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Collembola help lichens in competition with algae

Collembola are terrestrial arthropods that prefer humid environments, probably because their relatively thin chitinous carapace is vulnerable to dehydration. They feed primarily on algae, but certain Collembola may feed on lichens (Leinaas & Somme 1984). They are often found in lichen samples, but the lichens involved do not generally appear to be damaged. Microclimatic conditions within lichens may favour occupation by Collembola as the humidity in the interior of foliose lichen thalli may be relatively high compared to that of the surroundings (Prinzig & Wirtz 1997).

In the Netherlands, stones of megalithic monuments are the only large expanses of natural acid rock. There are 54 such megaliths; nearly all erected more than 5000 years ago, but most were covered by sand until 300 years ago. Compared to other substrata in the Netherlands, these monuments have had a remarkably long exposure time and are especially rich in lichens. Many of the lichen species found on them belong to an upland floristic element, and 27 appear on the Red List of Lichens in the Netherlands (Aptroot *et al.* 1998).

The lichen vegetation on megaliths is monitored regularly to follow changes caused, for example, by climate and pollution. During the most recent survey (Sparrius & Aptroot 2003), all the lichen specimens collected were sampled for Collembola. All the specimens were checked under the dissecting microscope soon after collecting, and any living Collembola, which became active owing to the higher room temperature in the laboratory, were caught with an exhauster and collected in glass tubes with 70% ethyl alcohol. Generally only a few or no individuals were present in a lichen specimen, but in a specimen of *Xantho-parmelia conspersa* from monument D29 near Buinen, province of Drenthe, many tens of individuals of the Collembola, *Anurophorus laricis*, were present. The lichen was not obviously harmed by this arthropod density. However, a bare zone without algal growth was clearly present surrounding the lichen specimens (Fig. 1). As lichens compete with faster growing free-living algae for space and nutrients, the grazing of the algae by the Collembola can only benefit the lichen. We checked microscopically the contents of the guts of several of the preserved Collembola, and found them to contain green algae, but no lichen fragments. Furthermore, no physical damage to the lichens was observed; on the contrary, the lichens looked quite healthy. Exposed rock surfaces can be very dry and hot, but microclimatic conditions inside and below lichen thalli are less severe. We can only assume that the Collembola are seeking shelter in and below the lichens during dry periods and leave this shelter to feed on surrounding algae when the air humidity is favourable. We postulate that the occupation of lichen thalli by Collembola in this case is of mutual benefit.

Many hundreds of lichen specimens were sampled, and a conspicuous algal-free zone was observed only around the few specimens on this single megalithic monument. All specimens with such an algal-free zone supported many Collembola. Therefore other hypotheses explaining the zones of algal clearance can be excluded, for example, the possibility that the secondary metabolites leaching from the lichen are toxic to the algae.

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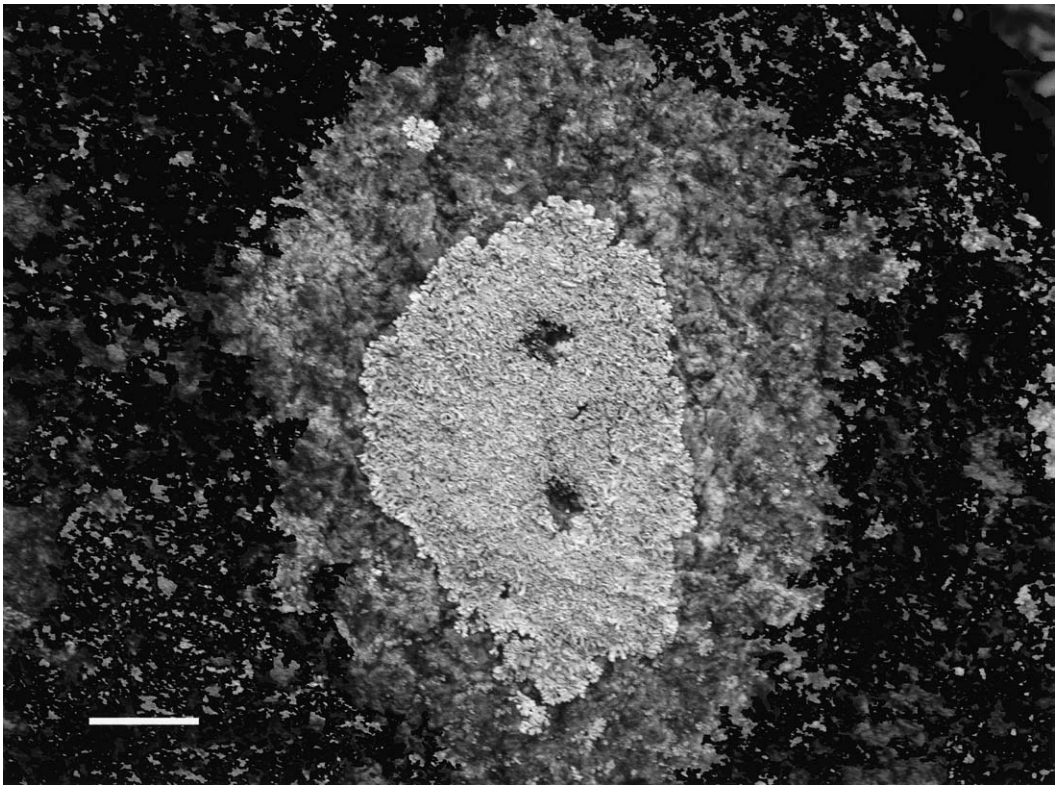


FIG. 1. *Xanthoparmelia conspersa*, upper surface of lichen on a granite megalithic monument near Buinen (Drenthe, The Netherlands), showing the zone devoid of algal growth around the specimen and some young colonies. Scale bar=2 cm.

The lichen *X. conspersa* is one of several upland species that in the Netherlands are almost entirely restricted to megalithic monuments. It is in decline, possibly due to global warming (van Herk *et al.* 2002). Global climate change appears to affect it, in part, via the increased algal competition favoured by increased precipitation, a climatic factor that in the Netherlands has been correlated with overall trends in global warming. If a third party, i.e., Collembola are added to the symbiotic complex, giving lichens a means to influence adjacent free-living algal populations as seen in Fig. 1, this may ultimately slow or even reverse the decline, and also provides a space for the establishment of new colonies.

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