# TECHNICAL PAPERS

## Effect of Cooking on the DDT Content of Beef

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During the spring of 1946, hay containing DDT was fed to beef cattle at the Alabama Agricultural Experiment Station. At the end of the feeding period several of the animals were slaughtered and the carcasses held in freezer storage until December, when they were shipped to the Agricultural Research Center at Beltsville, Maryland. Portions of one animal were used to determine the DDT content of the meat before and after cooking. This animal had received the following ration: from January 5 to March 17, 10 lbs of concentrate (1 part of cottonseed meal plus 4 parts of corn-cob shuck meal) and 10 lbs of clover hay containing 184 ppm of DDT residue; from March 18 to April 1, 10 lbs of concentrate (as before) and 10 lbs of clover hay containing 84 ppm of DDT residue. From April 2 to May 10 the animal was on pasture and received no DDT-treated hay. It was slaughtered on May 10.

Five methods of cooking were used—roasting, broiling, pressure cooking, braising, and frying (*1*). Samples of beef to be cooked by each method were prepared in duplicate. One portion of each sample was analyzed raw, and the other portion, including the drippings, was analyzed after cooking.

A two-rib cut with a normal amount of fat was divided into two one-rib roasts, and one portion was roasted medium done (65° C) at an average oven temperature of 186° C.

A sample of loin with a normal amount of fat was divided into two steaks of about equal weight or thickness, and one steak was broiled to the rare stage (54° C).

Several pieces of round steak were boned, cut in small pieces, and then divided into three portions. Two portions were cooked well done and tender as stews, one in a pressure sauce pan and the other braised in the more usual manner.

Several additional pieces of round were ground up as hamburger, and one was molded into cakes and fried well done (76° C). In this test the cooked meat and pan drippings were analyzed separately.

Chemical analyses for organic chlorine in both the raw and the cooked meat were made by the method described by Carter (*2*) for use with this kind of material. Colorimetric determinations of the DDT in both the raw and the cooked meats were made by the method described by Schechter, *et al.* (*3*). The samples were prepared for analysis by separating the bones from the meat and fat, which were then mixed, ground, and again mixed before analysis. Each sample therefore represents meat and fat only, and the results have been calculated on that basis, without regard for the weight of the bones.

TABLE 1
DDT Content of Raw and Cooked Beef From Animals Fed Hay Containing This Insecticide

| Method of cooking | DDT (ppm) calculated from— | | | |
|---|---|---|---|---|
| | Organic chlorine determinations | | Colorimetric determinations | |
| | Cooked portion | Raw portion | Cooked portion | Raw portion |
| Roasting | 30 | 39 | 19 | 27 |
| Broiling | 27 | 24 | 21 | 18 |
| Pressure cooking | 8 | 9 | 8 | 15 |
| Braising | 7 | .. | 7 | .. |
| Frying | .. | .. | 16*<br>33† | 24 |

* Meat alone.
† Drippings.

The results of the chemical analyses, given in Table 1, indicate that the DDT in the beef was not materially decomposed or lost during the cooking.

### References

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## Experiments on Bird Navigation[1]

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Students of bird migration have generally assumed that birds head straight toward their goal, even when flying across wide stretches of ocean or other areas devoid of landmarks. Since natural migrations do not readily lend themselves to experimental study, most of our knowledge of bird navigation has stemmed from artificial homing experiments. In such experiments birds are captured, usually at their nests, and carried to a distance before release. Many species have returned from hundreds of miles, sometimes from territory which the individual birds had almost certainly never visited before, and to the sensory physiologist these homing flights have gen-

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erally appeared to pose the same problems as natural migrations. Nevertheless, one of us concluded recently, after considering all the evidence then available (*1*), that the basic assumption of an essentially straight flight path might be incorrect. Indeed, it was possible to account for most of the recorded data by assuming (A) that birds have a well-developed topographical memory, so that, having flown over an area in migration or natural wanderings, they could thereafter orient themselves within it by means of landmarks; and (B) that, when artificially transported to unknown surroundings, they explore wide areas until they reach familiar territory.

