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Notes on *Atriplex* (Amaranthaceae) species and hybrids, particularly *A. littoralis* and the hybrid *A. littoralis* x *A. prostrata* (*A. x hulmeana*)

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Abstract
Atriplex prostrata Boucher ex DC. (Spear-leaved Orache) and *A. littoralis* L. (Grass-leaved Orache) are two distinct taxa. Observations on their hybrid *A. x hulmeana* Taschereau suggest variation relates to hybridisation, backcrossing and or segregation. These features may also relate to difficulties in identifying other species and hybrid combinations.

Keywords: segregation; introgression; leaf teeth; leaf lobes

Introduction

Some of the leaves of *Atriplex littoralis* L. depicted by Leaney (2018) have crenate to more sinuate-dentate margins and the key therein states, "… edges usually dentate". In Sell & Murrell (2018) this would relate to *A. littoralis* var. *serrata* (Huds.) Gray. However, I believe that such morphology is possibly the result of introgression (backcrossing to *A. littoralis*) in the hybrid with *A. prostrata* Boucher ex DC. (*A. x hulmeana* Taschereau) and or segregation. This hybrid is said to be more or less fertile (Taschereau, 1988; Stace *et al*., 2015; Stace, 2010, 2019).

Evidence for introgression and/or segregation

Typical leaves of *A. littoralis* are long and narrow with no teeth (Fig. 1, left). A large colony of *A. littoralis c*.30-40 m long, on the NE coast of England (NZ5527, South Gare, N.E. Yorkshire, v.c.62) has a number of fairly distinct plants of *A. x hulmeana* (Fig. 1, centre and right) mixed in with it. These were originally found by the Vice-County Recorders, Vincent Jones and Dave Barlow in 2017. However, the colony has plants ranging from the more obvious hybrids all the way back to *A. littoralis* (*i.e.* with a decreasing number of leaf teeth and or leaf lobes). The main hybrids are similar to those illustrated in Hulme (1957) and Taschereau (1988). The South Gare plants show the lower to mid-stem leaves with a lobe on one or both sides of the cuneate base, and leaves going up the stem are distinctly to weakly-toothed, though these 'hybrids' also have many leaves that are like the usual leaves found in *A. littoralis*.

The decreasing number of teeth and or lobes ranging all the way back to plants with narrower leaves and no teeth suggests that putative hybrid plants are probably backcrossing (introgressing) to *A. littoralis* in this colony. However, segregation (see

Taschereau, 1988) is another option; plants that have grown from a seed of an F_1 hybrid (an F_2 or more) can exhibit varied or reduced characteristics of the F_1, in this case seemingly approaching *A. littoralis*.

Figure 1. Leaves of *Atriplex* taxa. Left: *A. littoralis*, the middle leaf 11 x 1.2 cm; centre: *A. x hulmeana,* the middle leaf from lower part of stem, 11.5 x 2.5 cm; right: *A. x hulmeana*, the middle leaf from lower part of stem, 10.5 x 2.5 cm.

Taschereau (1988) stated that, 'Segregants showing a wide range of character combinations sometimes occur amongst F_1 plants…' (In cultivation and the wild). However, in the wild, equally (being fertile) some of these could be backcrosses to *A. littoralis*. Taschereau (1988) noted three leaf-variants within the hybrid; a '*patula*-leaf variant, with falcate leaf lobes at the base', [see Fig. 1 centre image, far left leaf and Fig. 2 middle leaf]; a '*serrata*-leaf variant, [see all leaves in Fig. 3] with sinuate-dentate leaves like extremes of plants formerly known as *A. littoralis* var. *serrata*'; and a '*gigas*-leaf variant, plants to 1 m high, thick stem and gigantic leaves, with ovate-lanceolate irregularly lobed lamina up to 15 cm long and 4 cm wide'.

Fig. 2. *A. x hulmeana*. (Backcross or segregant – possibly F_2). Middle leaf with superficial *A. patula*-like lobes. Middle leaf from lower part of stem, 10 x 2 cm. Some plants may have many or all leaves like those 2nd or 5th from the left (and see Fig. 3) or mixed with more lobed leaves.

Interestingly, Sell & Murrell (2018) retain a 'var. *serrata* (Syme) P.D. Sell' in *A. x hulmeana* and 'var. *serrata*' in *A. littoralis*. They do not give the same names for the three leaf types of *A. x hulmeana* provided in Taschereau (1988) but give 'var. *hulmeana*' (for the *patula*-leaf variant), 'var. *serrata*' as mentioned and the '*gigas*-leaf variant' is given as 'var. *crassa* (Mert. & W.D.J. Koch) P.D. Sell'. In essence, in all three cases, Sell & Murrell (2018) have given variety names to the 'leaf-types' in Taschereau (1988). Essentially, they are probably just segregants or introgressed forms of the hybrid.

