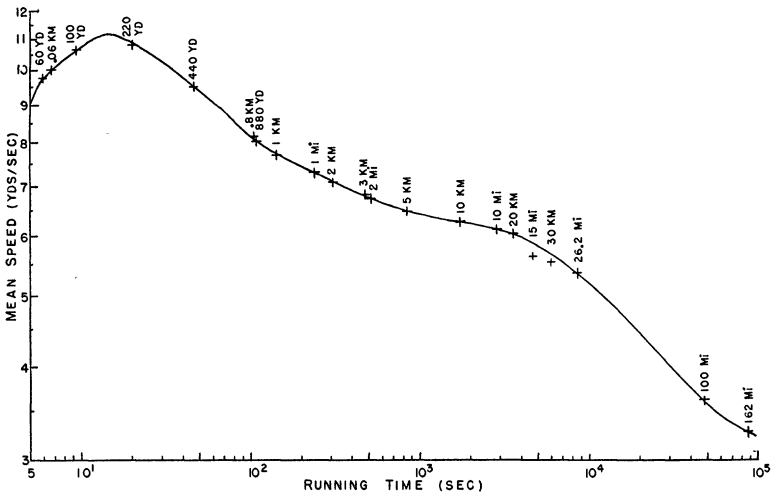

Fig. 1. Rate vs. time curve for 1954 world records in running.

Table 1. Curve constants.

Item	a (yd/sec)	k (sec)	Half-time
Energy loss	−13.10	2.48×10^{-1}	2.79 sec
Alactate	4.80	2.53×10^{-2}	27.4 sec
Lactate	1.70	3.45×10^{-3}	3.35 min
Glycogen	2.96	5.88×10^{-5}	3.27 hr
Fat, etc.	3.64	1.234×10^{-6}	6.5 days

It can be postulated that the maximum speed in running is limited by the energy reserves available for conversion into work, and that each of these resources begins to be depleted from the very beginning of the race in accord with an exponential law. These resources consist of the alactate and lactate oxygen debts, the glycogen reserve, body fat, and eventually body protein.

Also to be considered is the energy-loss factor, proportional to speed, that was at one time thought to be due to muscle viscosity. It is now known that the loss must be explained in more complicated terms. However, it is possible to represent this factor as a simple exponential term carrying a negative sign (*3*).

The available data do not permit an estimate of the role of protein depletion as an energy source in running, but it is doubtful that it is quantitatively important under ordinary circumstances. The rate of depletion of the other energy sources can be guessed at from various types of information—the half-times would be expected to be several days for fat, several hours for glycogen, 3 to 5 min for the lactate debt, and about 30 sec for the alactic debt.

Figure 1 shows a log-by-log plot of the equation

$$dy/dt = a_1e^{-k_1t} + a_2e^{-k_2t} + a_3e^{-k_3t} + a_4e^{-k_4t} + a_5e^{-k_5t},$$

using the curve constants given in Table 1. It will be observed that each of the rate coefficients k is of a different order of magnitude. It may also be noted that a parabolic rate equation would plot in a straight line in this figure. Details of the method of curve-fitting and explanation of the time constants are being published elsewhere (*4*).

References

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7 September 1954.

Comments and Communications

Avelinoite, a New Hydrous Sodium Ferric Phosphate Mineral from Minas Gerais, Brazil

Avelinoite, a hydrous sodium ferric phosphate, is the sixth new phosphate mineral described since 1949 from the granite pegmatite at the Sapucaia pegmatite mine, Minas Gerais, Brazil. [See *Science* **119**, 739 (1954) and Am. Mineralogist **34**, 541 (1949); **38**, 263, 1126 (1953)]. The mineral is named in honor of Avelino Ignacio de Oliveira, eminent Brazilian geologist and director of the National Department of Mineral Production, Rio de Janeiro.

Avelinoite occurs as yellow well-formed crystals, less than 1 mm in length, on cavity walls in altered phosphate, principally frondelite. Its specific gravity is 3.08 and its optical properties are: uniaxial, negative; $\omega = 1.803$; $\varepsilon = 1.769$. The crystals are assigned to the tetragonal pyramidal class. The basal pinacoid {001} and 1st-order pyramid {113} are prominent forms; the 2nd-order pyramid {012} is poorly developed. The axial ratio is $a : c = 1 : 2.650$; ρ (calc.) for {012} is 52°58′ and ρ for {113} is 51°20′.

Single crystal x-ray studies define the space group to be $P4_1$ (C_4^2). The cell size is $a_0 = 7.32$, $c_0 = 19.4$ A. On the powder pattern strong reflections occur with d-spacings of 4.85, 3.60, 3.186, 3.101, 2.913, 2.658, 2.209, 2.181, and 2.020 A. The unit cell contains $Na_4Fe_{12}^{III}(PO_4)_8(OH)_{16} \cdot 8H_2O$.

The chemical analysis shows: Na_2O, 4.70; K_2O, 0.63; MnO, 0.99; CaO, 0.10; FeO, none; Fe_2O_3, 47.87; Al_2O_3, 1.36; P_2O_5, 29.06; H_2O, 14.45; insol.,

1.04; *total,* 100.20 percent. The analysis, minus the insoluble residue and recalculated to 100 percent, compares favorably with the idealized formula $NaFe_3^{III}(PO^4)_2(OH)_4 \cdot 2H_2O$.

