

问题讨论

克隆植物矮嵩草对放牧的等级性反应

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摘要 对高寒草甸克隆植物矮嵩草 (*Kobresia humilis*) 基株、分株片断和分株3个层次构件单元的数量、生物量性状及其变异系数在不同放牧强度处理间以及构件等级间的变化进行了研究。研究工作于1999年至2001年在中国科学院海北高寒草甸生态系统定位站矮嵩草草甸内进行。家畜放牧实验设4个放牧强度水平。研究结果显示, 3a中矮嵩草克隆等级基株层次只有分株数和叶数在放牧处理间表现出显著差异 ($F_{(3,56)} > F_{0.05}$, $p < 0.05$), 而死亡分株百分数、死亡叶片百分数、基株大小以及繁殖分配4个性状在3a中未表现出显著差异 ($F_{(3, 56)} < F_{0.05}$, $p > 0.05$), 占被测性状的57.1%; 与此同时, 分株片断和分株两个层次在第1年就有50%以上的性状达到显著差异, 到第3年时全部被测性状都表现出显著差异 ($F_{(3,56)} > F_{0.05}$, $p < 0.05$)。放牧第3年时, 基株、分株片断和分株层次达到显著差异的性状数分别为42%、100%和100%。性状的变异系数在等级间的变化均表现为分株>分株片断>基株层次或分株>分株片断的顺序。被测性状的变异系数在放牧强度间无显著差异, 在放牧第1、第2和第3年, 变异系数在等级间有显著差异的性状比例分别为42%、71%和85%。这说明克隆植物矮嵩草基株、分株片断和分株各层次被测性状在放牧强度处理间表现出的差异性不同, 具有显著差异的性状比例在基株层次少, 在分株片断和分株层次高, 相同性状在处理间的差异可能先出现在分株和分株片断层次, 后出现在基株层次。放牧强度不影响性状的相对变异, 但长期持续的放牧扰动使性状在等级间的变异性逐渐增大。这些结果说明矮嵩草构件等级对放牧扰动具有明显的等级性反应, 并可概括为“分株层次>分株片断层次>基株层次”的等级反应模式。研究结果证实我们关于克隆植物等级选择模式的推断。

关键词 [克隆植物](#); [等级选择](#); [放牧处理](#); [矮嵩草](#)

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Hierarchical responses to grazing defoliation in a clonal plant *Kobresia humilis*

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Abstract The physiological integration of physically connected ramets may modify phenotypic plasticity and result in differences in plastic responses among hierarchical levels of clonal plants. In order to demonstrate the hierarchical responses to natural selection in clonal plants, we conducted a study to investigate the variances in the life history traits among grazing treatments and among hierarchical levels of clonal plant *Kobresia humilis* in an alpine meadow from 1999 to 2001. Our study site was located at the Haibei Alpine Meadow Research Station in Menyuan County, Qinghai Province, China. A fenced Tibetan sheep pasture, which was divided into four grazing pressures of ungrazed control, light grazing, moderate grazing and heavy grazing, was established in 1998. Three levels of modular hierarchy are genet level, ramet fragment level and ramet level in a clone. At the genet hierarchical level, the number of ramets and leaves per genet differed among grazing treatments for three years ($F_{(3,56)} > F_{0.05}$, $p < 0.05$) but the dead leaf and rament percentages, genet size and reproductive allocation remained constant. Traits differed among grazing treatments for 42.9% of all measured traits in the level in whole study period. At the ramet fragment and ramet levels, over 50% of measured traits differed among grazing treatments in first year and then all of them differed in last year. Differences in reproductive allocation among grazing treatments at

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he ramet fragment and ramet levels occurred in the second and last years respectively. The number of traits that showed differences among grazing treatments for genet, ramet fragment and ramet hierarchical level in last year account for 42%, 100% and 100% of all measured traits, respectively. These results indicated that there are different variances of measured traits among grazing treatments for three levels of the modular hierarchy in the clonal plant *K. humilis*. The ratio of traits showing differences among grazing treatments is greater at the ramet fragment and ramet levels than at the genet level, and trait differences among grazing treatments appeared earlier at the ramet fragment and ramet levels than at the genet level.

Coefficients of variance of measured traits were highest at the ramet level, intermediate at the ramet fragment level and lowest at the genet level but showed no differences among grazing treatments. Traits showing significant differences in coefficient of variance among hierarchical levels comprised 42%, 71% and 85% of all measured traits in 1999, 2000 and 2001, respectively. These results indicate that different grazing intensities did not affect the variances of traits among hierarchies but lengthening time of grazing disturbances will gradually enlarge trait variances. Our results showed that the extent of phenotypic variation in the modular hierarchy of *K. humilis* is greatest at the ramet level and lowest at the genet level. The model of hierarchical responses to grazing defoliation may be "ramet level>ramet fragment level>genet level". In this model, the ramet is a fundamental unit of functional response and natural selection in the *K. humilis* modular hierarchy and has greatest phenotypic variation in response to disturbance, whereas the genet is a relative stable unit in modular hierarchy. Thus we demonstrated the existence of hierarchical selection in this clonal plant species.

Key words [clonal plant](#) [hierarchical selection](#) [grazing treatments](#) [Kobresia humilis](#)

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