Therefore, whilst some of the leaves shown in Leaney (2018) could relate to Sell & Murrell's (2018) 'var. *serrata*', this is basically describing forms that are likely to have developed from seed-segregants, showing strong to weak characters of one or the other parent; and or it can equally be the case that backcrossing (introgression) is also occurring in the wild (at South Gare, *A. prostrata* was more frequent in 2017-2018 but difficult to find in 2019). These variants noted by Taschereau (1988) and Sell & Murrell (2018), from one extreme to the other, can easily been seen in the colony at the South Gare. With hybrid plants being known to be more or less fertile, the variation is likely to be a combination of segregation and or introgression relating to the commoner parent there (*A. littoralis*) rather than distinct varieties.

Another example, seen in v.c.66 (Co. Durham) at Cowpen Marsh (Fig. 3), is most likely a backcross with *A. littoralis* or a segregant (in each case one or more times, F_2 +), but either way it is less referable to the hybrid *A. x hulmeana*, and difficult to record as either. It was at least 1.5 m tall with a good number of leaves with larger to smaller teeth.

Fig. 3. *Atriplex x hulmeana* – backcross/segregant; ?≥F_2. Cowpen Marsh, v.c.66, (NZ5025) 2019. The central leaf is 17 cm long including the petiole and 2 cm wide including the teeth.

The leaves show varied large and small teeth. Most leaves are much less toothed than the hybrids in Figs. 1 and 2 and many (not shown) were closer to *A.*

littoralis. The marsh was not accessible (being a bird reserve) and so other plants could not be searched for. In a general view of the marsh it seemed that at least *A. littoralis* was common there, though there could have been many segregants or introgressed plants.

This hybrid has also been noted in Ireland (Co. Cork) by Paul Green (Green, 2017, 2018). There the plants seemed to be originally recorded as *A. littoralis*. Paul noticed that they were in fact part of the hybrid range (confirmed by the BSBI *Atriplex* referee, J. Akeroyd). At least at South Gare, it shows that within colonies of *A. littoralis* some plants may be the hybrid or variants thereof based on backcrossing or segregation, and thus the hybrid forms could be overlooked. While plants with small lobes and or teeth as in Fig. 3 might be recorded as *A. littoralis* they may be segregants (or backcrosses) of the hybrid.

Other plants, on road verges more inland away from the sea (as a halophyte), are often *A. littoralis*. However, some show aspects of hybrid plants, though most are closer to *A. littoralis* or become too close to it to be called hybrids. It may be possible to find plants closer to the hybrid inland but they would need to have leaves similar to those shown in Figs. 1 and 2 (or between those and the ones in Fig. 3). Also, away from the coast, segregation is more likely in successive generations forming from seed in *A. littoralis*-like plants with teeth/lobes, as they are likely to have come in as 'segregants', though some introgression with *A. littoralis* cannot be ruled out in such circumstances if plants without 'teeth/lobes' occur.

Studies on *Atriplex* do not seem to mention introgression (backcrossing) in these hybrids despite several being fertile, and this may be occurring in the wild (as is potentially the case at the South Gare), but Taschereau (1988) did note what appeared to be segregation. Therefore, plants of F_2 or more and being relatively fertile, could be segregants and or backcrosses in the wild (both these options are likely to be the case). At least the basic findings here suggest that introgression is another possibility as the colony at the South Gare seems to be so mixed that some appear to be backcrossing with *A. littoralis* to form weaker versions of the hybrid.

This may also help to explain difficulties in the case of *A. longipes* Drejer (Long-stalked Orache) and its associated hybrids with *A. prostrata* (*A.* x *gustafssoniana* Taschereau) and *A. glabriuscula* Edmondston (Babington's Orache) (*A.* x *taschereaui* Stace), respectively. Some plants taken to be what we call *A. longipes sensu stricto*, could be part of the hybrid range. Regardless of putative hybrids in this latter group, there is much confusion between these species. If both *A. prostrata* and *A. glabriuscula* usually have sessile bracteoles, it is unclear why one of the hybrids with *A. longipes* has pedunculate bracteoles to 10 mm and the other up to 5 mm; there may be greater variation than this in these hybrids. It is possible that some are triple hybrids in this complex as the *A. prostrata* x *A. glabriuscula* hybrid is said to be fertile (which itself is no doubt an overlooked taxon) and thus this hybrid (or backcrossed/segregant forms of it) may be crossing with *A. longipes*. Therefore, in species and or hybrid combinations with a wide spectrum of variation, introgression and or segregation, may be in part, some of the mechanisms blurring the taxon definitions in this difficult group. Further morphological and particularly molecular work would be required to establish if this could be the case.

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