Reports

Natural Tritium Measurements by Ethane Counting

Abstract. A method is described for the synthesis of ethane from hydrogen that is at present used for the counting of low-level tritium activity at the La Jolla tritium laboratory. The reaction procedure is simple and involves the mixing of the hydrogen with acetylene over a colloidal palladium catalyst. Counting characteristics of ethane are found to be ideal. With a 1-liter counter filled to three atmospheres of ethane, only a tenfold tritium enrichment is necessary in order to obtain a sensitivity of 0.32 counts per minute per tritium unit.

Hydrocarbon gases are well known for their remarkable counting characteristics. The long flat plateaus, low working voltage, and low sensitivity to impurities make them ideal for gas counting. Acetylene has been used for many years (*1*) for the counting of low-activity, natural carbon-14.

Hydrogen is the only gas to date that has been used for counting tritium in the gas phase (*2*). However, the use of hydrogen presents various difficulties. In the Geiger region double and triple pulse formation is very prolific, even with ethylene-argon counting mixtures. Most workers overcome this problem by using external electronic quench circuits. An alternative method previously used by one of us (A.E.B.) is a 1- to 1.5-msec paralysis time in the electronics. The use of hydrogen in the proportional region is also difficult, owing mainly to the steep gas gain versus voltage characteristics, and the ease of formation of negative ions.

Use of a hydrocarbon synthesized from water has the following advantages: (i) better counting characteristics; (ii) operation in the proportional region which makes possible background reduction by energy discrimination; (iii) more than two atoms of hydrogen per molecule; (iv) satisfactory operation also at pressures of several atmospheres. Hence, much larger amounts of hydrogen can be put into a counter when converted to a hydrocarbon, without unduly increasing the background. In this way the need for enrichment can be reduced by more than a factor of ten. Consequently, measurements of a considerably greater accuracy can be obtained, because the main error arises from the determination of the enrichment factor, whether it be by electrolysis, distillation, or thermal diffusion, and because the fractional error increases logarithmically with the enrichment.

There are many papers (*3*) on the reaction

$$C_2H_2 + 2H_2 \xrightarrow{Ni} C_2H_6$$

We have tried nickel as a catalyst and the results obtained only add to the general confusion in the literature concerning conditions and end products of this reaction. The main cause of the difficulties encountered is the large temperature coefficient of the reaction and the formation of higher hydrocarbons, including oils and waxes, at higher temperatures. Also, commercially available "palladium on powdered charcoal" catalyst (*4*) proved to be unsatisfactory for our purpose, because ethane is strongly absorbed on charcoal at room temperature. Satisfactory results, however, were obtained with a palladium catalyst prepared in our laboratory according to the following procedure: Palladium chloride is reduced with formaldehyde in dilute solution with a trace of potassium carbonate added. The colloid is filtered on a Millipore HA filter which is subsequently ashed in a covered quartz crucible. Colloidal palladium is stable in air at room temperatures, but in the presence of hydrogen changes color from blue to metallic gray as it is transformed to palladium hydride. As only 300 mg of catalyst is used, the loss of hydrogen by this reaction is negligible, but to avoid the possibility of a memory effect, fresh palladium is used for each sample.

The volume of hydrogen is measured in a 12-liter Pyrex flask which also contains the catalyst scattered on the bottom. Half this volume of acetylene is measured in a separate ballast flask and then transferred by freezing into a small trap attached to the reaction flask. The reaction has been tested for volumes of H_2 up to 6.6 liters and initial total pressures from 20 to 71 cm-Hg. The pressure has no appreciable effect on the reaction rate. In 2 to 4 hours the volume of gas is reduced to the original volume of acteylene. This indicates that the reaction is complete. No further volume reduction occurs, even if the product is left in contact with the catalyst for 48 hours. Analysis by gas chromatography shows that there is no detectable amount of ethylene present in the product. Tank acetylene is used after purification and the hydrogen is generated from the water sample by reduction of water vapor over magnesium at 600°C.

For our counter, with a 3-mil stainless steel center wire and 3 atmospheres of C_2H_6, the operating voltage was 9000 volts. The plateaus for both anticoincidence and meson counts were several thousands volts long, with slopes of 2 percent per 1000 volts. By our use of discriminators, the background was 1.6 count/min for a counter volume of 0.8 liters in the energy range from about 1 to 30 kv. The total background was 5.5 count/min, made up of the following components: pulses produced by neutrons and gamma rays; activity present in the counter material; and alphas partly produced by radon in the tank acetylene. Over the past 6 months we have made control measurements with a tritium standard producing 80 count/min. The reproducibility was better than 0.5 percent. The background of 1.6 count/min in the low-energy channel over the same period did not show any statistically significant fluctuations. The tritium activity is 6.7 disintegrations per minute per liter of water and tritium unit, or 5.4×10^{-3} disintegrations per minute per liter of H_2 gas at standard temperature and pressure and tritium unit. Hence we observe 0.26

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Type manuscripts double-spaced and submit one ribbon copy and one carbon copy.

Limit the report proper to the equivalent of 1200 words. This space includes that occupied by illustrative material as well as by the references and notes.

Limit illustrative material to *one* 2-column figure (that is, a figure whose width equals two columns of text) or to *one* 2-column table or to *two* 1-column illustrations, which may consist of two figures or two tables or one of each.

For further details see "Suggestions to contributors" [*Science* **125**, 16 (1957)].

disintegrations per minute with a filling of 3 atmospheres of ethane, and with a sample containing 10 tritium units in our counter, which has a sensitive volume of 0.8 liter. A larger counter (2-liter) is at present being constructed. No effects from isotope separation were observed by using hydrogen of known tritium content. This is in agreement with the fact that the chemical yield of the ethane synthesis is close to 100 percent. Results of tritium measurements currently being carried out at this laboratory will be published elsewhere.

