lactation lasts about 8 weeks. Young born in late October would therefore be suckling until about late December. The records above demonstrate that the bond between the mother and her young may persist for about 3 to 4 weeks after lactation. Extension of this bond beyond lactation has not been recognized in any other species of bat.

In Australia *M. adversus* is found near water. Group foraging over water has been observed, and coordinated following behavior may occur when bats forage from the water surface (*11*). The social system of *M. adversus* therefore involves at least three components: elaboration of the pair bond to give male territoriality and harem formation, extension of the mother-young bond beyond nursing, and the development of group foraging. In showing these features, *M. adversus* differs from the usual interpretation of sociality in microchiropteran bats. With the exception of this study and studies of *T. b. mexicana* and *Miniopterus schreibersii*, no serious attempt has been made to seek possible social patterns in this group of mammals (*12*). These studies do not support the view that microchiropteran bats are socially conservative.

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Thermoresponsiveness of the Preoptic Region of the Brain in House Sparrows

Abstract. *Heating the preoptic region of the house sparrow caused the bird to decrease its metabolism and to decrease its body temperature, whereas cooling that region caused an increase in metabolism and an increase in body temperature. These responses indicate that the preoptic region of birds, like that of other vertebrates, is an important center for thermoregulation.*

Localized thermosensitivity is centered in the preoptic area of mammals (*1*), fish (*2*), and reptiles (*3*). Temperature changes in this area elicit thermoregulatory responses. Similar sensitivity has not been clearly demonstrated in birds. Von Saalfeld (*4*) showed that heating the anterior dorsal midbrain in pigeons increases the respiratory rate to the point where panting is simulated. Localized thermostimulation of the spinal cord elicits thermoregulatory responses in birds (*5*). There is some evidence that the hypothalamus is required for maintenance of uniform body temperature in birds (*6*). In the study reported here we found that heating the preoptic region of the house sparrow caused the bird to decrease its metabolism and to decrease its body temperature, whereas cooling that region caused an increase in metabolism and an increase in body temperature. These responses indicate that the preoptic region of birds, like that of other vertebrates, is an important center for thermoregulation.

Adult male house sparrows (*Passer domesticus*) in winter plumage caught locally in September and October have a mean weight of 25.5 ± 3.2 g ($N = 25$). An ultrasmall thermode (0.75 mm in outside diameter) modeled after that of Williams and Heath (*7*) was stereotaxically implanted at various angles in the anterior forebrain directed toward the preoptic area. Birds were allowed to recover for 2 to 3 days after surgery before cooling or heating of the thermode was initiated. The thermode was cooled by the passage through it of a continuous flow of water (18° to 21°C) and heated by a flow of 44°C water. We controlled the temperature of the tissue immediately adjacent to the thermode by adjusting the temperature of the thermode efflux. The body temperature of the birds was recorded continuously by means of thermocouples in the cloaca. A small number of these birds were tested for metabolic response to thermode heating and cooling. The oxygen consumption of the birds was used to estimate changes in the intensity of shivering, which is the only form of thermoregulatory heat production in birds (*8*).

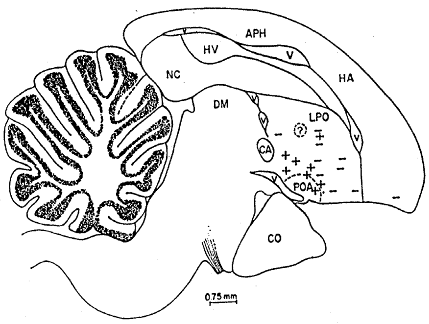

Fig. 1. Drawing of a sagittal section of the brain of the house sparrow approximately 0.5 mm from the midline. The symbols represent the location of the thermode tip in the brain of a bird responsive (+) or nonresponsive (−) to thermal stimulation. One preparation that gave variable results is labeled with a question mark. *APH*, Area parahippocampalis: *CA*, commissura anterior; *CO*, chiasma opticum; *LPO*, lobus parolfactorius; *HA*, hyperstriatum accessorium; *HV*, hyperstriatum ventrale; *NC*, neostriatum caudale; *POA*, nucleus preopticus anterior; *DM*, nucleus dorsomedialis thalami; *V*, *ventriculus* (*11*).

We were able to measure the oxygen consumption and cloacal temperature of birds with an implanted thermode by restraining them in a dark chamber (22° to 23°C). By means of a Beckman paramagnetic oxygen analyzer we monitored a continuous flow of air (1000 ml/min) through the chamber for a change in the percentage of oxygen. When testing was completed, the brain of the bird was removed, embedded in celloidin, sagittally sectioned at 40 μm, and stained with cresyl violet.

