the positively charged histamine ions into the skin. It has now been found that if the negative pole be applied to the surface of the wheal formed by the scratch or by the iontophoretic method, sufficient histamine is transported out by this reversal of iontophoresis to form secondary wheals in new areas of the skin. In this way, histamine has been recovered from wheals which have been produced by iontophoresis from original dilutions as high as 1:100,000. Indeed, histamine may be recovered by diffusion alone, sufficient histamine being readily obtained for detection by means of the preceding methods within a diffusion period as short as 3 minutes. Histamine has been recovered from wheals produced by higher concentrations for as long as 40 minutes after wheal formation.

Using this method of reversed iontophoresis of histamine, attempts have been made to obtain histamine from (1) ragweed wheals, (2) timothy wheals, (3) wheals produced by ultraviolet light in a case of *urticaria solare,* (4) and wheals produced by stroking in a severe case of dermographism. It should be noted that the size of the wheals in all of these instances corresponded as well as could be ascertained by present methods with the size of histamine wheal investigated by reversed iontophoresis. In no instances (in the 4 types of wheals just enumerated) was histamine obtainable by reversed iontophoresis. Since the size and character of the allergic wheals from which histamine was not obtained corresponded in general with the size and character of the histamine wheals from which histamine was readily obtained, it seems unlikely that histamine was present in sufficient quantity in the allergic wheals to produce the whealing observed. These experiments, then, do not support the point of view that histamine or a readily diffusible substance of low molecular weight (H-substance) like histamine is responsible for the production of the allergic wheal.

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Extra-Hormonal Factors in Maternal Behavior.

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In rats and mice the main manifestations of maternal behavior are retrieving, licking, and cuddling of the young. Along with these activities, but often independent of them, may occur nest-building,

defense reactions, and prolonged station on the nest. Nest-building, especially, is largely determined by body temperature[1] and other physiological factors[2] which do not seem to affect the principal forms of maternal behavior.

The retrieving of young is the type of maternal behavior which lends itself most readily to objective measurement. It is different from mere retrieving of material to the nest since the latter is not accompanied by licking and cuddling. It is elicited in a mouse not only by its own young, but apparently to the same degree by any young of the species which are of the same age.

The maternal behavior of the mouse was examined in 5-minute test periods with newborn young by a method previously described.[3] Only animals that had retrieved newborn in 2 test periods are reported as being maternal. Both normal and experimental animals were tested, the normals comprising virgin females, females during and after lactation, and males under 120 days of age; the experimental animals consisted of males castrated either at birth by Pfeiffer's method[4] or after puberty, males grafted with ovaries, and males injected with oestrin from birth on. The latter animals are comparable to hypophysectomized animals, at least as far as the gonads are concerned.

The results (Table I) show that maternal behavior may be elicited in almost all adult mice, whether male or female. A fairly complete pattern of behavior may be obtained in such animals. Our earlier statement[3] that the expression of maternal behavior is much less marked in non-parturient than in parturient animals is thus revised on the basis of a greatly increased number of observations. However, in males and virgin females it is usually necessary to leave newborn young in the cage of the tested animals for 1 to 4 days previous to the test. The "sensitization" of maternal behavior thus provided affected the results of the tests markedly, and is reported in Table I under the heading: "sensitization with young."

Maternal behavior was observed most readily in females during lactation. Only a small percentage of the tests was negative. This more uniform expression of maternal behavior by lactating females may be due to the continuous presence of their own young, since, as has already been pointed out, the mere presence of young over a period of time enhances the manifestation of maternal behavior.

[1] Kinder, E. F., *J. Exp. Zool.*, 1927, **47**, 117.

[2] Richter, C. P., *Symposia on Quantitative Biology, V*, Cold Spring Harbor, Long Island, N. Y., 1937.

[3] Leblond, C. P., and Nelson, W. O., *Am. J. Physiol.*, 1937, **120**, 167.

[4] Pfeiffer, C. A., *Am. J. Anat.*, 1936, **58**, 195.

TABLE I.
Incidence of Maternal Behavior (Retrieving) in Normal and Experimental Mice.

