



**Three new species of *Lessonia* Bory (*Lessoniaceae*, *Phaeophyceae*) from New Zealand: *L. media* sp. nov., *L. meridionalis* sp. nov. and *L. septentrionalis* sp. nov.**

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*Lessonia* Bory (in Dumont d'Urville 1825) is the type of the family *Lessoniaceae* Setchell & N.L.Gardner (1925) and includes 11 currently recognised species (Guiry & Guiry, 2023), and it is the only genus in the Laminariales confined to the southern hemisphere (Martin & Zuccarello 2012; Starko & al. 2019; Nardelli & al. 2023). The generitype is *Lessonia flavicans* Bory from Chile. Natural populations are harvested extensively (FAO, 2018) and perhaps over-harvested. However, species of *Lessonia* have aquaculture potential (Zuniga-Jara & Soria-Barreto, 2018). Prior to the present study, there were four named species in New Zealand waters. From the outlying Southern Ocean islands there are: *Lessonia adamsiae* C.H.Hay from the Snares, and *L. brevifolia* J.Agardh from the subantarctic Auckland Islands, Campbell, Antipodes and Bounty Islands. *Lessonia tholiformis* C.H.Hay is thought to be endemic to the Chatham Islands (Martin & Zuccarello 2012). *Lessonia variegata* J.Agardh has previously been considered to be widespread on the North and South Islands, and Stewart Island.

Molecular studies on the mainland species, *Lessonia variegata*, have shown that consists of four genetic lineages (Fig. 1; Martin 2011; Martin & Zuccarello 2012; Zuccarello & Martin 2016), with distinct geographic distributions (Fig. 2), in which overlapping populations have not been detected. J. Agardh (1878: 6) included three collections (probably individual specimens) in the original description of *L. variegata*, two from Lyall Bay (Wellington Region) and one from Hokianga (northern North Island). The distribution of this genetic entity (referred to as the 'Wellington species' in Zuccarello & Martin 2016) is from the East Cape of the North Island southward to the northern regions of the South Island (Marlborough) and occurring in Wellington (Zuccarello & Martin 2016). Another distinct lineage was found in the north of the North Island, from East Cape north on both the east and west coasts of the northern tip of New Zealand. This lineage was known as the 'northern species' (Zuccarello & Martin 2016). There was a separate lineage in the southern end of the South Island (from Banks Peninsula, Canterbury, South Island) to Stewart Island/Rakiura in the far south. This was designated as the 'southern species' (Martin & Zuccarello 2012, Zuccarello & Martin 2016). Another species had a more restricted distribution around the east coast of the north end of the South Island (Cape Campbell to Goose Bay), overlapping with the town of Kaikoura and between the 'Wellington species' and the 'southern species'. This was designated the 'Kaikoura species' (Martin & Zuccarello 2012; Zuccarello & Martin 2016; Fig. 2). Attempts were made by Martin (2011) to separate the species morphologically, but while there were some differences in examined specimens, the number of samples observed was too small to make generalizations on diagnostic characteristics for these species (Table 1), and he suggested that further sampling and observations be made.

**Table 1.** Morphological characteristics and habit of *Lessonia variegata sensu lato* lineages (modified from Martin 2011).

Feature	<i>L. variegata</i>	<i>L. septentrionalis</i>	<i>L. media</i>	<i>L. meridionalis</i>
<b>Lamina colour</b>	Variegated, light brown to yellow	sometimes striped variegation	Golden, not variegated	Light brown often lighter at the margins,
<b>Lacunae</b>	Numerous, large	Numerous, small	Few (2-3/mm)	Rare (on average 1/mm)
<b>Holdfast</b>	Massive, woody; dichotomously branched haptera	Flat, appressed on the substrate; at least in young specimens, flattened stipes	Massive, building half of a sphere	
<b>Stipes emerging from holdfast</b>	Up to 20 and more			few

These designations, while clearly supported by sequence data and geographic distribution were not formally described (Martin & Zuccarello 2012, Zuccarello & Martin 2016). With the raised interest in seaweed aquaculture, together with the threats to seaweed abundance and potential changes in distribution due to climate change, we think it is important that the species be formally described even if at present they are accurately distinguishable only by molecular data.

