fraction contained 1.5 g of solid which accounted for most of the abscission-accelerating activity in the sample. A quantity of 0.8 g of this material was rechromatographed on a similar column (3.5 × 20 cm), chloroform being used as the eluting solvent. A number of visible bands separated on the column, characterized in the order of dark-brown, yellow, yellow, yellow, and red. The third band was found to be highly active, and from it abscisin was induced to crystallize as diagonal prisms from ethyl acetate. The crystalline substance accelerated abscission in the cotton explant test at a quantity as low as $10^{-2}\mu$g per abscission zone. In a typical experiment, for example, when abscission was determined 64 hr after the application of abscisin, the controls had 40 percent abscised while the explants with abscisin at 10^{-2}, 10^{-1}, and 1 μg per abscission zone had 52, 60, and 82 percent abscised, respectively.

The compound was crystallized to a constant melting point of 197° to 198°C, with a yield of 3 mg. Abscisin is an acidic compound soluble in chloroform and dilute sodium hydroxide, slightly soluble in ether but insoluble in dilute hydrochloric acid. It contains 67.93 percent of carbon and 6.26 percent of hydrogen. Its ultraviolet absorption maximum in methanol is at 250 mμ, and its infrared spectrum in KBr pellets is shown in Fig. 1 (*9*).

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8. Silicic acid was washed with 10-percent sodium bicarbonate until effervescence ceased, then thoroughly washed successively with water, methanol, and acetone before activation at 100°C for 8 hr.
9. This investigation was supported in part by funds from the National Cotton Council administered through the U.S. Department of Agriculture. The assistance rendered by the U.S.D.A. Fruit and Vegetable Laboratories, Pasadena, Calif., in making their facilities available for the extraction and concentration of the plant material, is gratefully acknowledged. We are particularly grateful to Dr. F. T. Addicott, Department of Botany, and Dr. Charles A. West, Department of Chemistry, University of California, Los Angeles, for their interest and advice, and to Mrs. J. L. Lyon for her technical assistance throughout the investigation.

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2 April 1961

Effect of Major Meteoric Showers on the Densities of the Upper Atmosphere

According to the recent results obtained by satellite measurements, reported by Lagow and Alexander (*1*), Dubin (*2*), and Nazarova (*3*), the amount of meteoric dust entering the earth's atmosphere is quite significant. From their data we have found that during a major meteor shower the energy injected by these particles into the atmosphere is sufficient to raise the temperature at 110 km by at least 5°K. This rise in temperature should produce an increase in density at the higher levels by 5 to 10 percent. A preliminary analysis of the density data obtained by drag measurements on the satellites at 300 and 600 km indicated a small rise in density on the day of a major meteoric shower.

Our calculations are based on data which indicate that the daily accretion rate of the interplanetary dust is of the order of 10^9 g. This implies a rate of approximately 2.10^{-15} g cm^{-2} sec^{-1}. If the mean velocity of these particles is assumed to be 30 km/sec, the energy brought in is found to be approximately 1.10^{-2} erg cm^{-2} sec^{-1}.

During a major meteoric "shower" the rate of influx of particles increases by a factor of 10 to 100, although Nazarova (*3*) reported an increase by a factor of 10^4 on 15 May 1958, which was attributed to a major meteoric stream (probably O-cetids). If, however, an increase by only a factor of 20 in the particle density during an average "major shower" is assumed, the energy input into the atmosphere will be as high as 0.2 erg cm^{-2} sec^{-1}. (A conservative value of velocity has been used. Major showers are known to have velocities up to 65 to 70 km/sec, which implies an increase in energy by another factor of 4.)

The energy brought in by the meteor particles can be given up to the earth's atmosphere, probably in the 100 to 120 km region, in three possible ways: (i) luminous radiation, (ii) ionization, and (iii) heating.

According to Whipple, the "luminous efficiency" factor for the meteoric particles is given by

$$\tau=\tau_0 V$$

where log τ_0 is -9.07 and V is the velocity of the particle (3×10^6 cm/sec), giving

$$\tau\approx 3 \times 10^{-3}$$

that is, only 0.3 percent of the energy will go as visible radiation. This can be regarded as negligible.

The "ionization efficiency factor," as given by Kaiser, is 0.1. The remaining 90 percent of the energy—that is, 0.18 erg cm^{-2} sec^{-1}—therefore goes immediately in heating. Since the major meteoric showers last, on an average, at least several hours, the energy available for heating the *E*-layer is of the order of 600 erg cm^{-2} hr^{-1}.

Table 1 gives the amounts of energy per square centimeter column required to heat the atmosphere above the altitude Z by 1°K, as calculated from the Jastrow-Kyle atmospheric model (*4*).

As the table shows, if the meteoric showers give up their energy in the 110- to 120-km layer, this region will be heated up by 5°K in 6 hr. This increase in temperature will produce an increase in density in the upper layers of the atmosphere given by the following relation:

$$\rho_{(z)}=\rho_{(z_0)}\frac{T_0}{T_m}\,e^{-\int(mg/KT_m)\,dz}$$

where T_m is the molecular scale temperature and $KT/mg=H$ (scale height).

Table 2 presents estimates of per-

Table 1. Energy required to heat the atmosphere above altitude Z by 1°K.

Z (km)	Mass of atmosphere above Z km (g)	Energy (erg/cm^2 column)
90	1.858×10^{-3}	2.207×10^{4}
100	3.366×10^{-4}	3.999×10^{3}
110	8.348×10^{-5}	9.917×10^{2}
120	2.796×10^{-5}	3.322×10^{2}
150	5.856×10^{-6}	6.957×10^{1}
200	1.756×10^{-6}	2.086×10^{1}

Table 2. Estimates of percentage density increases resulting from a 5°K temperature rise over a 10-km layer.

