ratio, but without definitive results. The ranges of these variables are given in Table 1.

TABLE 1

Variable	Range
Flow rate	5–35 cc/sec (STP)
Pressure	50–250 mm Hg
Current	75–200 ma
Composition	3–25% H_2O by volume
Voltage	500–600 v
Gap distance	5 mm
Frequency	3 mc
Electrodes	Copper and Inconel

The following methods of analysis were employed:

1. Infrared spectra of the product gases were examined in the range of wavelengths of 2.5–15 μ with a Perkin-Elmer model 12C automatic-recording spectrophotometer. The only compounds having absorption bands in the above region which could be definitely identified were CO_2, H_2O, and CO.

2. To meet with the sensitivity of the chemical tests employed in detecting the products of the irradiation, the duration of runs was increased from 4–90 min. The exit gases from the discharge tube were thoroughly scrubbed in liquid-water traps. Since all of the likely products (formaldehyde, formic acid, carbon suboxide, glyoxal, etc.) are soluble in water, this method should collect nearly all of the products of interest. In general, no positive tests were obtained with, e.g., dilute permanganate, modified Schiff's reagent (for formaldehyde [*1*]) and dimethyldihydroresorcinol (*2*), a standard reagent for formaldehyde. Tests for formic acid and methyl alcohol (*3*) also gave negative results. Occasionally the ice from the dry ice-acetone trap or washings from the walls of the discharge tube decolorized permanganate solution but still gave no specific compound tests. In an effort to recover monomers from possible polymeric products present, several samples were made basic and digested to depolymerize any substances such as paraformaldehyde. Again, no positive results were obtained.

3. The product gases were passed through 1% sodium bisulfite solution according to the procedure of Goldman and Yagoda (*4*) for estimation of traces of formaldehyde in air. The excess bisulfite is titrated with 0.1 *N* iodine solution in acid medium. This solution is made basic with Na_2CO_3–acetic acid buffer and the formaldehyde liberated from the bisulfite complex is titrated with 0.01 *N* iodine solution. Sensitivity of the order of 7 parts (by wt) per million is claimed in this method. No formaldehyde could be detected, however.

In summary, it appears that under the conditions employed, no interesting reduction products of the carbon dioxide–water reaction are formed, at least in quantities greater than 10 ppm. Traces of the usual matter found in discharges tubes—solid polymers of unknown composition—may be formed, however.

The reason for the nonappearance of reduction products in chemically significant quantities is not clear. The decomposition of CO_2 to CO took place to the extent of about 9%, and it is known (*5*) that CO and hydrogen atoms (produced from H_2O) react in discharge tubes to give formaldehyde. Either there was an insufficient supply of hydrogen atoms, or any product formed was decomposed thermally in the region of the arc plasma itself or at the electrodes.

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Susceptibility of *Rattus hawaiiensis* Stone to Warfarin

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Previous cage tests (*1*, *2*) have shown that warfarin-treated rolled oats were readily accepted by the five rodent species, *Rattus norvegicus* (Erxleben), *Rattus alexandrinus* (Geoffrey), *Rattus rattus* Linn., *Rattus hawaiiensis* Stone, and *Mus musculus* Linn. present in the Territory of Hawaii and that all these species died from the effects of the poison.

Field tests reported by Doty (*1*) showed that warfarin-treated oats gave good control of rats damaging sugar cane, and he suggested that for satisfactory results the warfarin bait should be exposed for at least 17 days or until the consumption of bait reached zero.

Gross, Baker, and Bonnet (*3*) in a large scale field test in an endemic plague region in Hawaii, have shown that all species of rodents were adequately controlled with the same bait formula except the local endemic species, *Rattus hawaiiensis*. The importance of this species in the epidemiology of rodent plague in the Territory of Hawaii (*4*) indicated the desirability of investigating further the susceptibility of this species to warfarin-poisoned rolled oats.

A series of cage feeding tests was instituted after the procedures previously used. Specimens of *Rattus norvegicus* and *Rattus hawaiiensis* were captured alive near Honolulu and confined in laboratory cages. A record was kept of the sex and weight. The animals were provided with pieces of coconut, plain rolled oats, and unlimited water. After a short period of adaptation to the cages each rat was presented with a weighed quantity of warfarin-treated oats.[1] The poisoned oats were removed and replaced with unpoisoned rolled oats every other day. The amount of food or bait eaten was determined by daily weighing of the food dish and its contents. The warfarin bait was regularly accepted and there was no evidence of consistent bait refusal or avoidance during the test. This

[1] A commercial product prepared according to the formula of Doty (*1*) and containing by weight 0.025% warfarin, 11.0% white mineral oil, 0.25% *p*-nitrophenol (a mold deterrent) and 88.73% rolled oats. This is identical with the warfarin bait used in previous tests (*1–3*).

