ECOLOGY

Prey and Predation

from our Animal Ecology Correspondent

ECOLOGISTS interested in interactions of predators and their prey have for long taken Volterra's classical work (*Mem. Acad. naz. Lincei* (ser. 6), **2**, 31 ; 1926) as the starting point of their deliberations. There are, however, some aspects of this work that are far from satisfactory from a biological viewpoint. The chief amongst these, when both predator and prey are warm-blooded, is that the differential equation used assumes (1) that both predator and prey breed continuously and that the rate of breeding is directly related to the amount of food eaten, (2) that the rate at which prey animals are eaten is proportional to the probability of a chance encounter between predator and prey, and (3) that there is no other limitation on the prey population. It is hardly conceivable that these conditions operate in a situation in which there are sharply defined breeding seasons controlled by environmental factors and in which there is some time lag between the consumption of prey by a predator and the production of young. Lastly, a limit must eventually be imposed on prey populations although they may be kept below this asymptote by the activities of their predators.

J. Maynard Smith and M. Slatkin have developed a model to describe the interaction of vertebrate predator and vertebrate prey that goes much further than Volterra's (*Ecology,* **54**, 384 ; 1973). They take as their starting point the age-old observation that predator-prey interactions are remarkably stable and populations of both coexist for long periods of time. Two stabilizing processes seem possible. The first is the movement of predators and prey in space, and the second is that owing to age and other differences, not all individual predators will be equally efficient hunters. In many species, especially of mammalian predators, the juveniles have to be taught how to hunt and when they are independent may concentrate on older or younger prey than do their parents. The new model examines the second of these possibilities.

The authors show by their computations that when stable coexistence occurs, the population of a prey species is only a little lower than the level at which it would achieve equilibrium in the absence of predators. If the prey population falls substantially below the environmental carrying capacity, instability follows and the extinction of one population results. Stable coexistence is enhanced by the variety of hunting ability found in mixed aged populations. In years when prey populations are low at the start of winter, survival of adult predators is good at the expense of juveniles. The Volterra model suggests that the presence of cover may increase stability but it seems from the new model that this is not so. Because the predators cannot hunt efficiently enough to annihilate the prey totally, cover for the prey will only make it more likely that the predators will become extinct.

The principal merit of the new model is that it regards the interaction from a sound biological viewpoint and attributes biological characteristics to the participating species and explains some of the evolutionary mechanisms resulting in the "prudence" attributed to predators when they do not over-exploit their food resources.

FOOD CHEMISTRY

Slimmer's Protein

from our Molecular Biology Correspondent

DEPENDING on one's outlook, the word protein may bring to mind a schlieren boundary or a beefsteak, provoke cerebration or salivation. In the bright light of modern protein chemistry the two images may now perhaps be united. It was never of course supposed that the blend of denatured muscle proteins confers the flavour on the beefsteak, for it is small molecules that have invariably been associated with taste. Indeed receptors have been isolated from taste organs, which will specifically bind sweet-tasting sugars, for example, but not others. Many amino acids, particularly D-isomers, are sweet, and at least one intensely sweet dipeptide has been discovered. The first example of a macromolecule with taste activity was the protein, miraculin, which has the remarkable property of transforming the sourness of acids into a sweet sensation. A protein which is sweet in its own right has been isolated and characterized in two laboratories in recent months. An earlier report suggested that it might be a glycoprotein, but this proved to be erroneous.

The protein, which comes from a tropical fruit, was isolated more or less pure by van der Wel (*FEBS Lett.*, **21**, 88 ; 1972) by a two-stage gel filtration of a water extract, and later by ion-exchange (van der Wel and Loeve, *ibid.*, **29**, 181 ; 1973). The sweetness was found to reside in the principal electrophoretic zone in a starch gel (prudently preferred for the purpose to polyacrylamide), scanning by tongue being apparently the method of detection. The molecular weight was estimated from the elution volume on the gel-filtration column as some 10,000. Morris and Cagan (*Biochim. biophys. Acta,* **261**, 114 ; 1972) covered much the same ground using ion-exchange chromatography to prepare the protein, and preempted for it the name of monellin. More recently (Morris *et al., J. biol. Chem.*, **248**, 534 ; 1973) they characterized the protein in some detail, and found a molecular weight of 10,500 by SDS-gel electrophoresis and a similar value based on the minimal tryptophan content. The protein is rather basic, and there is one thiol and no disulphide bonds. More particularly van der Wel and Morris *et al.* are agreed that there is no carbohydrate. Proteolysis destroyed the flavour.

Last year van der Wel and Loeve reported the isolation of yet another sweet protein from a different type of fruit. They dubbed it thaumatin after the name of the plant, and found that it comprised two electrophoretic species, one of which appeared to be a partially deaminated form of the other. Again there is no saccharide. The molecular weight by sedimentation equilibrium was 21,000. The thaumatins are basic and contain seven disulphide bonds, in which respect they differ sharply from monellin. The nature of these proteins is an engrossing subject, and Korver, van Gorkom and van der Wel (*Eur. J. Biochem.*, **35**, 554 ; 1973) have embarked on a conformational study. The circular dichroism shows a set of small Cotton effects arising from the tyrosine and tryptophan residues, and stronger features that can be assigned to the abundent disulphide chromophone. (It might be remarked that for the interpretation of disulphide circular dichroism in terms of the chirality of the torsional angle it is by no means sufficient to follow the precepts offered by Urry and his co-workers, in a spirit of optimism rather than rigour ; one can conclude only that they are in a locked configuration.) There is clearly no appreciable content of α-helix. High resolution proton magnetic resonance spectra show high-field features characteristic of aliphatic protons perturbed by ring-currents of neighbouring aromatic side chains. These characteristics, together with a sharp thermal melting profile, the denaturation temperature depending on pH, which is manifested in a change of the circular dichroism and the generation of an ultraviolet difference spectrum, make it clear that thaumatin is a genuine globular protein. Its thermal denaturation, which is reversible, is accompanied by the disappearance of the sweet taste.

It thus seems that the taste is a characteristic of the native conformation, that is to say of a defined geometric constellation of residues. Both thaumatin and monellin exhibit sweetness to a prodigious degree, compared for example with sugars, and the sensation persists on the tongue for long periods. Now it is known that sugars bind only rather weakly to the taste

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