Layer	Increase (%) in density at altitude			
	120 km	200 km	300 km	600 km
90 to 100 km	6	8	9	10.5
100 to 110 km	2	5	6	7
110 to 120 km		3	3	4

centage density increases resulting from a 5°K temperature rise over a 10-km layer. The computations have been made by Kyle by adding 0.5°K/km to the temperature gradients of the Jastrow-Kyle model atmosphere in the three representative layers, 90 to 100 km, 100 to 110 km, and 110 to 120 km.

A first analysis of the density data inferred from the satellite measurements is consistent with the expected 5 to 8 percent density increases at 355 and 660 km during the major meteor showers. However, more accurate data on orbital decelerations will be required to confirm this hypothesis.

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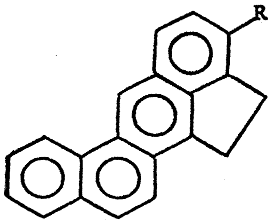
23 June 1961

Polynuclear Aromatic Hydrocarbons, Steroids and Carcinogenesis

Abstract. In addition to the electronic factors, there is a steric factor responsible for the carcinogenicity of polynuclear aromatic hydrocarbons. A carcinogenic polynuclear aromatic hydrocarbon must bear steric resemblance to steroids. One possible implication to this requirement for carcinogenicity is that these hydrocarbons may act on the same sites as steroid hormones.

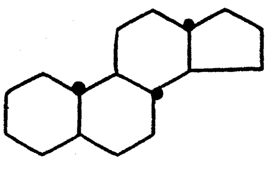
Numerous attempts have been made to correlate the carcinogenicity of polynuclear aromatic hydrocarbons and their structures by molecular orbital calculations (*1*), fluorescence spectra (*2*), absorption spectra (*3*), chemical reactivities (*4*), and abilities in molecular complex formation (*5*). All these approaches were based primarily on the electronic structure of the polynuclear aromatic hydrocarbons, and generally the carcinogenic hydrocarbons must possess low electronic excitation barriers. However, the overall results of these correlations are not satisfactory to account for the relative carcinogenicity of various alkylated polynuclear aromatic hydrocarbons (*6*). The carcinogenicity of these compounds was found to be dependent on the size of the alkyl substituents as well as on the position of the substituent. Usually carcinogenicity decreases as the size of the alkyl substituent increases, for example, the higher homologs of 3-alkylcholanthrenes (I) (*2*) and 8-alkylbenzanthracenes (*7*) are less carcinogenic than the corresponding methyl derivatives. There seems to be no definite rule governing the relative carcinogenicity of these hydrocarbons with respect to the position of the alkyl group; for example, among the methylbenzanthracenes, 7-methylbenzanthracene is strongly carcinogenic, 8-methyl followed by 12-methyl derivative is quite carcinogenic, whereas other methyl derivatives are about as ineffective as the parent compound (*8*). The increase in carcinogenicity of 7- and 12-methylbenzanthracene may be interpreted by an increase in electronic effect due to the introduction of a methyl group into the meso positions (*9*), but the carcinogenicity of the 8-methyl derivative cannot be accounted for. It is well known that the electronic effect of a methyl group substituted in an aromatic or unsaturated system is very similar to that of an ethyl group, while the latter is virtually indistinguishable from its higher homologs (*10*). Since all previous correlations were based on the electronic properties of the hydrocarbons, it is not surprising that these attempts failed in the case of alkylated polynuclear aromatic hydrocarbons.



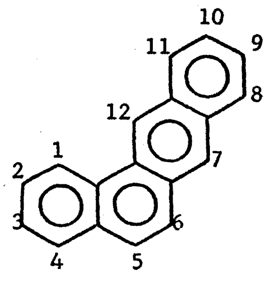
I

Most carcinogenic polynuclear aromatic hydrocarbons contain four to five condensed aromatic nuclei, and their structural similarity to steroids has been noted (*6*). Steroids may be converted under drastic conditions to a number of polynuclear aromatic hydrocarbons, among which are the noncarcinogenic Diel's hydrocarbon and the highly carcinogenic 3-methylcholanthrene. Numerous efforts to effect such a conversion in vivo have been unsuccessful.

By careful examination of the Stuart-Briegleb melocular model (*11*) of various carcinogenic hydrocarbons and steroids, we observed a remarkable resemblance between these two classes of compounds. There is usually a direct increase in carcinogenicity as the hydrocarbons become sterically more similar to steroids. Some of these results are illustrated in Figs. 1–4. In Fig. 1 the molecular model of norandrostane (II) is compared with that of benzanthracene (III); there is a discrepancy near the top of the molecule which may be easily compensated if the 17 position of norandrostane is substituted by a hydroxyl or an acetyl group as in most steroid hormones. In Fig. 2, the molecular model of benzanthracene is compared with that of norandrostane; there is a discrepancy at the positions equivalent to C_{15} and C_{16} of steroids. Introduction of a methyl group to either 7 or 8 position of benzanthracene will decrease this discrepancy. 7,8-Dimethylbenzanthracene and cholanthrene, which have the same molecular dimension as that of steroids, are among the most potent carcinogens known. 7- or 8-Methylbenzanthracene, which is sterically more similar to steroids than the parent hydrocarbon, is also much more carcinogenic. The introduction of higher alkyl groups into benzanthracene or cholanthrene will cause the molecule to deviate sterically from steroids; therefore, the higher alkylated hydrocarbons are less carcinogenic, as observed in the homologs of 8-alkylbenzanthracene (*7*) and 3-alkylcholanthrene (*2*). In Fig 3, the molecular model of 16-methyl-17-acetylnorandrostane (IV),



II



III