planned to test birds of the same and of different stocks at other home points, we must reserve judgment regarding the prevalence and consistency of the directional factor in homing until more results are available. Already, parallel data have been obtained at a loft in Mountville, S.C. (*5*) and in southern Germany; data from both points suggest that directional differences are a general phenomenon in pigeon homing. The combined data of these cross releases thus clearly confirm the earlier Wilhelmshaven findings of systematically unequal homing performances from different directions.

We are not able at this time to offer an explanation of the direction differences. However, it is conceivable that this discovery may provide a clue to the basis of the bird's orientation ability. Further study of the effect seems imperative.

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References and Notes

1. These experiments were conducted under contract NR 160-244 between the Office of Naval Research, Department of the Navy, Washington, and Duke University.
2. We are indebted to the following for their assistance in the 53- to 59-mi release: M. H. Carson, T. H. Goldsmith, L. C. Graue, T. N. E. Greville, D. R. Griffin, H. B. Hitchcock, and G. V. T. Matthews.
3. For the 16- to 17-mi flights, $\chi^2 = 38.6$ (9 d.f.); $P = < 0.0001$. For the 53- to 60-mi flights, testing returns from each direction on the release day versus later and lost birds yields $\chi^2 = 14.8$ (3 d.f.); $P = 0.002$. For both distances combined $\chi^2 = 51.5$ (9 d.f.); $P = < 0.000001$.
4. Comparing independent flights from N and S from a total of 38 birds that flew in all eight releases at 17¼ mi gives the following ratio of $\geqq 15$ mi/hr to < 15 mi/hr birds: (i) during the first four releases, 5/19 and 16/17 ($\chi^2 = 4.57$, 1 d.f.; $P = 0.032$); (ii) during the second four releases, 11/20 and 19/12 ($\chi^2 = 4.13$, 1 d.f.; $P = 0.042$). Thus, the only obvious effect of practice is a general increase in speed.
5. We are indebted to John B. Cooley for providing birds and assistance in these experiments.

29 August 1955

Formation Constants for Cu(II)-Peat Complexes

A great deal of evidence, much of it indirect, points to the fact that soil organic matter forms relatively stable complexes with di- and trivalent metal ions. However, no quantitative information concerning the stability of such complexes is available. This is a preliminary report (*1*) on the determination of formation constants for metal ion-organic matter complexes; it deals entirely with the binding of Cu(II) by peat.

Table 1. Ionization constants of H-peat and formation constants of Cu(II)-peat complexes.

Cu(II) added (10^3 mole/lit)	KNO_3 (mole/lit)	*pka*	*n*	*Kc* ($\times 10^{-6}$)	*B*
2	0.01	5.5	2.2	80	2.5
2	0.1	4.8	2.2	8.0	2.5
2	1.0	4.3	2.2	1.6	2.5
0.6	1.0	4.3	2.2	1.0	
0.2	1.0	4.3	2.2	1.0	

Peat and other soil organic matter specimens possess acidic (proton-donating) groups thought to be carboxylic, phenolic, and enolic (*2*). Such groups are believed to be responsible for the cation exchange capacity, which generally lies between 2 and 3 milliequivalents per gram. The intrinsic ionization constant for the carboxylic groups appears to be about 10^{-5} (*3*), and these are the only acidic groups thought to be ionized to an appreciable extent at *p*H of 7 and below.

The similarity of the acidic nature of peat to that of polyacrylic acid and the various cross-linked polymers whose Cu(II) complexes were studied by Gregor *et al.* (*4, 5*) suggested that a similar treatment might yield values for the formation constants of Cu-peat complexes.

The peat-Cu(II) reaction may be written in two ways, with P referring to the concentration of peat functional groups:

$$2P^- + Cu^{++} \leftrightharpoons CuP_2; \qquad Kc = \frac{(CuP_2)}{(Cu^{++})(P^-)^2} \qquad (1)$$

$$2HP + Cu^{++} \rightleftarrows CuP_2 + 2H^+; \qquad B = \frac{(CuP_2)(H^+)^2}{(Cu^{++})(HP)^2} \qquad (2)$$

For calculating the apparent formation constant Kc the condition is sought where $CuP_2 = Cu^{++}$—that is, where the degree of formation is 0.5 (*6*). Then $Kc = 1/(P^-)^2$.

As is pointed out by Gregor *et al.* (*4*), since Kc is a constant for a reaction between a metal ion and charges on a colloidal particle, Kc should vary with the degree of neutralization and the ionic strength to the same extent as the acid ionization constant but in the opposite direction. On the other hand, B, which essentially is the product of Kc and the ionization constant ka, should be independent of ionic strength.