*Lessonia variegata* J.Agardh, 1878: 6

Description: Attached by variable to massive rigid/robust haptera and multiple stipes; with blades emanating from the intercalary meristem. Blades split ontogenetically, various widths. Margin often with teeth, widely spaced. Blades variegated (spotty dark and light regions), brown to yellow. Reproduction by large, mostly oval, sporangial sori on blades.

Syntype localities: “New Zealand: Colenso; Lyalls Bay, Cooks str.: Lyall; Lyalls bay, Hokianga: Berggren” (J. Agardh 1878: 6)

**Lectotype (here designated):** Lyalls Bay [Lyll Bay], leg. David Lyall; **LD** 2164 (Fig. 3a).

Phycobank registration (of lectotype): <http://phycobank.org/104263>.

**Epitype (here designated for the above lectotype):** Fighting Bay, Marlborough Sounds, New Zealand, leg. Peter Martin No. A729, 23 January 2007. **WELT** A035457.

Phycobank registration (of epitype): <http://phycobank.org/104264>.

Note: Adams (1994: 95) and Nelson (2013: 123) have considered one of the Lyall Bay specimens as the type (Fig. 3a), and we here designate this specimen as the lectotype (Phycobank registration: 104263). A sequenced epitype is here designated as the lectotype could not be sequenced.

*Lessonia media* sp. nov. Zuccarello & D’Archino (Fig. 3 b)

Description: Attached by variable to massive rigid/robust haptera and multiple stipes; with blades emanating from the intercalary meristem. Blades split ontogenetically. Blades parallel; various widths, with or without widely spaced teeth; distinguished from *L. variegata* by blades not being variegated (Fig. 4). Reproduction as in *L. variegata* with sori on blades. Distinguished from other species by the genetic regions: Mitochondrial: (1) the spacer between the tRNAs for tryptophan and isoleucine (*trnW*-spacer), a partial sequence of the gene coding for nicotinamide adenine dinucleotide (NADH) dehydrogenase subunit 6 (*nad6*); (2) partial cytochrome oxidase

subunit I and 3) the spacer region between adenosine tri-phosphate dehydrogenase subunit 8 and tRNA serine (atp8-Sp); the chloroplast regions: (1) the spacer between the large and small subunit of the ribulose-1,5-bisphosphate carboxylase/oxygenase gene (*rbc*-spacer) and (2) ribulose-1,5-bisphosphate carboxylase/oxygenase large subunit gene (*rbcL*); the nuclear region covering the internal transcribed spacers (1 and 2) between the small and large ribosomal RNA subunits, and including the 5.8S ribosomal RNA (ITS) (Martin & Zuccarello 2012, Zuccarello & Martin 2016).

**Etymology:** Named for its middle geographic position on the northeast coast of the South Island between Cape Campbell and Goose Bay, between the distribution of *Lessonia variegata* and *L. meridionalis*.

**Holotype:** WELT A035569.

**Phycobank registration:** <http://phycobank.org/104240>

**Type locality:** Cape Campbell, Marlborough, South Island, New Zealand (41.726081°S, 174.278226°E)

**Holotype sequence data:** *rbcL*: OR978109; COI: OR978115; *trnW*-L spacer: OR978121.

***Lessonia meridionalis* sp. nov.** Zuccarello & D'Archino (Fig. 3 c)

**Description:** Attached by variable to massive rigid/robust haptera and multiple stipes; with blades emanating from the intercalary meristem. Blades split ontogenetically. Blades parallel; various widths, usually without widely spaced teeth; distinguished from *L. variegata* by blade edges of a lighter golden colour (Fig. 5 c, f, g). Reproduction as in *L. variegata* in sori on blades.

