Abstract

Background

The projected 2.7-fold increase in population in sub-Saharan Africa by the end of the century demands consideration as to how agricultural output can keep pace. Augmenting nitrogen inputs is a practical necessity, but this must be accomplished in such a way that avoids the environmental costs of past advances and also places the resource in the hands of those who will be the most affected. Biological nitrogen fixation might play an important role. The realization that certain algae are able to provide for their own nitrogen needs by fixing atmospheric N_2 raises the possibility that an endosymbiont responsible for the nitrogen might be transferred to crop plants. For this to take place, it is necessary that the endosymbionts be (or be made to be) sufficiently independent of their hosts so that they may establish themselves in crop plants appropriate to African agriculture.

Results

Genomes from six endosymbionts from diatoms within the family Rhopalodiaceae were analyzed. They were compared to genomes from free-living cyanobacteria and to those of the nitroplast UCYN-A and chromatophore from Paulinella, to which they are related. Unlike the latter two endosymbionts, the six from Rhopalodia encode all the enzymes considered that underlie metabolic processes and provide the energy to power N-fixation. Some of the endosymbionts also appear able to synthesize cofactors essential for central metabolism. The analysis points to possible carbon sources the endosymbionts might take up from their hosts, including glycerol and chitobiose. Possible routes of nitrogen export to the host were also examined.

Conclusions

Within the limits of genome analysis, some of the Rhopalodian endosymbionts appear to be metabolically independent of their hosts, except for requiring a carbon source. However, the choice of carbon source and the likely means of nitrogen export are not compatible with crop plants. Genetic modification would surely be necessary for any prospect of propagation of an endosymbiont in a plant of agricultural importance, and significant questions must first be answered in the laboratory. To this end, the endosymbiont of *Epithemia clementina* may be best suited for such investigations, eventually after transfer to the model diatom *Phaeodactyllum tricornutum*.