

## REPLY COMMENT

## The *Mytilus edulis* population in Svalbard: how and why

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Norton & Feder (2006, this volume) have come forward with a critique concerning our interpretation of the recently discovered population of *Mytilus edulis* near Sagaskjæret in the outlet of Isfjorden, Svalbard (see Berge et al. 2005). Their critique, as far as we can see, is based mainly on a comparison of both large and small scale physical factors on both sides of the Arctic Ocean, more specifically, a comparison of physical conditions at the west coast of Svalbard and Barrow, Alaska.

As was the case after the discovery of the blue mussel *Mytilus edulis* on Svalbard (identification recently confirmed by DNA sequences: C. Schander et al. unpubl. data), the discovery of *Mytilus trossulus* in Barrow, Alaska was initially interpreted as being a northward extension of the species' distribution range and subsequently a response to an elevated sea-surface temperature (SST). However, based on extensive sampling and analyses of both data and available literature, they (Feder et al. 2003) later reached the conclusion that the blue mussel *M. trossulus* was not a new invasive species, but that individuals of this species most likely have persisted in Arctic Alaska throughout the Holocene. They now raise the same question regarding our records of *M. edulis* at Svalbard: is this really a northward extension of the range, or simply a discovery of a species which has been present all along, but not found due to insufficient sampling?

First of all, we emphasise that we do not question the conclusions of Feder et al. (2003) about *Mytilus* in Arctic Alaska. Secondly, we acknowledge that the use of the word 'relict' may have caused some misunder-

standings regarding our interpretation of Feder et al. (2003), of which we were aware when we wrote our original paper. Finally, we cannot totally rule out the possibility that *M. edulis* has persisted in small and undiscovered populations on Svalbard throughout the Holocene, although we judge this scenario to be quite unlikely. Competent marine biologists from several nations have worked around the Svalbard archipelago since the last part of the 18th century and not reported any such populations.

There are some marked differences between the ecosystems in Barrow, Alaska, and Svalbard, which have implications for the interpretation of the recent discovery of *Mytilus edulis* at Sagaskjæret. First of all, the geography of Svalbard Archipelago is such that, for both the marine and the terrestrial environment, there is a strong west–east gradient from a more sub-Arctic climate on the west side to a more a high-Arctic climate on the east side. The reason for this is the strong influence of warmer Atlantic water flowing northwards by the West Spitsbergen Current (WSC) along the western side of Svalbard (Berge et al. 2005, their Fig. 1). Therefore, if *M. edulis* had persisted on Svalbard during the entire Holocene, the most obvious localities would be along the western coast, where the climate is significantly warmer. Taking into account that this also is the most accessible area (lowest quantities of sea-ice throughout the year), where biological surveys have been conducted almost continually for the last 3 to 4 decades, we believe it is safe to assume that such a conspicuous and well-known species as *M. edulis* would have been observed if present. In addition, the site where we actually did discover the mussels has been

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continually used as a sampling site by scientists of the University Centre in Svalbard since 1993 and before this by researchers from other universities. In addition, although this is more circumstantial, the site where the mussels were discovered in 2004 is strongly influenced by the warm Atlantic water. Hence, finding blue mussels at this very site is in full agreement with the hypothesis that larvae were transported northwards by the WSC (see Berge et al. 2005). Finally, the population examined at Sagaskjæret was rather homogenous and young. If larvae were coming from local populations, one would expect a much more heterogeneous population.

There are other aspects of our paper that Norton & Feder (2006) question, including our apparent unawareness (which is incorrect) of the reported population at Bjørnøya (Weslawski et al. 1997). Benthic surveys have been conducted both in the littoral zone (Christiansen 1965) and shallow sublittoral (Gulliksen 1979) at Bjørnøya (an island about midway between the northern coast of Norway and the southern tip of the Svalbard Archipelago), but none of these studies reported a population of *Mytilus edulis* at Bjørnøya. Weslawski et al. (1997) reported finding a few small *Mytilus* shells, which does not constitute a population. The sizes and numbers of these shells do not, however, suggest reproduction and thus recruitment to Svalbard. (Note: Bjørnøya is geographically not part of the Svalbard Archipelago). Buoy trajectories in Vinje et al. (1989) showed that particles entering the vicinity of Bjørnøya will become trapped in an anticyclonic motion around the island. Trajectory experiments from numerical models (Gjevik et al. 1994, Kowalik & Proshutinsky 1995) indicate that particles will stay trapped for at least 30 d. Thus, larvae spawned at Bjørnøya would be less likely to reach Svalbard than larvae originating from the mainland of Norway.

The last point we would like to stress, and which Norton & Feder (2006) correctly refer to as a set of circumstantial evidence, is the relationship between the modelled transport time, and both the remotely sensed data and data from oceanographic stations. Our aim

was to point out that it is actually possible for *Mytilus* larvae to be transported by the WSC to Svalbard from the coast of Norway. Remotely sensed data on SST from MODIS in the North Atlantic has only been recorded since 2002. Studies on some of the blue mussel samples at Sagaskjæret, conducted after Berge et al. (2005) was accepted, indicate that the majority of mussels had settled 1 or 2 yr earlier than 2002. The main conclusion, however, is still valid in our view; settlement of blue mussel spat on the western coast of Svalbard may be episodically induced by larvae transported from the nearest known source population in northern Norway. Such an event is rare, and dependent upon co-occurring favourable conditions, namely increased volume transport of Atlantic Water by the WSC, increased SST and local wind direction.

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