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### Highlights:

- Lichens are introduced as a model system for measuring isotope effects in photosynthesis.
- Lichens can be reversibly dehydrated then hydrated with either H<sub>2</sub>O or D<sub>2</sub>O.
- Photosystem II efficiency was measured with either H<sub>2</sub>O or D<sub>2</sub>O *in vivo*.
- H/D isotope effects are attributed to both donor and acceptor side reactions.

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