Distinguished from other species by the genetic regions: Mitochondrial: (1) the spacer between the tRNA's for tryptophan and isoleucine (*trnW*-spacer), a partial sequence of the gene coding for nicotinamide adenine dinucleotide (NADH) dehydrogenase subunit 6 (*nad6*); (2) partial cytochrome oxidase subunit I and 3) the spacer region between adenosine tri-phosphate dehydrogenase subunit 8 and tRNA serine (atp8-Sp); the chloroplast regions: (1) the spacer between the large and small subunit of the ribulose-1,5-bisphosphate carboxylase/oxygenase gene (*rbc*-spacer); (2) ribulose-1,5-bisphosphate carboxylase/oxygenase large subunit gene (*rbcL*); the nuclear region covering the internal transcribed spacers (1 and 2) between the small and large ribosomal RNA subunits, and including the 5.8S ribosomal RNA (ITS) (Martin & Zuccarello 2012, Zuccarello & Martin 2016).

**Etymology:** Named for its southern geographic distribution on the South Island and Stewart Island/Rakiura of New Zealand

**Holotype:** WELT A035567

**Phycobank registration:** <http://phycobank.org/104241>

**Type locality:** Native Island, Stewart Island/Rakiura, New Zealand (46.9163667°S, 168.1594833°E)

**Holotype sequence data:** *rbcL*: OR978108; COI: OR978114; *trnW*-L spacer: OR978119.

***Lessonia septentrionalis* sp. nov.** Zuccarello & D'Archino (Fig. 3 d)

**Description:** Attached by variable to massive rigid/robust haptera and multiple stipes; stipes often flattened, especially in young plants; with blades emanating from the intercalary meristem.

Blades split ontogenetically. Blades parallel; various widths, often with widely spaced teeth; distinguished from *L. variegata* by blades occasionally with striated variegation (stripes of dark and light tissue)(Fig. 6 e, f, g); Reproduction as in *L. variegata* in sori on blades. Distinguished from other species by the genetic regions: Mitochondrial: (1) the spacer between the tRNA's for tryptophan and isoleucine (*trnW*-spacer), a partial sequence of the gene coding for nicotinamide adenine dinucleotide (NADH) dehydrogenase subunit 6 (*nad6*); (2) partial cytochrome oxidase subunit I and 3) the spacer region between adenosine tri-phosphate dehydrogenase subunit 8 and tRNA serine (atp8-Sp); the chloroplast regions: (1) the spacer between the large and small subunit of the ribulose-1,5-bisphosphate carboxylase/oxygenase gene (*rbc*-spacer); (2) ribulose-

1,5-bisphosphate carboxylase/oxygenase large subunit gene (*rbcL*); the nuclear region covering the internal transcribed spacers (1 and 2) between the small and large ribosomal RNA subunits, and including the 5.8S ribosomal RNA (ITS) (Martin & Zuccarello 2012, Zuccarello & Martin 2016).

Etymology: Named for its northern geographical distribution on the North Island.

Holotype: **WELT** A035572

Phycobank registration: <http://phycobank.org/104242>

Type locality: Motuotau, Bay of Plenty, North Island, New Zealand (37.628735°S, 176.193603°E).

Holotype sequence data: *rbcL*: OR978110; COI: OR978116; *trnW*-L spacer: OR978126.

Morphological identification of species of *Lessonia* is difficult, both due to the scarcity of characters but also due to the plasticity of these characters, making diagnostic characters difficult to determine. This was recognized by J. Agardh (1878: 6, in Latin) “The species of *Lessonia* are not easily separated by characters, so the synonymy is as complicated as possible”, despite which he designated *L. variegata* as a new species. The advent of molecular-assisted taxonomy has helped separate intraspecific variation from interspecific variation. A *Lessonia* species recognised (Searles 1978) as *L. nigrescens* Bory was found along the Chilean coast from 17°S to 41°S. Molecular studies revealed that two species existed, neither being *L. nigrescens*, occupying almost completely non-overlapping distributions [*L. berteriana* Montagne and *L. spicata* (Suhr) Santelices; González & al. 2012; Tellier & al. 2011a; 2011b]. The authors also stressed the importance of recognizing the separate species correctly as wild harvesting needs separate management approaches to conserve these two species resources appropriately (Tellier & al. 2011c). The species confused under the name *L. nigrescens* were distinguishable anatomically by the number and diameter of cortical cells and density of medullary filaments (González & al. 2012). In our experiences, such differences were not obvious in the *Lessonia* species from New Zealand.

