* can also be confirmed via molecular identification, i.e. DNA-barcoding (C.E.C. Gemmill and S. Pratt, University of Waikato, unpublished data).

### Acknowledgements

This research was funded in part by a grant to National Institute of Water and Atmosphere Research (NIWA) by the New Zealand Ministry of Science and Innovation (Rehabilitation of Aquatic Ecosystems #C01X1002). Steven Pratt was funded by a University of Waikato Summer Research Scholarship. We are also grateful to the two referees for their constructive comments and suggestions for this manuscript. We thank Dr Svenja Heesch for providing a cultured sample, Dr Barry O'Brien (University of Waikato, UoW) for assistance with photography, and Rebecca Gladstone-Gallagher (UoW), Marenka Weis (NIWA) and Kelly Carter (UoW) for their assistance in the field.

### References

Adams NM 1994. Seaweeds of New Zealand. An illustrated guide. Christchurch, Canterbury University Press. 360 p.  
 Bliding C 1963. A critical survey of European taxa in Ulvales Part I *Capsosiphon*, *Percursaria*, *Blidingia*, *Enteromorpha*. *Opera Botanica* 8: 1–160.

de Winton MD, Hawes I, Clayton JS, Champion PD, Smith RK 1998. Sea lettuce dynamics and ecophysiology in Tauranga Harbour, Bay of Plenty. NIWA Client Report No. BPR802. National Institute of Water and Atmospheric Research Ltd, Hamilton, New Zealand. 68 p.  
 Garbary DJ, Hansen GI, Scagel RF 1985. Additions to the marine algae of Barkley Sound, Vancouver Island, British Columbia. *Syesis* 17: 43–45.  
 Green M, Ellis J, Schwarz AM, Green N, Lind D, Bluck B 2003. For and against mangrove control. NIWA Information Series 31. 8 p.  
 Guiry MD, Guiry GM 2012. AlgaeBase. World-wide electronic publication, National University of Ireland, Galway. <http://www.algaebase.org> (accessed 14 February 2012).  
 Laing RM 1927. A reference list of New Zealand marine algae. *Transactions and Proceedings of the Royal Society of New Zealand* 57: 126–185.  
 Laing RM 1932. List of seaweeds from the coast near Dunedin. In: *Dunedin Naturalists' Field Club. Catalogue of the indigenous, and introduced flowering plants, ferns, and seaweeds occurring in the Dunedin district.* Dunedin, Mills, Dick and Co. Pp. 31–41.  
 Londry KL, Badiou PH, Grasby SE 2005. Identification of a marine green alga *Percursaria percursa* from hypersaline springs in the middle of the North American continent. *The Canadian Field-Naturalist* 119: 82–85.  
 Naylor M 1954. A check list of marine algae of the Dunedin district. *Transactions of the Royal Society of New Zealand* 82: 645–663.  
 Neill K, D'Archino R, Farr T, Nelson W 2012. Macroalgal diversity associated with soft sediment habitats in New Zealand. *New Zealand Aquatic Environment and Biodiversity Report* No. 87. 127 p.  
 Park S 2004. Aspects of mangrove distribution and abundance in Tauranga Harbour. *Environment Bay of Plenty Environmental Publication* No. 16. 40 p.  
 South GR 1984. A checklist of marine algae of eastern Canada, second revision. *Canadian Journal of Botany* 62: 680–704.  
 Wynne MJ 1986. A checklist of benthic marine algae of the tropical and subtropical western Atlantic. *Canadian Journal of Botany* 61: 2239–2281.