To evaluate Eqs. 1 and 2 for Cu(II)-peat complexes, 0.2 g (0.46 milliequivalents of acidic groups) of acid-washed Florida peat was shaken for 48 hours with 50 ml of solutions containing 0.2, 0.1, 0.06, or 0.02 mmole of $Cu(NO_3)_2$ and 0 to 0.35 milliequivalents of NaOH. The systems containing 0.1 mmole of Cu(II) were 0.01, 0.1 or 1*N* in KNO_3; the systems containing the other amounts of Cu(II) were 1*N* in KNO_3.

The *p*H's were measured with glass and calomel electrodes. Titration curves for the acid-washed peat and for the systems containing 0.02, 0.06, and 0.2 mmole of Cu(II) are shown in Fig. 1. Strong binding of Cu(II) is indicated by the displacement of the curves.

The *p*H's of the partially neutralized peats at the three salt concentrations were plotted against $\log(1 - \alpha/\alpha)$, where α is the degree of neutralization calculated from the amount of base required to raise the *p*H to 7 in 1*N* KNO_3. The points for each salt concentration were fitted to a straight line, leading to the values for *pka* (the negative logarithm of the acid ionization constant) and *n* listed in Table 1. From the derived equations relating the extent of ionization with *p*H and from the condition of electroneutrality, values for CuP_2, P^- and H^+/HP were calculated. No corrections for activity coefficients were attempted.

To determine values for Kc and B, $\bar{n}$, the average number of acid groups bound for each Cu(II) ion in the system, was plotted against *p*P (the negative logarithm of the concentration of ionized peat) or $\log(H^+/HP)$. The former yielded values of $Kc(\log Kc = 2pP$ at $\bar{n} = 0.5)$ that varied widely with salt concentration. The "corrected" constant B was independent of salt concentration in the range studied. Values for Kc and B are listed in Table 1.

The Cu-peat systems were filtered, and Cu(II) was determined in the decolorized filtrates (darco carbon) with diethyldithiocarbamate. The mean of the formation constants (Kc) calculated from analytic Cu(II) data and the electroneutrality condition was 3.2×10^6, which is in reasonable agreement with the value deduced from the titration data.

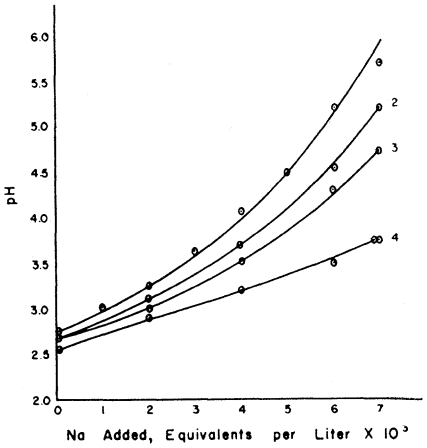

Fig. 1. Neutralization curves of 0.0092*N* H-Peat in 1*M* KNO_3 (1) no Cu(II); (2) 0.0002*M* Cu(II); (3) 0.0012*M* Cu(II); (4) 0.004*M* Cu(II).

The stability of the Cu-peat complex, particularly at low salt concentrations, would result in extremely small quantities of soluble ionic Cu(II) in most soils.

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16 August 1955

Modification of Electric Activity in Cochlear Nucleus during "Attention" in Unanesthetized Cats

Attention involves the selective awareness of certain sensory messages with the simultaneous suppression of others. Our sense organs are activated by a great variety of sensory stimuli, but relatively few evoke conscious sensation at any given moment. It is common experience that there is a pronounced reduction of extraneous sensory awareness when our attention is concentrated on some particular matter. During the attentive state, it seems as though the brain integrates for consciousness only a limited amount of sensory information, specifically, those impulses concerned with the object of attention.

An interference with impulses initiated by sensory stimuli other than those pertaining to the subject of attention seems to be an obvious possibility. It is clear that this afferent blockade might occur at any point along the classical sensory pathways from receptors to the cortical receiving areas, or else perhaps in the recently disclosed extraclassical sensory paths that traverse the brain-stem reticular system (*1*).

Recent evidence indicates the existence of central mechanisms that regulate sensory transmission. It has been shown that appropriate stimulation of the brain-stem reticular system will inhibit afferent conduction between the first- and second-order neurons in all three principal somatic paths (*2–4*). During central anesthesia, the afferent-evoked potentials in the first sensory relays are enhanced. This appears to be due to the release of a tonic descending inhibitory influence that operates during wakefulness and requires the functional integrity of the brain-stem reticular formation.