The geographical distribution of the species of *Lessonia* from mainland New Zealand appears to be non-overlapping (485 samples from 39 populations, Zuccarello & Martin 2016), so species assignments can be made fairly confidently based on location. The species *L. berteriana* and *L. spicata* also appeared to be non-overlapping in Chile, but overlapping populations and sympatric populations were found. This overlap was limited to a very small area and did not seem to spread (Tellier & al. 2011c; Tellier & al. 2011b). Whether these are mixed species populations and whether the distributions of the species in New Zealand have changed since the 2010’s collections needs further study (Martin, 2011), but these new names will give researchers a taxonomic basis for their research activities.

The species of *Lessonia* differ subtly from each other. While *L. variegata* seems to consistently have a spotty variegation on blades (Fig. 7), this has not been seen in *Lessonia media* (Fig. 4), nor has it been observed in *L. meridionalis* (Fig. 5). This type of variegation has been rarely seen in *L. septentrionalis*, but more often a striped (long parallel colour variation), or no variegation, is seen (Fig. 6). The blades of *L. meridionalis* are often distinct in having a lighter coloured edge (Fig. 5). *Lessonia septentrionalis* also had stipes that were often flattened. Whether any of these characters, or a new set of characters, are completely consistent within the species cannot be determined for certain at this time, but variation in these morphologies has been noted in most of the species based on site and presumed age. Anatomical variation has been studied (e.g. size and abundance of mucus ducts lacunae) but not widely enough to make definitive conclusion of diagnostic anatomical characters (Martin 2011).

While *Lessonia* is a commercially utilized crop around the world and experimental cultivation is in its early stages (Gouraguine & al. 2021; Nardelli & al. 2023) potentially including in New Zealand,



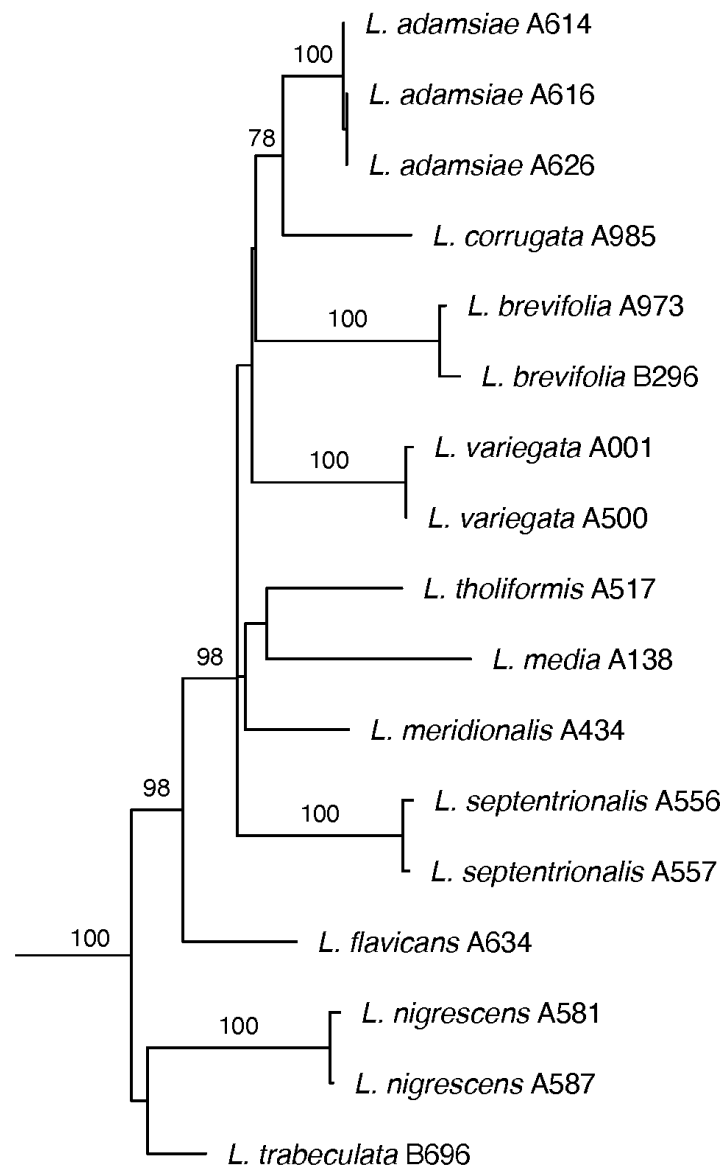
a correct nomenclature of the targeted species both for future research and for any management consideration is needed. We hope that this publication with the recognition of three new species in New Zealand provides that.

