the liver, however, Kupffer cells, which have long generation times, are heavily labeled, whereas stationary phase hepatocytes are only slightly labeled. Thus, DNA in microglia and hepatocyte nuclei inherently seems to be either more resistant to damage by strand scission or is more effectively repaired when damaged. At least, with age, a progressive stabilization of DNA-protein complex occurs in the liver (*9*).

Our results imply that, with aging, the nuclear DNA in certain cells may accumulate damage such as single strand breaks. Using 10-kr whole-body x-irradiation (*6*), which results in induction of a lethal central nervous system syndrome (*12*), to induce primarily single strand breaks, we have been able apparently to duplicate the age-associated changes that occur naturally in DNA of senescent brain cells. Such changes could arise if DNA-repair enzymes (*13*) are progressively lost or if age-associated increases in the release of hydrolytic enzymes occur. Evidence does exist demonstrating the age-associated increase in lysosomes (*14*) and lysosomal enzyme activities (*15*). A more direct proof of accumulation of strand breaks with aging and the resolution of mechanisms involved must await development of adequate physical and chemical techniques. Finally, our histochemical data should not be considered as support for any single generalized theory of aging. However, these data are consistent with any theory dealing with alterations in the information content of *certain specific* cell populations at the genome, such as molecular aging theories involving error-inducing mechanisms.

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Nest Predation Affecting the Breeding Season of the Clay-Colored Robin, a Tropical Song Bird

Abstract. Predation seems more important than food availability in determining the reproductive period of the clay-colored robin Turdus grayi. It breeds in the dry season when food resources are low. The rainy season brings more food but breeding stops, possibily because of greatly increased nest predation.*

Fluctuations in food resources have been named as the ultimate factor responsible for the short and distinct breeding seasons found in many tropical birds (*1*). The predation rate on nests is often higher in tropical than in temperate areas (*2*). I now report a case where predation seems more important than food abundance in setting the breeding season of a tropical bird.

Fifty-six nests of the clay-colored robin *Turdus grayi* were found in a 57-hectare area of Summit Gardens, Panama Canal Zone (*3*), before or during the time eggs were being laid in them. The range of dates of clutch initiations was 26 February to 17 May 1970 (median date 7 April).

Most breeding attempts (70 percent) were in the dry season, which in this area begins in December and ends in late April or early May. In 1970, after 20 April the rains were frequent enough that the ground remained continuously damp. Soon thereafter the robins ceased breeding.

Weighing nestlings gave an index to food abundance throughout the breeding season. Fledgling weights were lowest during the main part of the breeding season and some nestlings died of starvation (*4*). As the rains became more frequent in mid-April, fledgling weights increased and there was no starvation.

The increase in fledgling weight was largely due to the addition of earthworms to the diet. They became available after the ground became damp or flooded following rains. Fruit is abundant during the dry season (*5*) and may furnish adult robins with easily obtainable food, but the fast growth of the young probably requires protein-rich invertebrate food (*6*).

Why don't the birds breed later and thus fledge more and heavier young? The reason may be the increasing amount of nest predation that occurred after the rains began (*7*) (Table 1). Another indication of higher predation pressure may be that 64 percent of nests were lost in earlier stages (containing eggs) after 20 April. Before this,

Table 1. A comparison of nests lost to predators with successful nests with clutches started before and after 20 April. That date marks the beginning of the rainy season. A nest was considered to be successful if it fledged at least one young. Chi-square was 4.20 with 1 degree of freedom; $P < .05$.

Time	Lost (No.)	Successful (No.)
Before	21	15
After	17	3

56 percent of the nests lost to predators were in the nestling stage.

The causes of the increased predation are unknown. Possibly there may be a decrease in fruit for omnivorous predators. There could also be an increase in the predator's reproductive activities that may necessitate a higher protein diet.

Birds breeding in the dry season have about a 42 percent chance of fledgling young whereas those breeding in the early rainly season have a 15 percent chance. This difference in predation pressure has apparently been enough to cause this species to breed during a period when nestling food is relatively scarce. But young fledged during the dry season, although low in weight, probably reach independence from parental care near or during the period of increased food abundance after the rains begin.

