Warming-Induced Decline in Ecosystem Services Is Mitigated by Plant Traits on the Tibetan Plateau

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Warming-induced decline in ecosystem services is mitigated by plant traits on the Tibetan Plateau

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Introduction Experimental studies of how global changes and human activities affect plant diversity often focus on broad measures of diversity and discuss the implications of these changes for ecosystem function . We examined how experimental warming and grazing affected species within plant groups of direct importance to Tibetan pastoralists : medicinal plants used by humans and palatable plants consumed by domestic livestock . We posed the following questions : How do experimental warming and grazing affect the number of medicinal and palatable plant species ? Is one plant group relatively more vulnerable to species losses than the other ? Are plant traits associated with particular plant use groups ? If so , do the plant traits mediate the medicinal and palatable plant group responses ?

Materials and methods We established an experiment at four sites within the NE region of the Tibetan Plateau (latitude 37°37′ N , longitude 101°12′E) . We fenced each of the four 30×30m sites within which we laid out 16 plots in a 4×4 matrix . Within each site , we established a complete factorial experimental design where we simulated warming using open top chambers (OTCs) and the defoliation effects of grazing through selective clipping . We characterized the plant species as medicinal or non medicinal and as palatable or non palatable . We also characterized the species according to four plant traits : life history , growth form , rooting depth , and phenology . We examined significant associations between plant groups and plant traits using the Chi-Square statistic . We also examined plant group responses to the treatments using a split-plot , repeated measures ANOVA .

Results Warming resulted in species losses from both the medicinal and palatable plant groups ; however , differential relative vulnerability occurred . With respect to the percent of warming-induced species losses , the overall plant community lost 27% , medicinal plants lost 21% , and non medicinal plants lost 40% species . Percent species losses for both palatable and non palatable species were similar to losses in the overall plant community . Warming increased the proportion of medicinal plants by 0 .06 ; commensurate declines in the proportion of non medicinal plants occurred . The proportion of palatable and non palatable plant species did not change with warming . Most medicinal plants were deep-rooted , while most non medicinal plants were shallow-rooted . Palatable and non palatable plant groups were comprised of both deep and shallow-rooted plant species . The warming-induced percent species loss and proportional changes for deep and shallow-rooted plant species reflected those for the medicinal and non medicinal plant species , respectively .

Discussion The deep-rootedness of medicinal plants resulted in lowered sensitivity to warming , while the shallow-rootedness of non medicinal plants resulted in greater sensitivity to warming ; the variable rooting depth of palatable and non palatable plants resulted in an intermediate response to warming . Some degree of resistance was built into the response of the palatable plant group due to the presence of both deep and shallow-rooted plant species . Predicting the vulnerability of plant groups to human activities can be enhanced by knowledge of plant traits , their response to specific drivers , and their distribution within plant groups . Knowledge of the mechanisms through which a driver operates , and the evolutionary interaction of plants with that driver , will also aid predictions .

Conclusions Plant groups which deliver important provisioning and cultural ecosystem services on the Tibetan Plateau are vulnerable to species losses with warming . These important plant groups are likely to be vulnerable to future warming in this region of the Tibetan Plateau , potentially leading to the reduced well-being of the pastoralists . Future steps to protect ecosystem services furnished by medicinal and palatable plants will be required under the novel stress of a warmer climate . Grazing may be an important tool in maintaining some of these services under future warming .