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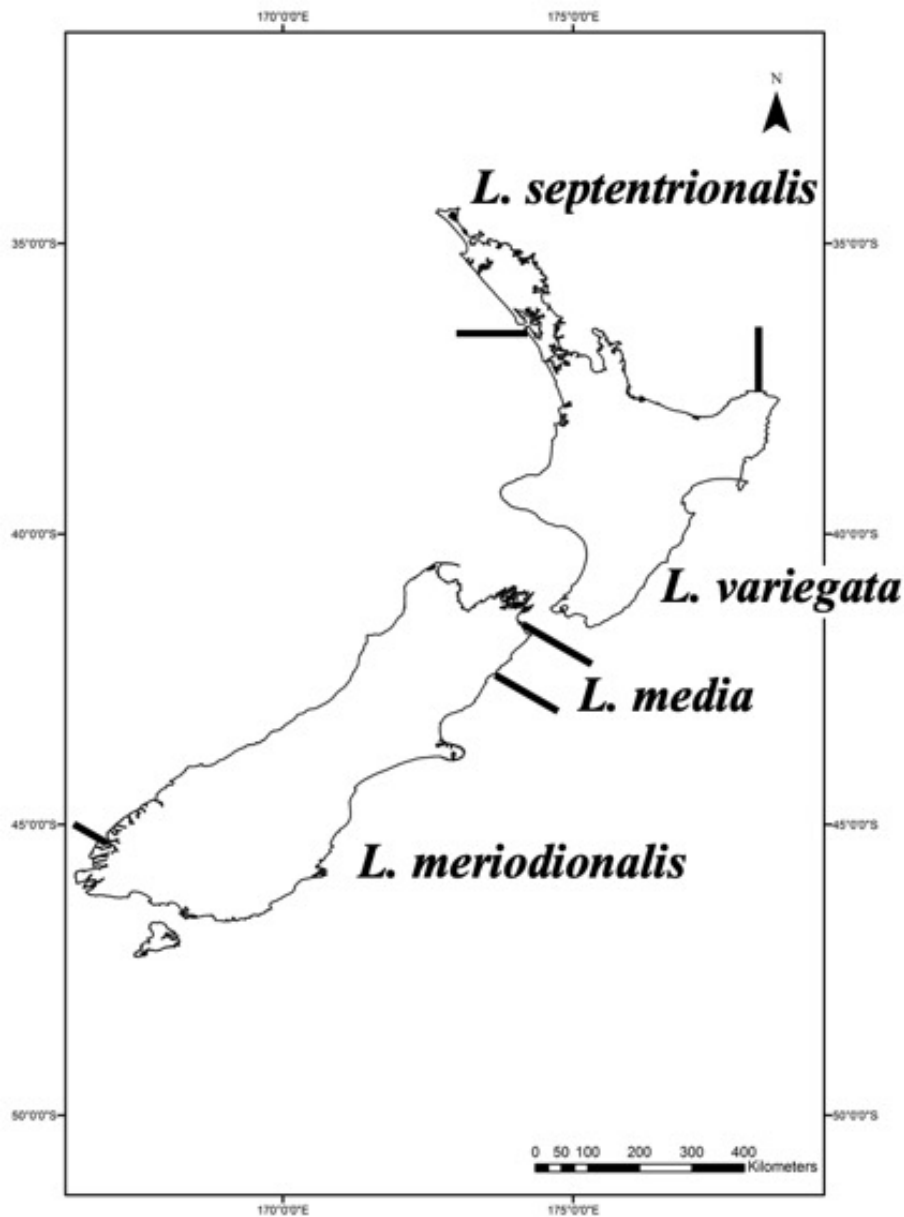
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**Fig. 1.** Maximum-likelihood phylogenetic tree of a five-gene dataset of various *Lessonia* species. Showing the three new species (for further details see Martin & Zuccarello, 2012). Bootstrap values above 70% shown on branches.