Clearly, the critical test of this exploration hypothesis would be to trace the actual flight paths of homing birds; if they fly essentially straight toward home when released in unknown territory, the hypothesis can be discarded. Gannets (*Morus bassanus*) were selected as the best available species for this experiment, since they are large white birds, easily observed from an airplane, and since they are strictly marine and virtually never fly more than a very short distance inland. Thus, we could be sure that the 17 gannets which we released more than 100 miles from the nearest salt water were in completely unknown territory. Nine of them were followed from an airplane, the remainder being controls against the possibility that the presence of the airplane 1,500′–2,000′ above the bird would influence its homing performance. Since both groups showed roughly the same speed (average, 99 miles/day) and the same percentage of returns (63% of those released in good physical condition), it seemed clear that the airplane had no detrimental effect on their homing. Furthermore, this speed and percentage of returns was comparable to the results obtained with other wild birds (*1*).

The performance of gannets is compared, in Table 1, with other species which have been transported in sufficient numbers to equivalent distances to permit a valid comparison.

TABLE 1

| Species | Returns (%) | Avg. speed (miles/day) |
|---|---|---|
| Herring gull (inland releases) | 97 | 90 |
| Swallow | 67 | 141 |
| Gannet | 63 | 99 |
| Leach's petrel | 61 | 38 |
| Starling | 54 | 17 |
| Noddy and sooty tern | 52 | 114 |
| Common tern (inland releases) | 29 | 109 |

The gannets fall in the middle of this series with respect to speed and per cent returns; and they might well have ranked higher in per cent returns but for the fact that overland flights were quite unnatural for them. They cannot take off from land without an appreciable head wind and an open space of 100 yards or more, so that any which were forced down over land from fatigue or other causes would almost certainly be lost. This probably reduced the number of returns in comparison with the other species listed in the table.

With these considerations in mind, it is appropriate to turn to Fig. 1, which shows the actual routes flown by 9 gannets followed by us for portions of their return flight ranging from 1 to 9½ hrs and from 25 to 230 miles. It is obvious that they did not head at all directly home. On the contrary, their flight paths radiate in many directions from the release point, with a suggestion of spiraling. Five of these birds were back at their nests after the following periods of time: No. 10, 70 hrs; No. 22, 45 hrs; No. 23, 45 hrs; No. 25, 24 hrs; and No. 78, 75 hrs. The rest (Nos. 3, 8, 21, and 24) did not return; but it should be noted that No. 24 was released in poor physical condition. It is quite likely that during previous fishing trips or annual migrations these gannets had flown along the entire coastline shown in Fig. 1 (with the exception of the upper Bay of Fundy). If so, this coast would be familiar territory within which they might be expected to orient themselves by means of landmarks remembered from their previous experience.

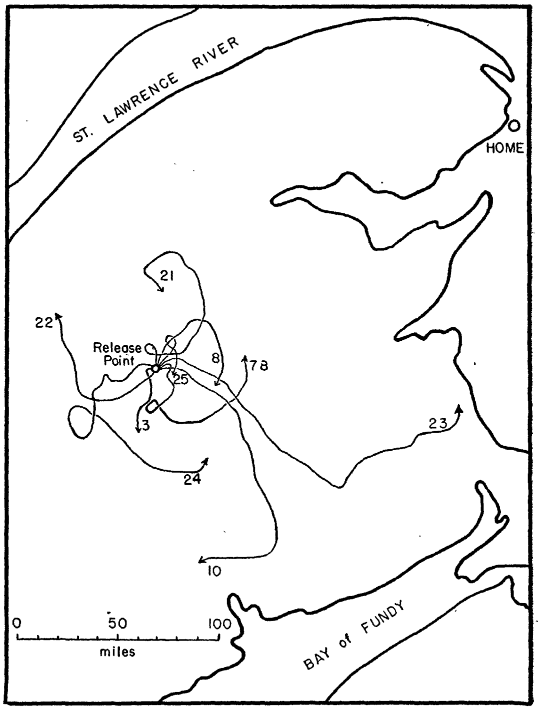

FIG. 1. Flight paths of homing gannets as observed from an airplane. The birds were captured at their nests on a small island marked "home," transported rapidly to the release point, which was in completely unknown territory, and followed as far as possible after release. The arrowhead indicates each bird's direction of flight when last seen.

