The following experiments illustrate the major findings. Weanling rats were divided into different groups with due regard for litter membership, sex and weight. The basal ration was: casein (vitamin-free) 15, glucose 66, salt mixture 4, hydrogenated vegetable oil (Crisco) 8, wheat germ oil (VioBin) 2, percomorph oil (Mead Johnson) two drops, and supplement 5. The supplements were respectively defatted wheat-germ meal (VioBin), defatted corn-germ meal (VioBin), defatted sunflower seed meal (VioBin), defatted soybean meal and dried brewer's yeast. In another series the supplements were given at a 10 per cent. level, instead of 5, and the glucose level was decreased accordingly. The growth results are indicated in Table 1.

TABLE 1

GROWTH RATE OF RATS FED LIMITED AMOUNTS OF LOW-TEMPERATURE, SOLVENT-EXTRACTED SUNFLOWER SEED MEAL AS THE ONLY SOURCE OF B COMPLEX VITAMINS, IN COMPARISON WITH THAT IN RATS FED SIMILAR LEVELS OF DEFATTED WHEAT GERM, CORN GERM, SOYBEANS AND BREWER'S YEAST

Supplement	Level of supplement	Average gains*	
		7 weeks	14 weeks
	per cent.	g.	g.
Wheat germ	5	47 (12)	70 (3)
Corn germ	5	46 (14)	70 (3)
Sunflower seed	5	56 (15)	119 (3)
Soybeans	5	21 (11)	.....
Brewer's yeast	5	121 (2)	180 (2)
Wheat germ	10	114 (5)	169 (5)
Corn germ	10	109 (5)	177 (5)
Sunflower seed	10	115 (5)	186 (5)
Brewer's yeast	10	180 (4)	229 (4)

* The numbers in parentheses refer to numbers of rats used.

The growth, as well as the appearance of the animals, clearly show that sunflower seed meal fed at low levels is appreciably superior even to wheat-germ and corn-germ meals at comparable levels as a source of all the necessary B complex vitamins. It is far superior to defatted soybean meal and decidedly inferior to brewer's yeast in this respect.

In experiments with other rats fed the basal ration containing 5 per cent. of the sunflower seed meal the growth rate was not accelerated by daily supplements of thiamine, riboflavin, calcium pantothenate or pyridoxine. Slight acceleration of growth occurred when both thiamine and riboflavin were fed. Growth was markedly increased by administration of these two vitamins plus calcium pantothenate. In fact, it approximated the rate in rats fed yeast at a 10 per cent. level. The growth of rats given all four vitamin supplements was no greater than that in animals receiving only thiamine, riboflavin and calcium pantothenate. Detailed analysis of the data shows that pantothenic acid and riboflavin are limiting factors for growth in sunflower seed meal fed at the 5 per cent. level.

The sunflower seed meal is a light gray palatable powder. It can be satisfactorily blended with white flour and corn meal to make appetizing baked foods (as shown by the wife of one of us—H.G.D.).

These results reemphasize the importance of examining some of the ordinary, but neglected food materials available to us. They show that in common with wheat germ and corn germ,[5] sunflower seed may be of much more practical value in nutrition than has been recognized hitherto.

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THE HOMING INSTINCT IN PIGEONS[1]

IN his study of the problem of the sensory basis of bird navigation, Griffin[2] asks the question, "How does the bird know where to fly?" and then discusses fully much of the literature on the subject. He suggests that it seems more reasonable to explain the migratory and homing habits of birds by assuming that they use familiar landmarks, together with simple geographical, meteorological and ecological relationships rather than that they possess a new sense organ.

In an effort to obtain some additional information on the subject, especially on the necessity of training homing pigeons, trials were conducted in the spring and fall of 1944 at the New Jersey Agricultural Experiment Station. The pigeons used were reared at the substation of the Agricultural Experiment Station in Millville, N. J., and were flown on test from the headquarters of the Experiment Station at New Brunswick. In all instances the birds were shipped to New Brunswick by express and released within 24 hours after arrival.

The first trial was to determine whether young homing pigeons not previously trained from the loft would return home if released from New Brunswick, a straight-line distance by map of approximately 80 miles north-northeast of Millville. For the purpose, six youngsters hatched about January 1, 1944, were released individually at 5-minute intervals on April 6, 1944. None of the birds ever returned to their home loft in Millville. Weather conditions on the day of flight were fairly satisfactory; the air was clear and there was a brisk wind from the northwest. The wind would have had a tendency to carry the birds off a straight-line flight, but could hardly have been responsible for failure of the birds to return home. The birds apparently lacked all knowledge of home.

