**Predator-Prey Cycles**

**捕食者-被捕食者循环**

How do predators affect populations of the prey animals? The answer is not as simple as what might be thought. Moose reached Isle Royale in Lake Superior by crossing over winter ice and multiplied freely there in isolation without predators. When wolves later reached the island, naturalists widely assumed that the wolves would play a key role in controlling the moose population. Careful studies have demonstrated, however, that this is not the case. The wolves eat mostly old or diseased animals that would not survive long anyway. In general, the moose population is controlled by food availability, disease, and other factors rather than by wolves.

捕食者是怎样影响被捕食者的数量呢?答案并不是想象中那么简单。麋鹿通过穿越冬天的冰层到达了在苏必略湖的罗亚尔岛，并由于没有捕食者而自由繁殖。当狼在晚一点的时候到达那座岛时，自然学家都认为，狼对控制麋鹿的数量将起到关键作用。但是，严密的研究说明并不是这样。狼吃掉的大部分是年老的，或生病的动物，他们本身就不会存活很久。一般地，麋鹿的数量是由食物、疾病、和其它的一些条件，而不是狼控制的。

When experimental populations are set up under simple laboratory conditions, the predator often exterminates its prey and then becomes extinct itself, having nothing left to eat. However, if safe areas like those prey animals have in the wild are provided, the prey population drops to low levels but not to extinction. Low prey population levels then provide inadequate food for the predators, causing the predator population to decrease. When this occurs, the prey population can rebound. In this situation the predator and prey populations may continue in this cyclical pattern for some time.

在简单的实验条件下，捕食者经常吃掉了所有的实验设定的被捕食者，然后因为食物缺乏而自己灭绝了。但是，如果能给被捕食动物提供如同在野外的安全的区域，被捕食动物的数量会降低到很低的数值，但不会灭绝。被捕食者的数量的降低造成了捕食者的食物不足，使捕食者的数量下降。此时，被捕食者的数量又会反弹。这样，一定时间内捕食者和被捕食者的数量会持续地循环。

Population cycles are characteristic of small mammals, and they sometimes appear to be brought about by predators. Ecologists studying hare populations have found that the North American snowshoe hare follows a roughly ten-year cycle. Its numbers fall tenfold to thirty in a typical cycle, and a hundredfold change can occur. Two factors appear to be generating the cycle: food plants and predators.

这种数量的循环是小型哺乳动物的特性，有时候这种循环是由捕食者带来的。生态学家对野兔数量的研究发现，北美白靴兔一直遵守着大约以十年为周期的循环。在一个典型的循环中，其数量会以十倍到三十倍的减少，甚至会出现一百倍的改变。有两种因素会导致这种循环：食物和捕食者。

The preferred foods of snowshoe hares are willow and birch twigs. As hare density increases, the quantity of these twigs decreases, forcing the hares to feed on low-quality, high-fiber food. Lower birth rates, low juvenile survivorship, and low growth rates follow, so there is a corresponding decline in hare abundance. Once the hare population has declined, it takes two to three years for the quantity of twigs to recover.

白靴兔比较喜欢的食物是柳木和桦树树枝。野兔的密度增加时，这些树枝的数量就减少，迫使野兔去吃一些低质量的，高纤维食物。随之而来的是低生育率，低成活率，低生长率，所以野兔数量随之减少。一旦野兔数量减少，树枝的数量需要两到三年恢复。

A key predator of the snowshoe hare is the Canada lynx. The Canada lynx shows a ten-year cycle of abundance that parallels the abundance cycle of hares. As hare numbers fall, so do lynx numbers, as their food supply depleted.

白靴兔的主要捕食者是加拿大山猫。加拿大山猫的数量呈现了平行于野兔的十年为周期的循环。野兔数量下降时，山猫的食物供给减少，数量也随之减少。

What causes the predator-prey oscillations? Do increasing numbers of hares lead to overharvesting of plants, which in turn results in reduced hare populations, or do increasing numbers of lynx lead to overharvesting of hares? Field experiments carried out by Charles Krebs and coworkers in 1992 provide an answer. Krebs investigated experimental plots in Canada’s Yukon territory that contained hare populations. When food was added to these plots (no food effect) and predators were excluded (no predator effect) from an experimental area, hare numbers increased tenfold and stayed there—the cycle was lost. However, the cycle was retained if either of the factors was allowed to operate alone: if predators were excluded but food was not added (food effect alone), or if food was added in the presence of predators (predator effect alone). Thus, both factors can affect the cycle, which, in practice, seems to be generated by the conjunction of the two factors.

什么造成了捕食者和被捕食者的周期振动呢?是野兔数量的增长使得植物被过度采食，随之导致了野兔的减少还是山猫的增加导致了野兔被过度捕食?在1992年，Charles Krebs和其合作者的野外试验提供了答案。Krebs研究了在加拿大Yuhon地区有野兔种群的试验田。当食物被加到这片试验田(没有食品因素影响)并且将捕食者移去(也没有捕食者因素影响)。野兔的数量增加了十倍并且保持稳定----不再循环。但是，在任意一个因素单独存在时，循环都会出现：不管是捕食者被移除，食物不添加(也就是只有食物影响);还是食物在捕食者存在的情况下被添加(也就是只有捕食者影响)。因此，两个因素都可以影响这个循环，即在现实中，循环是两个因素同时作用的结果。

Predators are an essential factor in maintaining communities that are rich and diverse in species. Without predators, the species that is the best competitor for food, shelter, nesting sites, and other environmental resources tends to dominate and exclude the species with which it competes. This phenomenon is known as “competitor exclusion.” However, if the community contains a predator of the strongest competitor species, then the population of that competitor is controlled. Thus even the less competitive species are able to survive. For example, sea stars prey on a variety of bivalve mollusks and prevent these bivalves from monopolizing habitats on the sea floor. This opens up space for many other organisms. When sea stars are removed, species diversity falls sharply. Therefore, from the standpoint of diversity, it is usually a mistake to eliminate a major predator from a community.

捕食者是保持群体多样性和数量的必要条件。没有捕食者时，那种在对食物、庇护所、筑巢点和其它环境资源的争夺中胜出的竞争者，趋向于统治，并且灭绝与其竞争的其它物种。这种现象被称作“驱逐竞争者”。但是，如果种群中的具有最强竞争力的物种存在天敌，那这一物种数量就被控制。因此，竞争力比较弱的物种都会得以生存。比如，海星捕食各种双壳的软体动物，防止这些双壳动物垄断海底。这使得其它的很多生物有了生存空间。海星被移除后，物种多样性大幅度降低。因此，从多样性的角度说，从一个种群中消除一个主要捕食者通常是错误的决定。