The aquatic moss *Fissidens berteroi*: Observations of habitat characteristics from populations in the Wellington region

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INTRODUCTION

Fissidens berteroi is a native aquatic moss that is currently classed as a nationally endangered species by the Department of Conservation (Hitchmough et al. 2005). It is also known to occur in both Australia and South America. Populations of *F. berteroi* have previously been recorded from several places in both the North and South Islands, although locations of many of these early collections were imprecise and the original populations have not subsequently been relocated. Until recently, extant populations were known from just two locations in Auckland and two in the Wairarapa (Beever 1995). Deteriorating water quality, changes in flow regimes and competition from introduced aquatic weeds have all been implicated in the possible decline of populations (www.nzpcn.org.nz/flora_details.asp?ID=4996, accessed 10 November 2009).

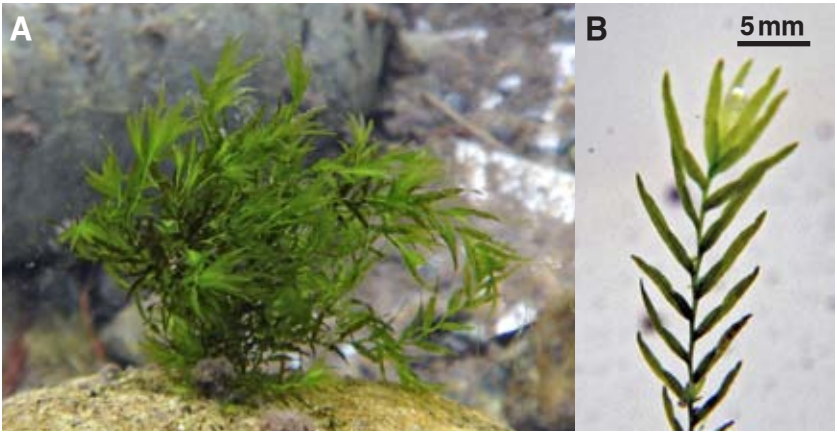

Figure 1. (A) A medium sized tuft of *Fissidens berteroi* attached to a large boulder in a spring-fed stream in Masterton. (B) A single *F. berteroi* stem.

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Fissidens berteroi is distinct in appearance, enabling it to be readily distinguished from other aquatic plants. It is also large for the *Fissidens* genus so it is not easily mistaken for other aquatic *Fissidens* species, of which there are several (Beever 1999). *Fissidens berteroi* plants are typically bright to dark green in colour and, under suitable conditions, can form large obvious tufts up to 10 cm long and containing numerous 'fronds'. Where it occurs in less favourable conditions, plants are often considerably smaller and limited to fewer fronds. The stems are flexuous with obvious leaves (5–10 mm in length) that are flattened into two ranks, giving a frond-like appearance (Fig. 1). It is generally found attached (by rhizoids) to rock, wood or concrete substrates in moderate to swiftly flowing water (Beever 1995); larger plants can often be observed waving in the current.

The recent discovery by the author of five new populations of *Fissidens berteroi* in the wider Wellington region (three in Masterton, one just south of Featherston and one in Karori, Wellington City) suggests that it may not be as scarce as previously thought (Fig. 2). These new sites are vouchered by specimens in the Museum of New Zealand Te Papa Tongarewa: WELT M038784, M038814, M038889, M039292, and M039807.

Figure 2. Locations of *Fissidens berteroi* sites in the Wellington region. Squares indicate previously known sites and circles indicate new sites.

These five new populations, along with the two previously known populations in the Wellington region, all exhibit several habitat characteristics in common. As bryophytes are considered to be rather

specific in their micro-environmental, or habitat, preferences (Beever 1999), identification of these habitat preferences and then subsequent investigation of sites with similar characteristics may lead to further discoveries of previously unknown populations. Indeed, this is how the more recent of the five new populations were discovered. This paper presents observations of habitat characteristics from *Fissidens berteroi* populations in the Wellington region, along with preliminary analysis of what factors may be important in determining suitable habitat for this species.

HABITAT CHARACTERISTICS

Populations of *Fissidens berteroi* in the Wellington region are all found in small to moderate sized streams located in highly modified urban (Fig. 3) or agricultural catchments. This includes one entirely artificial 'stream' which is fed by water pumped from a nearby river. The prevalence of *F. berteroi* populations in these highly modified environments may be due to the common occurrence of stable substrates (such as concrete lined channels, culverts, bridges, and associated structures) in streams of agricultural and urban areas.

Figure 3. Concrete channelisation of urban streams can provide ample stable substrate for *Fissidens berteroi.*

The presence of stable, or immobile, substrate may be an extremely important factor in the occurrence of *Fissidens berteroi* populations. In

aquatic environments, increases in flow (e.g., floods) can lead to significant disturbance events (i.e., movement of the stream bed). This movement of mobile substrate (e.g., rocks, cobbles, gravels, etc.) can then result in significant abrasion and scouring of aquatic plants (along with other biota). The occurrence of and/or frequency of these increased flows and the corresponding disturbance of the stream bed is known to strongly influence the composition of aquatic communities (Jowett 2000). At some sites, populations of *F. berteroi* are only found on the single large stable substrate present (i.e., the concrete structure of the one bridge that crosses the stream) as it potentially cannot persist on the smaller more mobile, and hence easily disturbed, substrate present elsewhere. In streams where there is a large amount of stable substrate—such as urban streams with extensive concrete lined channels—*F. berteroi* can be extremely abundant.