Sex	Condition of the animal	Age in days	Sensitization with young*	No. of animals		No. of tests		% of positive tests
				Tested	Found maternal	Total	Positive	
F	Before opening of the vagina	23-25	++++	5	4	21	8	38
F	Virgins	36-180	++	9	8	39	22	56
F	First lactation	60-148	—†	15	15	132	114	76
F	2nd-3rd lactation	116-179	—†	5	5	35	30	86
F	6-24 weeks after last parturition	?	—	12	10	39	35	90
M	Before descent of testes	22-28	++++	8	7	40	19	47
M	Normal	36-120	++	50	47	162	103	63
M	Castrated at birth	35	+++	2	2	11	5	45
M	Castrated after puberty	70	++	3	2	12	5	42
M	Ovarian grafts	150 (?)	—	3	2	14	5	36
M	10,000-16,000 R.U. oestrin since birth	121-203	—	9	8	34	16	47

*Each + indicates presence of newborn young in the cage for one day.
†During lactation there is stimulation by the animal's own young.

Hormonal factors must also play a rôle because, as analysis of the data shows, there is an increase in maternal instinct at the end of the first pregnancy without contact with young other than that afforded by testing. However, during the lactation period no variations of maternal behavior, such as reported for the rat,[5] were observed in the mouse. Later on, either during subsequent lactations, or 6 to 24 weeks after the last parturition, maternal behavior is maintained at the same high level. In the latter case, neither the uninterrupted presence of young nor lactation hormones, but only a nervous mechanism could account for the maintenance of maternal behavior.

The presence of maternal behavior in males castrated at birth shows that this behavior does not require previous action of the sex (gonadal) hormones. Finally, the positive results with hypophysectomized animals[3] demonstrate that hypophyseal hormones are not necessary for maternal behavior. In rats, similar positive results have been obtained with virgin females, normal young males, and young castrated males.

Conclusion. The pattern of maternal behavior includes (a) retrieving, licking, and cuddling of the young; and (b) nest-building, prolonged station on the nest, and defense reactions. The initiation and maintenance of the latter group of activities are due to various physiological factors; for instance, temperature regulation[1] and thyroid function[2] account for nest-building, while decrease of activity[8] is at least in part responsible for prolonged station on the nest.

Retrieving, licking, and cuddling of the young, which may be considered as the main features of maternal behavior, may be initiated and maintained without hormonal intermediaries. The mere presence of young in the cage of the animals for some time is sufficient to bring about maternal behavior, even in hypophysectomized animals. Evidently nervous mechanisms play the determining rôle.

In addition to nervous factors, hormonal actions may be detected just before, and possibly during the first lactation period. However, the absence of measurable variations in maternal behavior during and after the first lactation period, as well as the presence of this behavior in males and females under various normal and experi-

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[6] Rogers, F. T., *J. Comp. Neurol.*, 1922, **35**, 21; Noble, G. K., *Anat. Rec.*, 1936, **64** (supp.), 34.

[7] Coghill, G. E., *Anatomy and the Problem of Behaviour*, Cambridge, 1929.

[8] Slonaker, J. R., *Am. J. Physiol.*, 1925, **71**, 36.

mental conditions, show that neither gonadal nor hypophyseal hormones play a primary rôle in the mouse.

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Distribution of Chloride in the Gastric Mucous Membrane of the Dog.

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An improved histochemical method for the demonstration of chloride was employed in a study of the dog's gastric mucous membrane under different physiological conditions. It was hoped that with this sensitive method it would be possible to throw some light on the site and mode of formation of hydrochloric acid in the gastric juice. A recent reconsideration of the problem by Hoerr[1] confirmed the theory developed by Harvey and Bensley[2] 25 years ago. These workers believe that hydrochloric is formed in the outer portion of the lumen or in the foveolus of the gastric glands by the hydrolysis of some organic chloride formed, stored and secreted by the parietal cells. In support of this theory chloride in large amounts has been demonstrated in these cells by methods which, however, have been considered by some investigators to be of questionable value.[3] Opposed to this theory are the findings of Lopez-Suarez[4] and Lison[5] who claim that the parietal cells contain less chloride than the other types of cells in the fundic glands. These opposing views emphasize the need for a reinvestigation, with more reliable methods, of the distribution of chloride in the gastric mucous membrane.

The method used in this investigation for the histochemical identification of chloride[6] is believed to visualize this ion accurately

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2 Harvey, B. C. H., and Bensley, R. R., *Biol. Bull.*, 1912, **23**, 225.

3 Lison, L., *Histochemie Animale*, Paris, Ganthies-Villers, 1936.

4 Lopez-Suarez, J., *Biochem. Z.*, 1912, **47**, 490.

5 Lison, L., *Z. f. Zellforsch u. mikr. Anat.*, 1936, **25**, 143.

6 Gersh, I., *Anat. Rec.*, 1938, in press.