Predation may be an important factor in the selective value of a low clutch size in tropical birds. It has been hypothesized that, given a high rate of nest predation, smaller clutches may be favored by selection if this reduces the chance of a nest being found (*8*). We must now add to this the hypothesis that predation may cause breeding to occur when food for nestlings is scarce. A small clutch would be favored by selection as an adaptation to low food availability.

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Chemical-Cue Preferences of Newborn Snakes: Influence of Prenatal Maternal Experience

Abstract. *Newborn garter snakes* (Thamnophis sirtalis) *responded similarly to worm and fish surface extracts regardless of whether the mothers were fed exclusively on fish or worms during the gestation period. Worm extract was the more effective. This result is in contrast with the easy modifiability of chemical-cue preferences in young snakes after birth. The initial stimulus control of the attack response in newborn snakes thus seems relatively unmodifiable.*

Ethological work on early experience and imprinting has revitalized concern with the modifiability of many species-characteristic behaviors. However, along with reemphasizing the importance of early experience, ethologists also emphasized the fact that many animals will respond with a stereotyped response to only a small portion of the total stimulus situation presented by a naturally occurring object, even without prior experience with that object. The cues eliciting such specific responses, termed sign stimuli, can be shown to be influenced by genetic factors if specific prior experiences are controlled (*1*).

For a number of years I have been working on the prey-attack response of newborn snakes which seems to involve such an innate sign stimulus. For example, young garter snakes (*Thamnophis sirtalis*) will give increased tongue flicking and actual overt attacks to cotton swabs dipped in chemicals extracted from the surface substances of normally eaten prey such as fish and earthworms (*2*). This response is mediated primarily by the tongue—Jacobson's organ system (*3, 4*). Clear species differences exist in the type of prey extracts responded to by inexperienced young, and these differences are closely related to differences in the prey normally eaten by the various species (*5*). An evolutionarily based explanation for the presence of such selective discrimination is certainly reasonable—that is, a mechanism which is ultimately dependent upon some type of genetically encoded information. However, the question remains as to which experiences, if any, can alter the prey-attack behavior of newborn snakes to chemical stimuli.

Results up to now indicate that if naive snakes are force-fed an unnatural food such as strained liver for up to 6 months, the resulting chemical-cue and feeding behavior deprivation seems to have no effect either on the overt behavior itself, on the elicitation of attacks by chemical stimuli, or on the relative hierarchy of releasing values of various effective extracts (*4*). Consequently, we can conclude that the "innate schema" of newborn snakes does not change without some experience other than that of deprivation itself.

Such results support the view that rigid, built-in preferences are present in newborn snakes. However, unmodifiable preferences would certainly have unfavorable consequences under many conceivable environmental conditions. In fact, actual overt or "voluntary" feeding by the animal *is* capable of modifying the chemical preferences of the newborn snake (*6*). A further experiment separated the effects of food reinforcement from the chemical extract experience itself and found that under certain circumstances preexposure of newborn snakes to chemical prey extracts was sufficient to alter later responsivity to prey extracts (*7*). Therefore, postnatal experience can alter the chemical preferences shown by newborn snakes.

Although such evidence seems to point to the presence of an ethological innate releasing mechanism modified by postnatal experience (*8*), it might be argued that the differential responding to chemicals by newborn snakes is not a genetic, evolutionary, innate, or similarly labeled behavior at all. Prenatal experience may be an important, if not the sole, influence. In considering how such a mechanism might work, maternal feeding experience is one of the few nongenetic paths which might provide some specific information dealing with the type of precise knowledge of adaptive food habits possessed by the newborn snake. This possibility has been mentioned earlier (*5*), although it is difficult to see how it could provide the range of information possessed by the neonate. The newborn young of some species can recognize many classes of chemical stimuli such as those from frogs, leeches, salamanders, fish, and earthworms.

If maternal feeding does play a role in the selectivity shown by newborn