antiinflammatory response to steroids awaits further investigation. Our suggestion that σ receptors may be involved in the antiinflammatory action of certain steroids cannot be ruled out at present. As to the possibility that exogenously administered steroids may induce psychiatric disturbances, several reports have already indicated such a finding (*8*).

We close with the following statement from a review article by Gorski and Gannon (*9*).

> It should be apparent to the reader that a wide variety of mechanisms have been suggested to explain steroid hormone action. One of the minority views mentioned here or perhaps not even referred to in this review may hold the key to understanding steroid hormone action. Until more substantial evidence clearly establishes the validity of one model, it is obviously prudent to maintain an open and critical mind when considering new data and their interpretation.

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Hydrolysis of Carbon Tetrachloride

The ocean water dating technique described by M. Krysell and D. W. R. Wallace (*1*) uses careful measurements of the ratios of concentrations of several anthropogenic halocarbons. Krysell and Wallace recognize that some of these compounds can hydrolyze, but our recent experiments (*2*) show that the standard literature reference for hydrolysis of carbon tetrachloride (CCl_4) (*3*) is wrong. That is, the reaction is reported as second-order in CCl_4, but we have found clear first-order kinetic behavior. It is only for a first-order reaction that the half-life is independent of concentration. In addition, hydrolysis reactions have significant activation energies, so half-lives vary over wide ranges as temperature changes. The 7000-year half-life cited by Krysell and Wallace is a calculated value for CCl_4 assuming a second-order reaction process at 25°C and an initial concentration of 1 ppm. For a first-order reaction, the half-life $\tau = 0.69/k$, where k is the rate constant. Specifically, we have found that, for CCl_4 $k(\text{hyd}) = 4.07 \times 10^{12} \exp(-13{,}790/T)\ \text{min}^{-1}$ and for methyl chloroform (CH_3CCl_3), $k(\text{hyd}) = 2.96 \times 10^{14} \exp(-13{,}970/T)\ \text{min}^{-1}$, where T is temperature in degrees Kelvin. These rate constant expressions yield the values shown in Table 1:

Table 1.

	CCL_4		CH_3CCl_3	
T (°C)	k (min^{-1})	τ (year)	k (min^{-1})	τ (year)
25	3.25E-8	40.3	1.29E-6	1.0
10	2.80E-9	468	1.08E-7	12.2
0	4.70E-10	2790	1.77E-8	74.2

The results in Table 1 show that Krysell and Wallace correctly assumed negligible degradation of CCl_4 in seawater at 0°C, but for what appears to be the wrong reason. Clearly, CCL_4 does not have a 7000-year half-life under all conditions, but at 0°C is half-life is very long compared with the other ages of interest. Conversely, methylchloroform is also stable enough at 0°C that its concentration should provide valid and independent dating information. However, if this technique is used in significantly warmer water than those found in the Arctic Sea, then the hydrolysis rates of these compounds should be integrated into the age calculations. It should be reemphasized that both CCl_4 and CH_3CCl_3 hydrolyze by (pseudo) first-order reactions with no pH dependence and no significant contribution from other nucleophilic catalytic agents, so that the hydrolysis rate is determined strictly by the temperature.

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Response: The new measurements by Jeffers *et al.*, if applicable to seawater, have implications for the use of CCl_4 as an oceanographic tracer. Figure 1 shows that for a volume fraction of ~92% of oceanic waters, more than 95% of the initial CCl_4 level remains even after 70 years. The absolute amount of CCl_4 loss (not shown) in much of the older, colder water is almost undetectable with the use of current analytical techniques (for example, less than 0.025 pmol/liter). For the relatively small volume fraction of warm ocean waters, corrections for hydrolysis should be applied. Such corrections necessitate that temperature as well as the tracer be modeled. Fortunately the warmer, upper-ocean water masses tend to have sufficiently short renewal times with the ocean surface so that they are labeled with more recently introduced members of the "halocarbon tracer suite" [F-11 (CCl_3F), F-12 (CCl_2F_2), F-113 (CCl_2FCClF_2)]. Hence corrections will be both small and facilitated by supporting tracer data.

The unique CCl_4 input function (*1*) is ideally suited to studies of the circulation of the cold, deep waters that make up the bulk of the world's oceans. Hydrolysis corrections are almost negligible in these waters and in high-latitude seas (for time scales of less than 100 years). Even over 500 years [the average mixing time scale of the ocean deeper than 1500 m (*2*)], losses due to

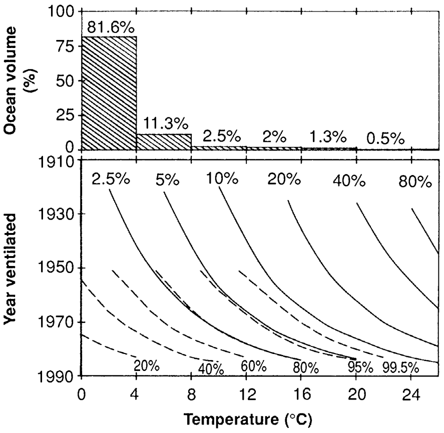

Fig. 1. Plot of the percentage concentration decrease by the year 1990 for CCl_4 (solid lines) and CH_3CCl_3 (dashed lines) for various water temperatures, based on the assumption that a water mass equilibrates with the atmosphere during a "ventilation year" and is subsequently isolated from exchange with the atmosphere and other water masses. Absolute concentration decreases were also calculated; for CCl_4, a preindustrial atmospheric CCl_4 mixing ratio of 6 ppt was assumed (*1*).