Population Dynamics of *Dremomys pernyi* and *Callosciurus erythraeus* in the Protective and Non-protective Pine Forests at Different Ages

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**Abstract:** Four pine forests (6–10, 11–15, 16–20 and 31–40 year-old) located in the Cangshan Mountain and Erhai Lake National Reserve and seven pine forests (1–5, 6–10, 11–15, 16–20, 21–30, 31–40 and more than 50 year-old) located in the non-protective area near the national reserve were selected. Three replications of each forest was set and a total of 33 sites were investigated. At each site, we quantified six habitat variables (species richness, abundance and percentage of grasses and shrubs coverage respectively at the bottom layer of forests) within randomly determined 5 m × 5 m areas. One hundred cages were set in five lines at each site to trap small mammals, whose species and numbers were recorded. Dominance of *Dremomys pernyi* and *Callosciurus erythraeus* in small mammal communities, time niche breadth and time niche overlap between the two small mammals were calculated respectively. Step-wise regression was used to analyze relationship between small mammals and habitat factors. Our results indicated that *D. pernyi* occurred earlier than *C. erythraeus* in protective pine forests. *D. pernyi* was captured in 6–10 year-old forest initially, and *C. erythraeus* was captured in 16–20 year-old forest initially. *D. pernyi* and *C. erythraeus* were captured in the 31–40 and 21–30 year-old forests initially in the non-protective area, respectively. Populations of *D. pernyi* and *C. erythraeus* in the 31–40 year-old protective forests were 3 and 3.75 times of those in the same-aged non-protective forests, respectively.

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Shrubs significantly influenced populations of the two small mammals. Populations of *Dremomys pernyi* was positively correlated with density of shrubs; populations of *C. erythraeus* was positively correlated with coverage of shrubs, and negatively correlated with coverage of grasses. *D. pernyi* and *C. erythraeus* were important for pine forests to scatter pine seeds. Human activities in the non-protective pine forests decreased the vegetation heterogeneity at the bottom layer of pine forests, postponed the occurrence of *D. pernyi* and *C. erythraeus*, and decreased populations of the two small mammals.

**Key words:** *Dremomys pernyi*; *Callosciurus erythraeus*; Population dynamics

1.2

1.3

1.4

15.1 °C, 950 – 2050 m, 1100 mm

**References**

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Berger-Parker

Levins

Berger-Parker

Levins

Cowell-Futuyma

C_{\phi}
计算生态位重叠度:

\[ C_{ij} = 1 - \frac{1}{2} \sum_{n=1}^{S} |P_{in} - P_{jn}| i \neq j \]

其中

\[ C_{ij} \]

是物种 \( i \) 和 \( j \) 的生态位重叠度；

\[ (\cdot, \cdot) \]

和 \( (\cdot, \cdot) \)

为第 \( i \) 和第 \( j \) 种在第 \( n \) 资源上分布的比例；

\[ \& \]

是生态位的资源等级数。

用逐步回归方法分析珀氏长吻松鼠和赤腹松鼠与松林栖境因子的关系。在进行回归分析前，先将环境因子标准化。用单因素方差分析，比较不同生境中珀氏长吻松鼠和赤腹松鼠的数量、优势度以及栖境因子的差异显著性。

结果与分析

保护区和非保护区各松龄段内两种小型兽类的种群动态

在保护区

31 ~ 40 年的松林内捕到珀氏长吻松鼠，随着松林年龄的增长，其种群数量也增加；在 16 ~ 20 年的松林里，种群数量达到最高

\[ \times 2 \times \text{年} \]

\[ \times \text{年} \]

的优势度达到最大，是小型兽类群落里优势度最大的物种；随后种群数量明显下降（图 1）。在保护区

31 ~ 40 年的松林内才捕到赤腹松鼠，比珀氏长吻松鼠出现的松龄段较晚；在 16 ~ 20 年的松林内，种群数量显著增加

\[ \times \text{年} \]

\[ \times \text{年} \]

\[ \times \text{年} \]

\[ \times \text{年} \]

\[ \times \text{年} \]

在小型兽类群落中的优势度为最大，替代珀氏长吻松鼠成为群落中的最优势物种（图 1）。

在保护区松林内，珀氏长吻松鼠的时间生态位宽度为

\[ \times \text{月} \]

\[ \times \text{月} \]

\[ \times \text{月} \]

赤腹松鼠为

\[ \times \text{月} \]

两者的生态位重叠度为

\[ \times \text{月} \]

在非保护区，分别在 16 ~ 20 年和 31 ~ 40 年的松林内才捕到珀氏长吻松鼠和赤腹松鼠，优势度较低，始终未达到

\[ \times \text{年} \]

\[ \times \text{年} \]

\[ \times \text{年} \]

\[ \times \text{年} \]

\[ \times \text{年} \]

而在 16 ~ 20 年的保护区松林内，珀氏长吻松鼠和赤腹松鼠种群数量分别是同年龄段非保护区松林的

\[ \times \text{倍} \]

\[ \times \text{倍} \]

\[ \times \text{倍} \]

\[ \times \text{倍} \]