Another common habitat characteristic of all of the *Fissidens berteroi* populations in the Wellington region is that they are in streams that are not prone to large and sudden increases in flow (e.g., floods) and as such have a low frequency of disturbance events. Populations in the Wellington region are generally found in spring-fed, wetland-fed or lake-fed streams, and in one case a pump-fed stream. These types of streams typically exhibit significantly lower variability in flow than streams that are associated with catchments located in hill/mountain ranges, which can experience frequent and large variations in flow. Large and frequent variation in flow is a typical characteristic of most New Zealand streams. No populations of *F. berteroi* have been located in streams that exhibit this type of flow regime in the Wellington region. The frequency of disturbance events and how this impacts on *F. berteroi* populations is probably closely linked with the availability of stable substrate. Where disturbance events are more common, populations appear to be limited to very stable substrates (e.g., a bridge), but where disturbance is less common, *F. berteroi* can persist on smaller substrate (e.g., gravel).

A moderate to swift flow (in terms of water velocity) was generally observed at all sites. A swift flow is potentially an important characteristic as it may minimise the impact of sedimentation (inputs of sediment are common in urban and agricultural streams). At low velocities sediment can settle out of the water column and smother not only the plant but also the substrate (i.e., no suitable substrate equals no *Fissidens berteroi*). The deposition of silt and fine gravels on the stream bed appears to be limiting some *F. berteroi* populations in some streams. Swifter flows keep the sediment mobilised, transferring it downstream and leaving behind larger rocks that are too heavy to be mobilised by the current and thus providing

stable substrate for *F. berteroi*. A swift flow may also limit competition from larger vascular plants that could out-compete *F. berteroi*. Larger plants may not be able to cope with as high a shear stress as the smaller bryophyte, and are also likely to prefer the smaller substrate/sediment that is not commonly found in these swiftly flowing streams (or the swifter flowing sections of some streams). Furthermore, gas exchange will likely be promoted by swift flows, which may be important because many aquatic mosses are dependent on free carbon dioxide (Beever 1995).

Fissidens berteroi was observed to commonly occur with a wide variety of aquatic and semi-aquatic plants, including a variety of algal species, other *Fissidens* species, other types of bryophytes, and a number of vascular plants. However, in streams that were dominated by other plant species, *F. berteroi* can be very scarce. This is often the case at sites that have minimal shade and that are dominated by larger aquatic plants like the native charophyte *Nitella hookeri,* or introduced invasive plants like *Lagarosiphon major*. In high-light environments where competition is high, *F. berteroi*, if it occurs, is more likely to be present in more heavily shaded refuges (e.g., within a culvert) (Fig. 4, 5). Irrespective of light conditions, where there is limited competition from other species and flow and substrate conditions are suitable, *F. berteroi* can be extremely abundant and make up a significant proportion of the aquatic flora. Competition, especially from invasive aquatic species, may be having a detrimental impact on some *F. berteroi* populations.

Figure 4. Culverts provide stable substrate for *Fissidens berteroi* growth (indicated by arrows). In streams dominated by other aquatic plants, *F. berteroi* may be limited to culverts.

Figure 5. A dense growth of *Fissidens berteroi* around the mouth of a culvert in an urban Masterton stream.

Complete drying of a stream does not appear to be a limiting factor as at least two of the *Fissidens berteroi* sites are known to dry during summer months. The other populations are probably completely inundated all year round. Potentially, the annual drying of a site could help limit competition from other aquatic plants that cannot persist through these dry phases. However, this has not been fully investigated.

CONCLUSIONS

Based on observations of seven *Fissidens berteroi* populations in the Wellington region, common habitat characteristics appear to be the presence of stable substrate, a lack of disturbance events caused by extreme flow events, a moderate to swift flow and minimal competition from other aquatic plants. Some aspects of highly modified streams, such as the large amount of stable substrate present through channelisation, may be beneficial in maintaining existing populations. While these habitat characteristics appear important in the Wellington region, they are not necessarily obligate for *F. berteroi*, as at least one population from the Auckland region is known from a quite different type of habitat: the bottom of a lake (Western Springs, Peter de Lange, pers. comm.).

The discovery of new populations in the Wellington region in recent years has also coincided with additional discoveries of populations in the Auckland region and on the Chatham Islands (www.nzpcn.org.nz/news_detail.asp?Status=3&ID=177, accessed 10 November 2009). Consequently, *Fissidens berteroi* may be more common than previously

thought. Further investigation of sites that share similar habitat characteristics to those discussed above may potentially lead to additional populations being discovered. Further work involving comprehensive investigations of suitable habitats throughout New Zealand is desirable.

Despite being more common than previously thought, the viability of some populations in the Wellington region still appears to be far from certain. The main threats to these populations appear to be sedimentation (specifically the deposition of silt on the stream bed) and competition from both native and introduced aquatic plants.

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