SULZER ANALOGY

The animal kingdom also has an energy budget

Consider the way in which bumblebees optimize the search for nectar, butterflies adapt the speed at which they fly, and chamois survive harsh alpine winters: it is only by dispensing with any luxury that a creature can gain the critical advantage in the genetic battle, which ultimately results in a larger number of offspring and the long-term survival of the fittest.

Insects, such as bumblebees, have a time and energy budget when harvesting nectar.

The basic economic question is simple: how much energy can I afford to expend and how much risk can I take to achieve a specific goal whose benefits outweigh its costs? Whether harvesting nectar, hunting for prey, finding a mate or raising young – a detailed analysis shows that creatures everywhere always pursue a strategy that generates a neutral to positive economic outcome.

From feeding ...

Insects that live off the nectar of flowering plants have a time and energy budget for their harvesting activities. If a bumblebee finds nectar-rich goldenrods when searching for food, it will spend up to 100 seconds on each individual flower. Conversely, the minute drops of nectar found on willow herb only merit a 2-second feeding stop. If the bumblebee has to fly relatively far to find flowers yielding large quantities of nectar, time becomes a limiting factor. The insect must fly more rapidly – and burns up more energy as a result. However, a sparser food supply means the insect cannot afford to expend as much energy and must fly more slowly.

Creatures must also optimize their habits to avoid predators. In Costa Rica, the flying speeds of various species of butterfly were recorded using high-speed filming techniques, and the frequency with which each species fell victim to predators was determined. In the case of butterflies that flew rapidly, up to 80% were able to evade attacks by birds, while most of the slower species were killed.

However, speed also has a cost. Insects that fly rapidly must invest over 40% of their body weight in flight muscles and consequently have a small abdomen. In the case of slow-flying insects, the females develop much larger ovaries in their abdomen and have a higher reproduction rate to compensate for their shorter lifespan.

... to establishing reserves

A high degree of energy efficiency is also essential to survive the winter. Creatures that do not migrate south to warmer regions—unlike swallows, storks and starlings—use various methods to try to survive the harsh climate. During the alpine summer when food is plentiful, chamois and ibex build up large fat reserves, which can eventually account for as much as one fifth of their body weight. To ensure that these fat reserves are sustained until the spring, the animals must rigorously conserve energy. They therefore remain virtually immobile for days and grow a special winter coat to restrict the loss of heat from their bodies. Chamois have a winter coat consisting of a top layer of long, rigid hair, with a thick layer of wool below. The air that is trapped in the coat insulates the animal against the cold. Animals also invented the heat exchanger principle long before energy technology was developed: arteries that lead to the creature's extremities are closely surrounded by veins that return the blood to the heart. This means the temperature of the cooler blood flowing back to the heart is raised efficiently by the warm blood flowing away from it.

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