[5] Council on Foods and Nutrition, *Jour. Am. Med. Asn.*, 125: 848–49, 1944.

[1] Journal Series paper of the New Jersey Agricultural Experiment Station, Rutgers University, department of poultry husbandry.

[2] Donald R. Griffin, *Quarterly Review of Biology*, 19: 1, 15–31, March, 1944.

A second trial was conducted with birds that had received some flight training, as outlined in Table 1.

TABLE 1

SCHEDULE OF TRAINING FOLLOWED FOR BIRDS USED IN SECOND TRIAL

Flight number	Date	Approximate distance from home loft	Direction from home loft
		(miles)	
1	April 17	2	North
2	April 18	2	North
3	April 19	5	West
4	April 20	8	North
5	May 8	11	Northeast
6	May 9	22	North-northwest
7	May 12	16	North-northeast
8	May 19	40	North-northeast
9 (test flight)	June 1	80	North-northeast

The ten birds used were trained as a group, all birds being taken for each of the training flights. They were released individually at 5-minute intervals in New Brunswick on June 1. Previously they had returned home as a group from a point half way between the home loft and New Brunswick, a distance of approximately 40 miles. The weather was warm and partly cloudy with no perceptible wind. Of the ten birds released, two found their way back to the home loft, one 30 days later, and the other 48 days later. As a check group, eight untrained birds were released the same day. None of these ever returned to the home loft. The trained birds were 4½ months old, and the untrained birds 3½ months old.

In comparison with the first trial and the control group, even the training of the birds over 40 miles in the same direction as the 80-mile test flight failed to assist them materially in finding their way home when flown individually.

A third trial was conducted with birds flown over a longer period of time and as a group over the territory to be covered by the individual test flight, namely, from New Brunswick to Millville. The flying experience of the birds used is shown in Table 2, together with the results obtained. Of the nine birds flown, three never were heard from. Each bird carried a message holder with instructions enclosed to notify the author if the bird was picked up at any point, but no word ever was received regarding the three birds that did not return home. The six birds that returned home found their way back on the day of their release, with one exception, and that particular bird—which previously had not flown the course—came in two days later. Previous experience in flying over a particular territory certainly appeared to be highly desirable for birds when flown individually.

TABLE 2

PREVIOUS FLYING EXPERIENCE AND RESULTS OF HOMING PIGEONS FLOWN INDIVIDUALLY IN THIRD TRIAL

Bird No.	Age of bird (months)	No. of group flights in training	No. of group flights over test course (80 miles)	Time required to reach home
6906	9	5	2	7 hrs., 2 min.
6911	8	9	2	4 hrs., 50 min.
6919	8	8	2	Lost
6930	8	6	1	Lost
6931	8	18	1	6 hrs., 40 min.
6947	7	15	0	2 days
6954	7	16	1	4 hrs., 37 min.
6966	6	2	2	4 hrs., 28 min.
6972	6	1	1	Lost

A point of interest in connection with the third trial was the fact that when flown as individuals the birds required from 4½ to 7 hours to find their way home, whereas on a previous flight as a group the birds covered the same distance in 2½ hours. Even on an additional flight in a fourth test, the birds as individuals required over 4 hours to come home. Weather conditions on all occasions were favorable and could not be considered as having affected the time required by the birds to find their home loft. Just why a group would know its way any better than the same birds as individuals is a point worthy of consideration and experimentation.

In summary, homing pigeons untrained in flights did not possess an instinct that would automatically take them back home when they were released individually at a point 80 miles from home. Even training for half the distance was of no avail. After once having flown with a group over the distance indicated, the majority of the birds, when flown as individuals, were able to find their way home.

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NEW JERSEY AGRICULTURAL EXPERIMENT STATION

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A COLORIMETRIC METHOD FOR THE MICRO-DETERMINATION OF 2,2, BIS(P-CHLOROPHENYL) 1,1,1 TRICHLORETHANE (DDT)[1]

THE efficiency of the compound 2,2 bis(p-chlorophenyl) 1,1,1 trichlorethane (DDT) as an insecticide, its tendency to remain effective for a long period of time and its cumulative toxic action,[2,3,4] makes it desirable that methods for the estimation of this sub-

[1] From the Chemistry Section, Antilles Department Medical Laboratory, U. S. Army.

[2] R. D. Lillie and M. I. Smith, *Pub. Health Rep.*, 59: 979–984, July 28, 1944.

[3] A. A. Nelson, J. H. Draize, G. Woodard, O. G. Fitz-