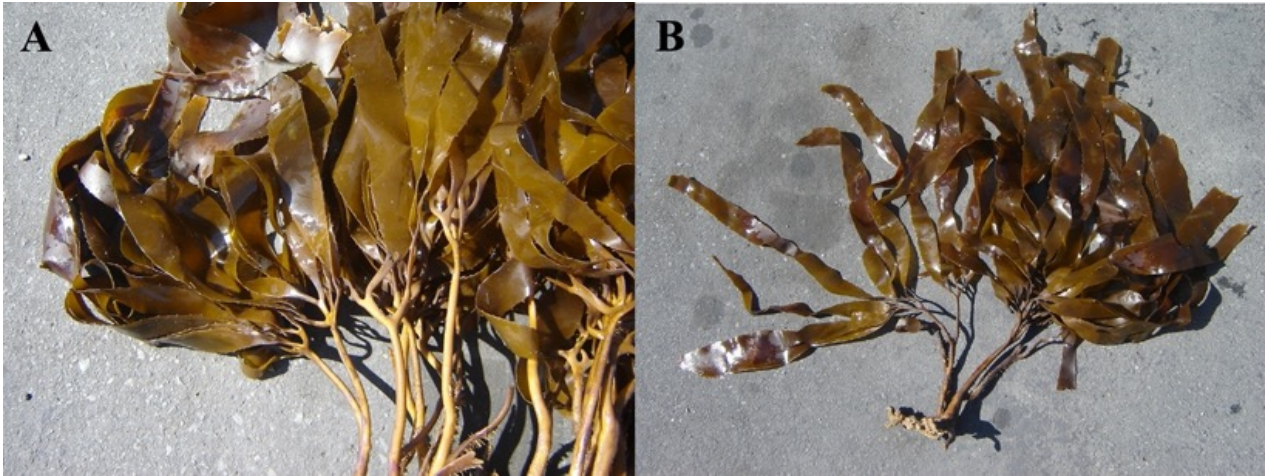


**Fig. 2.** Map of New Zealand showing biogeographical breaks of the four species of *Lessonia* in New Zealand (following Zuccarello and Martin 2016). Breaks shown as black lines. No sampling was done on the central west coast of the two main Islands.





**Fig. 3.** Type specimens of the four species of *Lessonia* on the main islands of New Zealand. 3a. **Lectotype** (designated here) of *Lessonia variegata*, Lund J. Agardh (LD 2164). 3b. Holotype of *Lessonia media* (WELT A035569). 3c. Holotype of *Lessonia meridionalis* (WELT A035567). 3d. Holotype of *Lessonia septentrionalis* (WELT A035572).