TABLE 1

	R. hawaiiensis	*R. norvegicus*
Number of animals	20	10
Mean weight of test animals	48.0 ± 1.8 g	186.7 ± 14.7 g
Number surviving 34 days of alternate feeding	15	0
Minimum day of death	7 days	4 days
Maximum day of death	34 days	11 days

regimen was continued until the animal died or 34 days of alternate exposure to warfarin-treated oats and plain rolled oats had occurred.

The results obtained are presented in Table 1.

The alternate feeding of warfarin oats and plain oats to *Rattus norvegicus* gave a kill identical to the results obtained by Doty (*1*) with continuous feeding of the same poison bait mixture. All individuals died in 11 days or less and showed evidence of internal hemorrhages on autopsy. On the other hand, with *R. hawaiiensis*, 75% of the test individuals survived more than 34 days of this alternate feeding of warfarin-poisoned oats and plain rolled oats. This period is double the 17-day period of feeding recommended by Doty as a practical time limit for field poisoning. The average consumption of poison bait during the 34-day period was approximately twice the average amount that had been previously found to kill this species when consumed on a daily basis (*2*). These data indicate that unsatisfactory results will be obtained in the case of *R. hawaiiensis* unless the present warfarin bait is consumed at a frequency greater than every other day. Very little is known of the feeding habits of *R. hawaiiensis* in its native habitat, but the results obtained in the field test (*3*), in the light of the present data, would seem to indicate that in spite of a heavy consumption of the bait in the field, individual *R. hawaiiensis* probably did not consume the bait consistently on a daily basis, and hence survived the poisonous effects of the warfarin.

The fifteen *Rattus hawaiiensis* individuals that survived 34 days of alternate feeding and poisoning were placed on a continuous diet of warfarin oats bait on the 35th day. They all died as a result of warfarin poisoning, and the mean day of death was 13.5 ± 0.9 days after the beginning of this continuous period of warfarin feeding.

TABLE 2

	R. hawaiiensis Present experiment	*R. hawaiiensis* Previous experiment (*2*)
No. of individuals	15	42
Previous exposure to warfarin	Every other day for 34 days	None
Total body weight	959.3 g	2313.8 g
Mean body weight	49.6 ± 1.7 g*	55.1 ± 1.2 g
Total warfarin oats consumed	373.5 g	899.0 g
Total warfarin oats % of total body weight	38.9 ± 2.0%	38.9 ± 1.3%
Mean day of death	13.5 ± 0.9	7.9 ± 0.5

* The lesser weight of the animals of this series is due to an overall weight loss during the 34-day exposure period. The initial weight of this group was 52.0 ± 2.5 g.

The results obtained in this test are compared in Table 2 with the results obtained in the test already reported (*2*) on animals which had no previous exposure to warfarin.

Although the quantity of warfarin oats bait consumed in terms of percentage of body weight is the same in both series (38.9%), the mean number of days elapsing before death is significantly greater in the series previously exposed to warfarin bait on an alternate day basis. The physiological basis of this finding has not been determined but it is a possibility that the test animals had no avidity for food as a result of the probable sublethal poisoning over the 34-day period and hence took a longer time to consume the quantity of warfarin oats necessary to kill.

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Synthesis of DDT Labeled with Carbon-14 in the Tertiary Position

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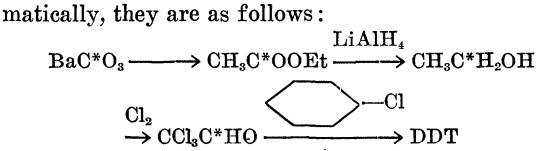
A method has been developed for the synthesis of radioactive Dichlorodiphenyltrichloroethane (DDT) in good yield in which the tertiary carbon is labeled.

Fields *et al.* (*1*) have developed a satisfactory procedure for incorporating C^{14} in the benzene ring. This procedure presumably was employed in a previously reported labeling of DDT with C^{14} (*2*). However, the complete synthesis of DDT by this procedure would involve at least seven major steps, with the consequent tendency towards low over-all yields. In the authors' procedure, only four major steps are necessary. Schematically, they are as follows:



The synthesis of carboxy-labeled ethyl acetate was carried out by special adaptations of the methods of Sakami *et al.* (*3*), Van Bruggen *et al.* (*4*), and Ropp (*5*). The ester was reduced to ethyl alcohol by a modification of the method of Cox and Turner (*6*). Chlorination was carried out in a specially designed apparatus,