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References and Notes

1. H. E. Suess, *Science* **120**, 5 (1954).
2. See for example the summary given by H. v. Buttlar and W. Stahl, *I.A.E.A. Symposium on Detection and Use of Tritium, Paper TTS/4* (Vienna, May 1961).
3. See, for example, G. Egloff, *Reactions of Pure Hydrocarbons* (Reinhold, New York, 1937); R. E. Dodd and P. L. Robinson, *Experimental Inorganic Chemistry* (Elsevier, Amsterdam, 1954).
4. K. Tamaru, *Bull. Chem. Soc. Japan* **23**, 64 (1950) and **24**, 177 (1951).
5. This work is supported by a contract with the Air Force Cambridge Research Center, Geophysical Directorate, Bedford, Mass. Laboratory instrumentation was provided from a grant from the Division of Biology and Medicine, Atomic Energy Commission. One of us (A.E.B.) is on leave from the Department of Scientific and Industrial Research, New Zealand.

6 June 1961

"Hypersexuality" in Male Cats without Brain Damage

Abstract. During 5 years of observation in a cat colony where mating tests are routinely conducted, the spontaneous occurrence of distortions of sexual activity in male cats has been recorded. Many of the behavioral patterns encountered have previously been described only in brain-damaged animals when they have been used as an index of "hypersexuality." Identical behavior occurs in normal males as a simple training effect.

The possible role of the temporal lobe in the normal regulation of sexual activity has remained a question of considerable interest since Kluver and Bucy described striking alterations in the sexual behavior of mature rhesus monkeys in the weeks after bilateral temporal lobectomy.

There is no doubt whatever that sexual manifestations in primates of both sexes increase, both in range and frequency, after such surgical interventions (*1*, *2*). Observations of a similar type have been extended, on rather less secure grounds, to several infraprimate species, and attention has been given in particular to the sexual activity shown by male cats toward (i) anoestrous, non-receptive female cats, (ii) other male cats, (iii) kittens, (iv) inanimate objects such as a child's woolly toy, and (v) alien species such as dogs, chickens, and rabbits (*2*, *3*). Aberrant behavior of this kind has been widely used as a criterion of abnormal hypersexuality. The observation of the occurrence of such patterns of behavior after destruction of, or lesions in, the amygdala and pyriform cortex has implicated these structures, and the temporal lobe generally, in the regulation of the sexual behavior of the male cat (*4*).

Some of the reports describing the distortions of sexual activity, which result either from altering the hormone balance or from physical interference with the brain, indicate a lack of familiarity with the range of behavior normally shown by the cat and with the shifts from the normal which can be produced by simple manipulation of the environmental situation. I have conducted several thousand mating tests with the cat during the past 5 years and, therefore, my experience may be of interest to others in this field (*5*).

If a mature male cat is trained to carry out mating tests with receptive females and is "in territory" within its home cage or test pen and is then presented with another mature male, the latter will invariably be mounted. The mounted male in most instances passively tolerates the neck grip and copulatory thrusts of the mounting male. The sequence of mounting does not depend upon the relative sizes of the animals, but upon the influence of territory; the animal in familiar surroundings in its home cage is dominant. If on a subsequent occasion, the mounted male is established in its own territory (where it has previously mated with receptive females), it will then mount the male by which it had previously been mounted. "Tandem" and multiple mounting occur readily in the laboratory when trained animals are used, and the sequence can be changed indiscriminately by changing the order in which animals are presented. Homosexual behavior in the test situation (in the sense that the sexual object is another male), as well as mounting activity between males housed in pairs, is thus a common observation (*6*). In contrast

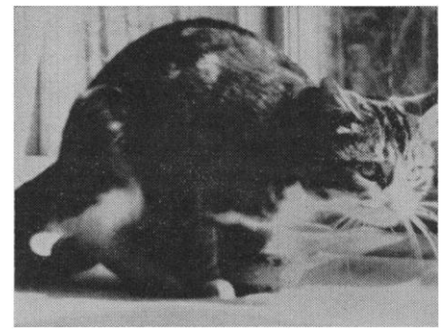

Fig. 1. Mounting activity and ejaculation shown by a normal male cat with a child's toy rabbit (frame from a motion-picture film taken in a private home).

to the foregoing, if two stud males, both of which have frequently mated in a test room and established territory rights there, are liberated in it simultaneously, serious fighting may ensue. It can be seen, then, that totally different behavioral patterns (passive acceptance of mounting or active fighting) can be evoked merely by a rearrangement of the test situation. Inexperienced males can be trained to show intense sexual interest in inanimate objects by alternately presenting a receptive female and some object such as a toy teddy-bear. A male so trained will then mount, secure a neck bite, and attempt copulation with any suitable soft object, including the sleeve and arm of the attendant's coat. Masturbatory activity of various kinds is readily observed in young, isolated males as well as in males housed in pairs, but only when the animals are well adapted to, and familiar with, the environment and not when newly arrived from a dealer.

Of even more interest than the sexual deviations which result from training and conditioning procedures within the laboratory is the occurrence of such phenomena spontaneously in domestic animals. Several reports of sexual activity with inanimate objects have reached me from owners of pet cats. One report, supported by a motion-picture film taken in a private home, describes a mature, intact male (Fig. 1). Although allowed complete freedom and the sire of many litters in the neighborhood, this cat, if left undisturbed, regularly mounted, and attempted copulation with, a child's toy rabbit from which sperm could be recovered. This type of masturbatory activity with an object which appears to stand for the true sexual object may be analogous to fetishism in the human. Careful histological examination of the temporal