AN INFLUENCE EXERTED BY THE SUN ON THE HUMAN BLOOD SERUM

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There exists today a considerable tendency to refer numerous terrestrial phenomena, whether of a physical, meteorological, biological or even physiological nature, to solar or cosmic causes. In doing so, it is often the case that no sufficiently clear distinction is made between extraterrestrial and more or less immediate environmental influences.

The case here described makes evident a direct connection between observable phenomena occurring on the sun and certain measurable properties of the human blood serum, serum from any person without restriction. The existence of this relationship is of like significance to physics, astrophysics and medicine. I am referring to recent work of the well known Japanese physician Maki TAKATA on the flocculation of the human blood serum {1}. To him we owe the Takata Reaction, which is particularly familiar to European medical men and which has already found fruitful application in liver diagnosis. Since in what follows we refer exclusively to this reaction, let me describe the method briefly. About five cm^3 of blood is taken from the occluded cubital vein of the subject, and is kept for about 12 hours at about 10°C. Then it is vigorously centrifuged to render the serum clear and transparent. After a ten-fold dilution with physiological solution, it is divided up among 9 test tubes, to each of which there is added 0.25 cm^3 of a 10% sodium carbonate solution. The Takata reagent itself consists of equal volumes of 0.5% mercuric chloride solution and 0.02% fuchsine solution; it is kept as 20°C in the same water-bath as the test-tubes. Adding the reagent to the dilute serum produces a flocculation of the latter. By systematic manipulation of the nine test-tubes, the quantity of reagent necessary to initiate flocculation may be precisely determined. In doing so, the onset of flocculation can be best observed against artificial

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* The Japanese paper on which this article is based seems to be no longer available.

It is interesting to note that a paper which is a somewhat amplified version of Kiepenheuer's article appeared in the Russian publication Priroda, 1951, 7, page 53-54; it is entitled "An Unknown Component of the Solar Radiation, Detectable by its Biological Effect", author B. N. Himmel'farb. (Tr.)

light in a darkened room, or by photoelectric methods. Takata defines a flocculation-figure as the final amount, in cubic centimeters multiplied by 100, of reagent required to cause flocculation.

The results quoted infra refer exclusively to the behavior of blood serum from young, healthy subjects of the male sex. The observed solar effects occur only with the blood in circulation. Serum removed from the system will no longer show any change, provided that it is not subjected to too great fluctuations of temperature.

*1) The flocculation figure (f.f.) shows a marked diurnal cycle (Fig.1a). Six to eight minutes before local sunrise, as astronomically determined, the f.f. suddenly goes up about 20%, and this is the case even when the eastern horizon is blocked by mountains which make the actual sunrise take place an hour later. Then during the day it continues to rise slowly and somewhat irregularly, only to decrease again shortly after sundown. Some examples will be found in Fig.1b. * It does not matter whether the subject giving the blood is outdoors or inside a stone or concrete building closed on all sides. Even when the blood is taken inside a close-meshed, electrically grounded wire cage, the diurnal cycle is unaltered. In contrast to other diurnal rhythms, the f.f. is not affected by drugs like adrenalin and atropin.*

2) During three total or partial solar eclipses, a distinct decrease in the f.f. was observed, with the f.f. curve and the eclipse curve to a great extent coinciding. Both from the relationship between the two curves and from the effects observed at sunrise and sunset, it must conclude that the f.f. induction-period cannot be much greater than a few minutes. Fig.2 shows the curve for three male subjects during the total solar eclipse which took place at Kushiro on February 25th.

3) Meteorological factors such as the passage of weather-fronts, fog, stormy weather or thunder storms, have no effect on the f.f.

4) S.Takata took blood from his subjects in an aircraft at various altitudes, and he finds a well-expressed increase of the f.f. with increasing height. The tests, with three young men as subjects, were made at heights up to 7.5 km and are in very good mutual agreement, as Fig.3 shows.

5) When the persons tested were subjected to the corresponding reduced pressures in a decompression chamber, no change in the f.f. took place.

6) With the passage of sunspot-groups of the larger and more rapidly changing type across the central meridian of the sun,

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* The diurnal cycle observed by Takata has been reproduced in several subjects at the Freiburg University Polyclinic.

there coincides almost in every case a marked increase in the f.f. Nevertheless, it is by no means the case that large sunspot-ratios result in high f.f.'s. It is only one or two years after the sunspot maximum that a marked and systematic increase in the f.f. takes place. To what extent this phase-displacement, as in the case of magnetic storms, is caused by the varying position of the sunspot-zones during the solar cycle is a question which will be decided only after another cycle has elapsed. The particular effectiveness of spots in the neighborhood of the central meridian and of spots at low heliographic latitudes points in both cases to a strong obscuration of the radiation from spots toward the edge of the disc. On the other hand, from the observations during eclipses (cf. Fig.2), there seems to exist an unvarying component which comes from the whole of the solar disc and thus has practically no edge-obscuration.