Wardite was recently shown to have the formula $NaAl_3(PO_4)_2(OH)_4 \cdot 2H_2O$ [Hurlbut, *Am. Mineralogist* 37, 849 (1952)]. Avelinoite, isostructural with wardite, is another example of substitution of trivalent iron for aluminum in a known mineral structure.

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23 November 1954.

A New and Physicochemically Well-Defined Group of Tumor-Promoting (Cocarcinogenic) Agents for Mouse Skin

In the course of our studies on the mechanism of experimental skin carcinogenesis [carried out since 1945; some of our previous papers are quoted in (*1*)], we have employed, as an aid, chemically and physicochemically well-defined nonpolar-polar substances as vehicles for the carcinogenic hydrocarbons. Some of these were naturally occurring, biologically active compounds; others were synthetic lipophilic-hydrophilic products, such as detergents and high polymers, especially carbowaxes (*2*). These substances were chosen by us partly because they have their principal counterparts in the living matter, and partly because these lipophilic-hydrophilic substances form a large group of well-defined compounds which, in regard to their physicochemical nature, can be arranged in systematic series. In addition, the interaction between certain nonpolar-polar compounds and biologically important proteins has been extensively investigated ***in vitro*** and partly also ***in vivo*** and constitutes now a fairly well-known field (*3*).

During our studies it appeared that some of these nonpolar-polar compounds—when used as carriers for the carcinogen—on the one hand delayed the development of tumors, whereas others greatly enhanced it and, on the other hand, caused different types of morphologic skin alterations. Therefore, and because the most powerful cocarcinogen now known, croton oil, contains many similar nonpolar-polar compounds, we decided to investigate whether some of our substances would have true cocarcinogenic properties.

The tumor-promoting property of an un-ionic detergent Span 20 (sorbitan monolaurate) was first studied by using Berenblum's technique (*4*). Two-month old male white mice of the same known ("anonymous") strain employed in all our previous studies were used. The animals were divided into three subgroups, 50 mice in each. The skins of the animals in group 1 received a single painting of 0.3 percent 9,10-dimethyl-1,2-benzanthracene dissolved in paraffin oil, but no additional treatment at all. Up to now—that is, 24 wk after the application—no tumors have developed, and all mice are alive. The mice in group 2 were painted twice daily during these 24 wk with pure Span 20; no tumors have developed in this group either. The animals in group 3 received a single painting of 0.3 percent 9,10-dimethyl-1,2-benzanthracene in paraffin oil, and then the same area of the skin of the back was painted twice daily with Span 20. In this group local cutaneous tumors began to appear at the end of the fifth week, and after 24 wk of treatment, 21 of the 50 mice have together 34 tumors. All mice were kept under similar conditions. Precautions were taken to avoid sources of methodical errors.

Large series of this kind of well-defined lipophilic-hydrophilic substances, having cocarcinogenic properties, are now being tested by us. The results available today point in the same positive direction, and a number of the compounds are highly potent cocarcinogens, even stronger than croton oil. Thus, another un-ionic detergent, Tween 60 (polyoxyetheylene sorbitan monostearate), for instance, showed significantly stronger tumor-promoting property than Span 20. When Tween 60 was used as a cocarcinogen in the aforementioned way, more than 70 percent of the animals developed skin tumors in 16 wk. The substances containing longer carbon chains appear to be stronger cocarcinogens. Further, the morphologic alterations seen in the skin of mice painted *only* with the nonpolar-polar compounds vary according to the compound used. In addition, the changes astonishingly closely resemble the alterations that are described as the "early response of the mouse skin to carcinogens." By changing the character of the lipophilic-hydrophilic solution, it was possible to induce alterations of different intensity in both the epidermis and the dermis (*5*).

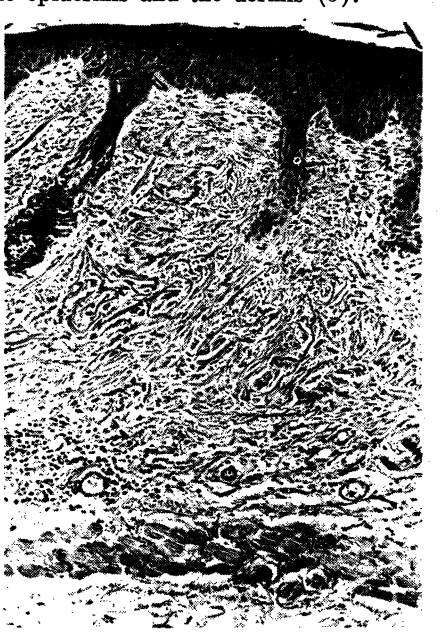

Fig. 1. Skin (right side of the back) of Mouse No. 54 after 2 wk of twice daily painting with Span 20 only. Thickening and distinct alterations in epidermis. Significant changes in dermis, collagenosis, dilated capillaries, and so forth. H + E. (× 85)