The possibility that a selective central inhibitory mechanism might operate during attention for filtering sensory impulses was tested by studying (*5*) afferent transmission in the second- or third-order neurons of the auditory pathway (cochlear nucleus) in unanesthetized, unrestrained cats during experimentally elicited attentive behavior. Bipolar stainless steel electrodes with a total diameter of 0.5 mm were implanted stereotaxically in the dorsal cochlear nucleus through a small hole bored in the skull. The electrode was fixed to the skull with dental cement. A minimum of 1 week elapsed between the operation and the first electroencephalographic recordings. Electric impulses in the form of short bursts of rectangular waves (0.01 to 0.02 sec) at a frequency of 1000 to 5000 cy/sec were delivered to a loudspeaker near the cats at an intensity comfortable to human observers in the same environment.

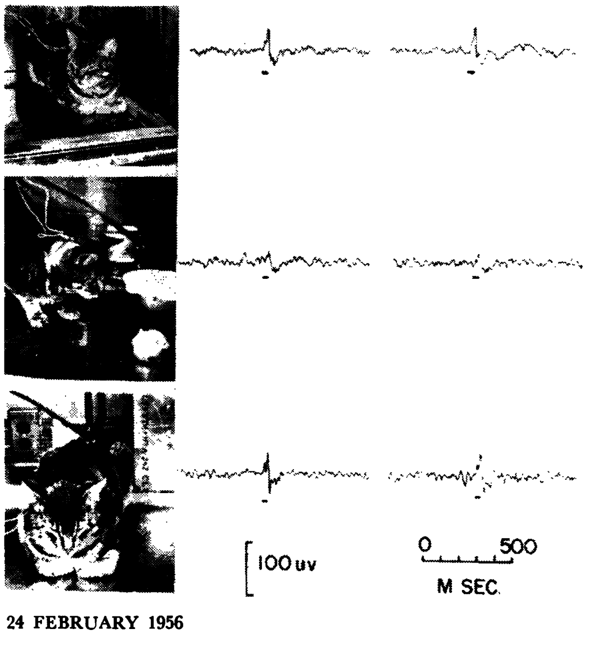

Fig. 1. Direct recording of click responses in the cochlear nucleus during three periods; the photographs were taken simultaneously. (Top and bottom) Cat is relaxed; the click responses are large. (Middle) While the cat is visually attentive to the mice in the jar, the click responses are diminished in amplitude.

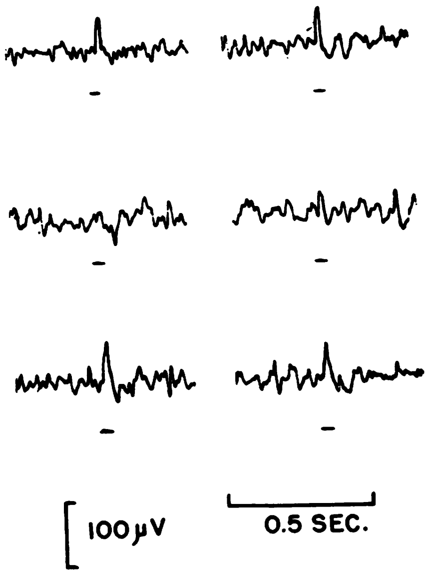

Fig. 2. Click responses recorded from the cochlear nucleus of the cat. (Top) cat is relaxed; (middle) cat is attentively sniffing an olfactory stimulus; (bottom) cat is relaxed again. Note the reduced amplitude of the click responses when the animal is sniffing.

Three types of sensory modalities were used to attract the animal's attention: visual, olfactory, and somatic. As is illustrated in Fig. 1, during presentation of visual stimuli (two mice in a closed bottle), the auditory responses in the cochlear nucleus were greatly reduced in comparison with the control responses; they were practically abolished as long as the visual stimuli elicited behavioral evidence of attention. When the mice were removed, the auditory responses returned to the same order of magnitude as the initial controls. An olfactory stimulus that attracted the animal's attention produced a similar blocking effect. While the cat was attentively sniffing tubing through which fish odors were being delivered, the auditory potential in the cochclear nucleus was practically absent (Fig. 2). After the stimulus had been removed and when the cat appeared to be relaxed once more, the auditorily evoked responses in the cochclear nucleus were of the same magnitude as they had been prior to the olfactory stimulation. Similarly, a nociceptive shock delivered to the forepaw of the cat—a shock that apparently distracted the animal's attention—resulted in marked reduction of auditorily evoked responses in the cochlear nucleus.

If this sensory inhibition during attentive behavior, as demonstrated in the auditory pathway, occurs in all other sen-