Furthermore, there is a distinct tendency for disturbances in the f.f. curve to repeat with a 27.0-day cycle; this points to active areas of restricted size existing in the surface of the sun.

7) On the basis of research within the confines of the Japanese islands, the intensity of the radiation which influences the f.f. seems, at ground level, to increase with increasing geographic latitude; that is, as the Zenith-distance of the sun becomes less.

8) The possibility of artificially affecting the f.f. by irradiation of the blood-donor has been exhaustively studied by Takata. Visible sunlight, ultraviolet light, electromagnetic irradiation both with wave-lengths of 3100 m and 6.7 m and with soft X-rays (λ 0.17 to 0.13Å) all showed no effect. Gamma rays and neutrons are effective in the sense of increasing the f.f., but only at intensities never to be expected under natural conditions. So too the breathing of air with an admixture of about 10^4 positive or negative ions has only a slight effect on the f.f.

9) All the results described under 1) to 8) were obtained only when the persons giving and taking the blood were electrically insulated from the earth. When the subjects were electrically grounded, practically no variations in the f.f. occurred. In spite of this, however, the diurnal f.f. cycle can scarcely be ascribed to electrostatic effects, because it appears even inside a grounded cage.

10) From tests in mines, not yet entirely concluded, the active component of the solar radiation seems to be no longer present at a depth of 200 m below the surface of the earth.

When he attempts to relate the observed effects to any known component of the solar radiation, the physicist encounters considerable difficulties. The visible light, ultraviolet light and infrared light of the sun (λ 700Å to 5mm) may be eliminated from consideration, because the effects are observed to take

place even through thick masonry. The same holds true for electromagnetic radiation in the centimeter, meter and kilometer ranges. None of these can pass through the wire cage employed, nor do they show the observed increase of intensity with altitude. Cosmic rays are out of the question, because they show no intensity-variations at sunrise and sunset. For the same reason we must rule out neutrons, for which nowadays we have extraordinarily sensitive detecting instruments at our disposal. Items 1) and 7) should mean that the active radiation comes from the zenith, and from a height of 6 to 7 km, corresponding to the /few minutes/ lead which the curve shows with respect to sunrise at ground level.

We are left with the conclusion that the solar radiation at the earth's surface must possess a component of unknown physical nature, but which nevertheless is capable of evoking measurable biological effects. The identification of this radiation is a matter of interest to medical research as well as to solar physics.

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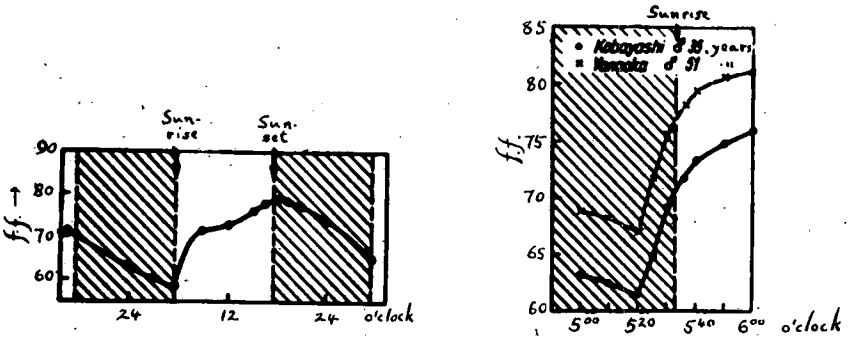

Fig.1, a and b.
a. Diurnal f.f. cycle for healthy male subject.
b. Course of f.f. curve at sunrise.

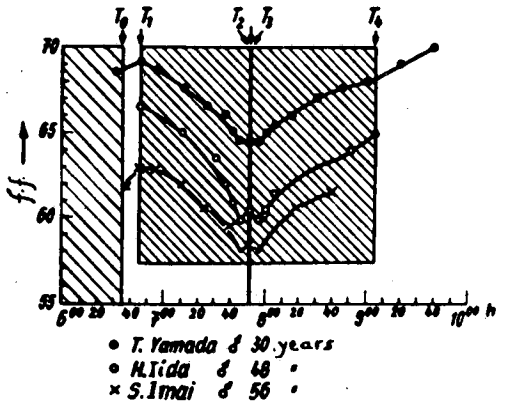

Fig.2. Course of f.f. curve for three subjects during total eclipse of the Sun at Kushiro, Japan, on Feb.5, 1943.

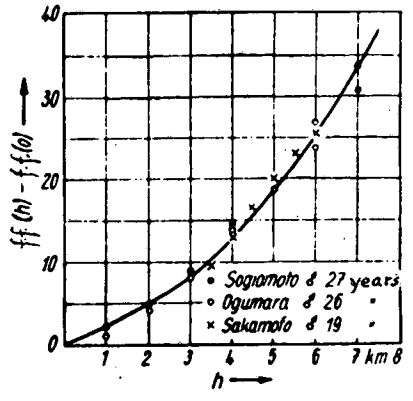

Fig.3. Curve of f.f. variation with altitude, for three subjects, during flight on July 17, 1943.