在非保护区松林内，珀氏长吻松鼠的生态位宽度为

\[ \times \text{月} \]

\[ \times \text{月} \]

\[ \times \text{月} \]

赤腹松鼠为

\[ \times \text{月} \]

两者的生态位重叠度为

\[ \times \text{月} \]

两者的重叠度比保护区高。

保护区与非保护区同龄段松林底层植被差异

图 1 保护区（）和非保护区（）不同年龄段松林中珀氏长吻松鼠和赤腹松鼠的种群数量

图 2 保护区（）和非保护区（）不同年龄段松林中珀氏长吻松鼠和赤腹松鼠的优势度

2.1

2.2
除了年松龄段保护区与非保护区灌木覆盖度、灌木物种多度无显著差异外，在其他松龄段，保护区灌木覆盖度、物种多度、密度显著高于非保护区（表#）。

所有松龄段非保护区草本植物覆盖度、密度均显著高于同松龄段保护区；除了年松龄段非保护区草本植物物种多度高于保护区外，其他松龄段都显著低于保护区（表#）。

两种小型兽类种群数量与栖境因子的关系对珀氏长吻松鼠和赤腹松鼠的种群数量与松林栖境因子进行多元线性回归分析，其结果见表&。

回归结果显示，松林底层的灌木对两种小兽的种群数量有重要影响。珀氏长吻松鼠种群数量与灌木密度呈正相关；赤腹松鼠种群数量与灌木覆盖度呈正相关，而与草本植物覆盖度呈负相关。

### Tab. 1 Comparison of shrubs and grasses between the protective and non-protective forests belonging to four age classes

| Age | Vegetation | Cover rate [%] | F_{1|4} | Species richness | F_{1|4} | Density | F_{1|4} |
|-----|------------|----------------|--------|------------------|--------|---------|--------|
|     |            |                | P      | N                | P      | N       | P      | N       |
| 6 ~ 10 | Shrub | 6.00 | 5.00 | 1.50 | 4.33 | 3.00 | 4.00 | 4.29 | 3.77 | 22.01 ** |
| 11 ~ 15 |            | 15.00 | 4.00 | 36.30 ** | 8.33 | 4.33 | 28.80 ** | 4.42 | 3.72 | 11.64 * |
| 16 ~ 20 |            | 27.00 | 2.33 | 248.91 *** | 10.00 | 2.33 | 132.25 *** | 6.20 | 3.36 | 246.79 *** |
| 31 ~ 40 |            | 42.33 | 8.00 | 230.63 *** | 10.33 | 6.33 | 8.45 * | 6.36 | 4.25 | 1003.23 *** |

| Age | Grasses | Cover rate [%] | F_{1|4} | Species richness | F_{1|4} | Density | F_{1|4} |
|-----|---------|---------------|--------|------------------|--------|---------|--------|
|     |          |                | P      | N                | P      | N       | P      | N       |
| 6 ~ 10 |            | 17.00 | 71.67 | 114.04 ** | 3.33 | 7.67 | 12.07 * | 5.21 | 8.88 | 1632.15 *** |
| 11 ~ 15 |            | 47.67 | 84.00 | 45.35 ** | 13.00 | 5.67 | 48.40 ** | 8.45 | 9.25 | 31.57 ** |
| 16 ~ 20 |            | 68.33 | 80.67 | 42.78 ** | 14.00 | 6.67 | 12.10 * | 8.69 | 9.15 | 12.85 * |
| 31 ~ 40 |            | 52.00 | 77.33 | 125.57 *** | 13.33 | 7.33 | 23.14 ** | 8.40 | 8.94 | 23.08 ** |

P < 0.05 " ** P < 0.01 " *** P < 0.001

### Tab. 2 Regression models to describe relationships between population of Dreommys perryi and Callosciurus erythraeus and habitat variables

| Species | Regression equation | R | F_{1|22} F-value | df | P |
|---------|---------------------|---|-----------------|----|----|
| Dreommys perryi | Y = 1.792 + 1.999X_1 | 0.914 | 112.285 | 1|22 | < 0.001 |
| Callosciurus erythraeus | Y = 0.833 + 1.843X_2 - 0.670X_3 | 0.828 | 22.983 | 2|21 | < 0.001 |

X_1, X_2, X_3 were the density of shrubs, cover rate of shrubs and cover rate of grasses, respectively.

### 3 讨论

小型哺乳动物的分布依赖于环境为其提供食物和隐蔽条件等基本生存要素。珀氏长吻松鼠和赤腹松鼠主要以种子和野果为食，也吃昆虫和鸟卵等动物。赤腹松鼠在松林里出现的时间晚于珀氏长吻松鼠，可能是由于赤腹松鼠种群更依赖于松树果实。在低龄的松林里，松树尚未结果或结果数量少。两种松鼠都要到树下活动取食，因此，树下植被对松鼠早期的种群建立特别重要。本研究保护区松林内珀氏长吻松鼠和赤腹松鼠的种群数量显著高于非保护区，可能与保护区灌木覆盖度和密度相对较高，可以为其提供更多的隐蔽条件和食物来源有关。


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