A detailed description of these experiments, together with an interpretation of the results, will be presented elsewhere; but it seems clear that, for this species at least, *the actual flight paths suggest exploration rather than any absolute "sense of direction."* Since the performance of gannets is comparable to that of most other wild birds, it is quite possible that their homing ability is also based largely on exploration for visual landmarks.

What of natural migrations, particularly those which cross long stretches of ocean, or those in which young birds seem to migrate along the route characteristic of the species without adults to guide them? Clearly, one should not speculate too widely on the basis of one experiment with a single species, but it would perhaps be pertinent to re-examine the evidence concerning the directness of natural migratory flights. Could it be that transocean migrants, for example, do *not* fly straight in the absence of landmarks—or such cues as wind direction —but rely, under difficult conditions at least, on some type of exploratory searching for their goal? Since observations of the usual type tell us little or nothing about the actual flight paths of individual birds, we cannot safely infer from them that a migrant flies along an essentially straight course, although this has generally been assumed to be the case, just as it has been assumed for the return flights of homing birds.

To be sure, the important experiments of Rowan (*4*), Rüppell (*5*), and Schüz (*6*) have shown that inexperienced young birds may migrate in approximately the correct direction even without adults to guide them. These flights were over land with many landmarks available, the problem being to explain how the birds selected the appropriate cues to guide their first fall migration southward. But it seems unnecessary to conclude, as many have done (*2*, *3*, *7*), that birds must possess an unknown sensory mechanism capable of informing them of their latitude and longitude, or the equivalent, so that they can travel to their nest or winter range, as the case may be, without reliance on such mundane cues as landmarks, the position of the sun, or wind direction. Neither the observed flight paths of homing gannets and herring gulls nor the indirect evidence that other homing birds rely on landmarks and exploration (*1*) are consistent with these theories. Merely as an example of an alternate explanation for the results obtained by Rowan, Rüppell, and Schüz, it should be noted that the birds were released north of 50° latitude, where even in summer the sun is always perceptibly south of the zenith. Rowan's releases were made in Alberta during November, when the sun never rises more than 20° above the horizon. Thus, a tendency to fly toward the sun could perhaps account for the southward movement of these inexperienced birds.

In so far as our conclusions are relevant for other species under other conditions, they suggest that birds do not possess a special "sense of direction" or any sensitivity to the earth's magnetic field. The behavior of the gannets reinforced our impression that birds navigate by means of environmental cues which lie within the scope of the known receptors. When landmarks (rivers, coastlines, mountain ranges, etc.), prevailing winds, or the direction of the sun are not available as guiding influences, or when birds are released in unknown territory where the environmental cues have no meaning, they may well reach their goal by a process of exploration. There is need, however, for more observations from the air of the actual flight paths of other birds, both during homing flights and during migration, and one can perhaps look forward to a solution of this classic problem of biology as investigators make greater use of aircraft and other fruits of modern technical ingenuity.

### References

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## A Mechanism of Concussion: A Theory[1]

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The similarity of the forms of pressure waves generated by two entirely different methods, both of which cause cerebral concussion, has led us to formulate a theory of the physical mechanism of concussion. One method, a standard one, involves the striking of the head of an animal by a mass of known weight and velocity. In the second method, a percussion wave was set up in water in which the head of an animal was partly submerged. This procedure was employed to prevent skull distortion as much as possible. The apparatus used in these experiments was similar to that described by Clark and Ward (*2*) but produced pressure waves many times as strong. When the top of the head of a small animal (guinea pig) received a pressure wave of sufficient strength, concussion resulted as judged by certain generally accepted criteria for concussion in animals ("start reaction" with the blow, loss of corneal reflexes, temporary inhibition of respiration, etc.). The bony air sinuses of the animal's head were kept just above the surface of the water at the moment of impact in order to mitigate the effects of the pressure wave on the brain via the sinuses (*25*).

The general problem of the mechanism or mechanisms of concussion raises two prime questions. First, how do effective forces bring about the changes in function of the nervous elements in the brain to give symptoms of concussion? Second, what types of forces are capable of eliciting these changes?

With respect to the first question, several mechanisms have been postulated. These have been discussed by Denny-Brown and Russell (*4*), who discarded many of them because they are based on inadequate data. Two underlying processes associated with concussion have considerable experimental evidence supporting them: excitation and inhibition (paralysis) of the neurons of the

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