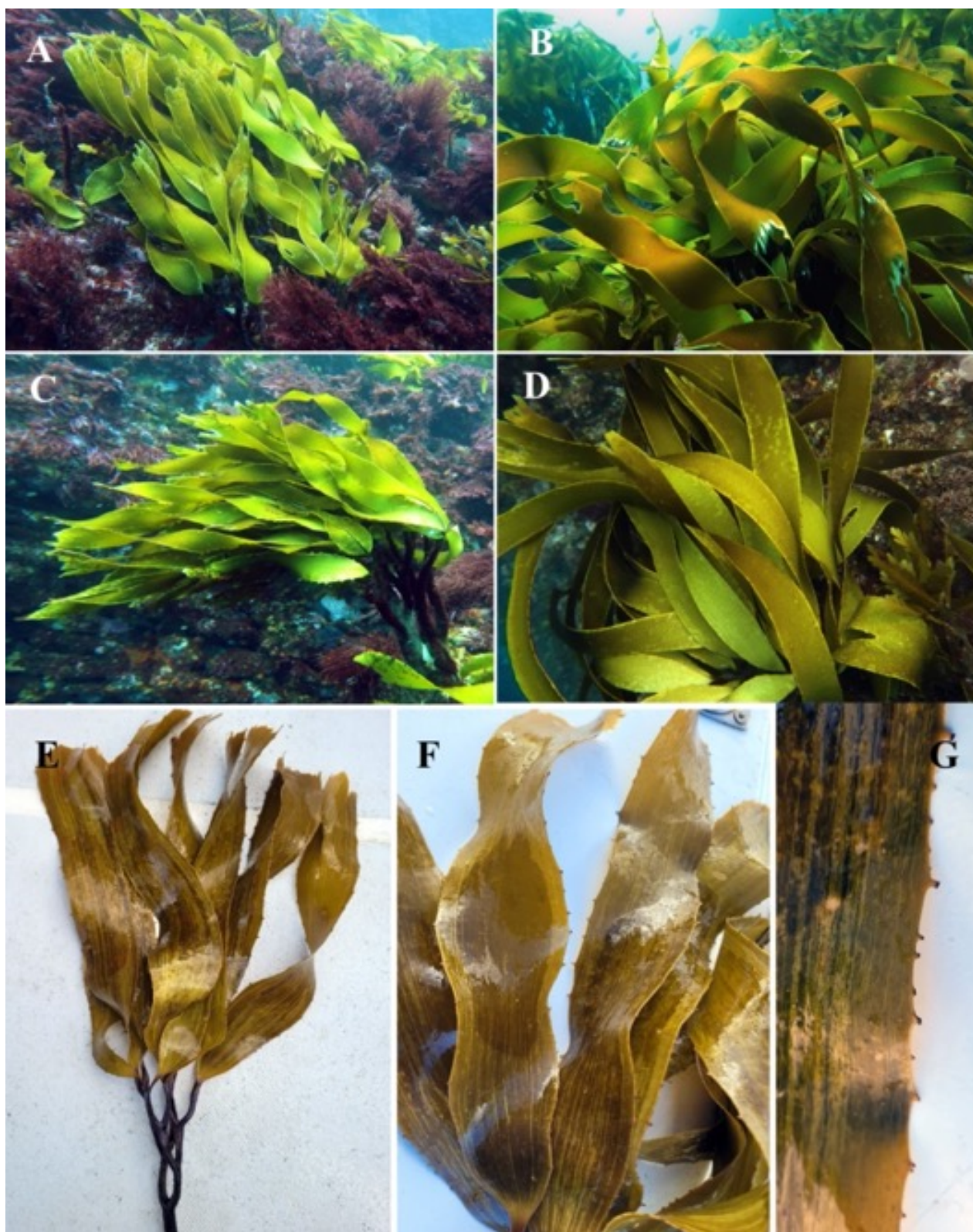
**Fig. 4.** Drift examples of *Lessonia media* from Kaikoura. No blade variegating known in this species.





**Fig. 5.** *In situ* images of *Lessonia meridionalis*, showing the lighter coloured edges (e.g. Fig 5c, g) of the blades that seem to be typical of this species.





**Fig. 6.** *In situ* images of *Lessonia septentrionalis*, showing the striped variegation (lower images) that are seen in some specimens of this species.





**Fig. 7.** *In situ* images of *Lessonia variegata*, showing the characteristic spotty variegation, a consistent character in this species.