A restraining device used to hold the birds during the experiments caused continuous stimulation which resulted in increased oxygen consumption and increased cloacal temperature. The mean body temperature at the time of placement in the restraining device was 41.1° ± 1.3°C. The mean oxygen consumption of seven restrained birds at an ambient temperature of 22° to 23°C was 6.2 ml of oxygen per gram per hour. These values were higher than those reported for resting house sparrows in the daytime (*9*).

Thermode cooling or heating produced a change in oxygen consumption and cloacal temperature in nine birds but no response in ten others. Figure 1 shows the position of the thermode in the 19 birds studied. Consistent increases in cloacal temperature or oxygen consumption, or both, in response to thermode cooling and consistent decreases in cloacal temperature or oxygen consumption, or both, in response to thermode heating indicate a thermally responsive area. The lack of changes in these parameters indicates a nonresponsive area. An area of nonresponsiveness surrounds an area of positive response to thermode stimulation.

The area of localized thermosensitivity is centered in the preoptic area of the sparrows. Cloacal temperature and oxygen consumption change steadily to a maximum response at approximately 15 minutes after initiation of thermal stimulation. Continued heating or cooling resulted in no further thermoregulatory response. Table 1 summarizes the changes in oxygen consumption and cloacal temperature of responsive birds after approximately 15 minutes of thermode heating or cooling. Although the birds are already somewhat hyperactive, cooling the brain elicits further heat production. All birds returned to their normal state within 15 minutes after the cessation of heating or cooling.

In dogs preoptic thermosensitivity is functionally important to temperature regulation (*10*). The body temperature of dogs is not altered by temperature extremes although the central nervous system is thermosensitive. Birds respond to thermal stress without major changes in body temperature (*8*). Since the preoptic region of house sparrows is thermoresponsive, this region is an important center for thermoregulation. These facts indicate that the thermal control system of birds is similar to that of mammals.

Table 1. Effect of 15 minutes of thermal stimulation of the preoptic area in the house sparrow (*Passer domesticus*) on the oxygen consumption and cloacal temperature at an ambient temperature of 22° to 23°C. For comparison, the mean body temperature of the birds at the beginning of the test was 41°C.

Thermode temperature (°C)	Body temperature: Maximum change ± range (°C)	Body temperature: *N*	Oxygen consumption: Percentage of initial metabolism ± range	Oxygen consumption: *N*
18°–21°	+0.9° ± 0.4°	8	115 ± 4	2
36°–37°	+0.5	1	113	1
45°	−0.5	2	88	1

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Darwinian Evolution of Proteins

Recently King and Jukes (*1*) have argued that most evolutionary changes in DNA and proteins are primarily due to neutral mutations and random genetic drift. They imply that "classical evolutionists" have given insufficient thought to the problems of macromolecular change. It therefore seems appropriate for a "classical evolutionist" to point out a number of weaknesses in their argument.

Distribution of amino acid changes. King and Jukes have tabulated the distribution of numbers of amino-acid changes in variants of globins, cytochromes c, and the variable (S-) regions of immunoglobulins. In plotting the number of changes per site against the number of sites having the specified number of changes, they claim that the results follow the Poisson distribution. They regard this apparent correspondence as evidence that most of the substitutions occur at random, but they have obtained it by statistically illegitimate methods. Before their figures will fit the Poisson, they are obliged to remove an arbitrary number of sites from the zero ("invariant") category. Manipulations of this sort would allow them to make the figures fit almost any distribution.

The Poisson distribution is based on the assumption of homogeneous probabilities. Disregarding the invariant sites (already known to be aberrant) it is easy to show that the remainder do not satisfy this assumption. If we consider the distribution of individual amino acids at sites where one substitution has been observed and compare it with the distribution at sites where several substitutions have been observed, we find that the distributions are significantly different. With the use of data given by Dayhoff (*2*) for the hemoglobins, the sites with single substitutions show highly significant relative excesses of valine, leucine, isoleucine, proline, and phenylalanine and relative deficiencies of serine, glycine, asparagine, and glutamine ($P < .001$). This observation shows that King and Jukes's "Poisson" distribution for the hemoglobins is in fact a compound of several different distributions, and it invalidates their conclusions. It also casts doubt upon the calculations of Fitch and Margoliash (*3*), which are also based on the Poisson distribution.

Even if the figures were to fit the Poisson, this would constitute no strong argument in favor of the "neutral" hypothesis. The dangers of reasoning of this kind are well known to population geneticists. The distribution of gene-frequencies in the land snail *Cepaea*, for example, was originally (and legitimately) fitted to a distribution based on the assumption of randomness (*4*), but was later demonstrated to have a strong selective component (*5*).

King and Jukes were unfortunate in choosing the S-regions of immunoglobulins as one of their examples. Many workers believe that the variability of the S-regions is due to a mechanism very different from that involved in normal allelic substitutions (*6, 7*). No