Table 1. Estimated energy budgets for a *Typha* marsh.

Form	Growing season				Year	
	Visible radiation		Total radiation		Total radiation	
	100 g cal/cm^2	Percent	100 g cal/cm^2	Percent	100 g cal/cm^2	Percent
Solar radiation	379	100	760	100	1292	100
Photosynthesis	8.4	2.2	8.4	1.1	8.4	0.6
Reflection	11.4	3.0	167	22.0	439	34.0
Evapotranspiration and conduction-convection	359	94.8				
Evapotranspiration			292	38.4	413	32.0
Conduction-convection			293	38.5	431	33.4

total energy basis with an estimate of winter albedo of around 50 percent, a median value for total reflection from old snow (*3*).

Evapotranspiration was measured in 1958 by Lawrence, Pearson, Rogosin, and Bray in a circular steel watertight tank 1.14 m in diameter which was located in a nearby and similar *Typha* marsh. This tank lost 49.3 g of water per square centimeter by transpiration and evaporation during the growing season. Taking the estimate of Transeau (*12*) that 593 g cal is required to evaporate 1 g of H_2O at the mean temperature of a Midwestern growing season, the energy expended in evapotranspiration was 29,235 cal/cm^2.

For the entire year, it is reasonable to assume that the evapotranspiration of the *Typha* marsh was very similar to the annual precipitation of 96.6 cm, since the level of water in the marsh was at the stable water table and while it overflowed slightly in the spring, it also received some runoff water from higher ground. Energy expended in evapotranspiration throughout the year was, therefore, about 41,300 g cal/cm^2.

The above measurements and estimates are incorporated in Table 1 which shows energy budgets for both visible and total radiation during the growing season (May through September) and for total radiation for the entire year. Energy incorporated in photosynthesis, an almost insignificant factor, is eventually changed to heat in a stable plant community. The decreased importance of total and visible albedo in summer is due to the greater absorption of light by chlorophyll. The similarity of values for reflection, evapotranspiration, and conduction-convection for the year is notable.

An estimate of an energy budget for "green vegetation" for total radiation during the growing season months May–September 1949 by Penman (*13*) in England gave 1 percent for photosynthesis, 20 percent for reflection, 39 percent for transpiration, and 40 percent for conduction-convection. These predicted values are very similar to those of my study.

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References and Notes

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16 January 1962

Distribution of Strontium in the Bovine Skeleton

Only limited information is available on the distribution of strontium in the bovine skeleton, although it is recognized that milk is one of the primary sources of strontium-90 in the human diet. Cattle can serve very efficiently as monitors of the human food supply. They furnish a significant portion of human nutrition through meat and milk, and they often serve as the last biological barrier between man and fallout. Cattle also serve as a monitor of the fallout available to animals because they eat largely unprocessed feedstuffs. If strontium is selectively deposited in the bovine skeleton, an erroneous evaluation of the strontium content of a cow would be possible, depending on the tissue examined. In experimental studies with domestic animals, it would also be desirable to follow strontium metabolism by successive bone biopsies. This technique would be most valuable if the bone sampled is representative of the entire skeleton.

Five Hereford cattle of different ages —a calf, a yearling, a 2-year-old, a 3-year-old, and a 6-year-old cow—were slaughtered in May 1960, to provide information on this problem (*1*). The cattle had spent their entire lives in northeast Nevada under range pasture conditions. Seven bones were removed from each animal: the rib, femur, thoracic and caudal vertebrae, frontal bone, incisors, and humerus. The rib, caudal vertebra, and incisors are easily obtained for routine bone biopsy. All bones were ashed; calcium and strontium were separated (*2*), and the amounts of calcium, strontium, and strontium-90 were determined for each bone (Table 1).

The incisors contained more calcium and less strontium-90 and the frontal bone was higher in both total strontium and strontium-90 than the other bones. Although the rib has been used frequently for determining strontium values, it is appreciably lower than the femur and the frontal bone in total strontium. However, other unpublished data from Nevada indicate that there is a high correlation (> .9) between the total strontium content of the rib and of the femur. These data suggest that either the femur, the humerus, or the thoracic or caudal vertebra can be taken as representative of the concentration of calcium and strontium in bovine bone. Of these, only the caudal vertebra is also easily adapted to bone biopsy techniques. The average concentration for the caudal vertebra did not differ more than 6 percent from the average for all bones sampled for any of the components studied.

The effect of the age of the animals on calcium and strontium concentrations in bovine bone is shown in Table 2. The calf had less calcium and strontium in its skeleton than the older animals. The concentration of calcium apparently reached equilibrium in the bovine skeleton at 1 year, while total strontium exhibited a progressive increase. Pieruccini *et al.* (*3*) reported that the total strontium content of human teeth decreased with age, but

Table 1. Calcium and strontium concentrations in bovine bone ash. Figures in the same column with different superscripts (a, b, c) differ significantly at $p < .05$.

Bone	Ca (%)	Sr (μg/g)	Sr^{90} (pc/g)	Sr^{90} (pc per gram of Ca)
Rib	34.8^{a}	238^{a}	23.1	66.3^{ab}
Femur	35.1^{a}	287^{c}	24.4	69.5^{b}
Humerus	35.6^{a}	265^{ac}	22.9	64.2^{ab}
Frontal	35.4^{a}	305^{c}	25.7	72.7^{b}
Incisors	40.1^{b}	255^{a}	20.2	50.2^{a}
Thoracic vertebra	34.9^{a}	265^{ac}	23.3	66.8^{ab}
Caudal vertebra	34.5^{a}	272^{ac}	24.1	69.7^{b}
Average	35.8	270	23.4	65.6

Table 2. Concentrations of calcium, strontium, and strontium-90 in bone ash of cattle of different ages. Figures in the same column with different superscripts (a, b, c, d) differ significantly at $p < .05$.

Animal	Ca (%)	Sr (μg/g)	Sr^{90} (pc/g)	Sr^{90} (pc per gram of Ca)
Calf	34.6^{a}	214^{a}	19.4^{a}	55.9^{a}
Yearling	36.0^{b}	243^{ab}	20.2^{ab}	55.7^{a}
2-yr-old	36.5^{b}	266^{bc}	25.9^{bc}	72.5^{ab}
3-yr-old	36.2^{b}	300^{cd}	26.9^{c}	74.7^{b}
Cow	35.5^{b}	327^{d}	24.6^{abc}	69.4^{ab}
Average	35.8	270	23.4	65.6

others (*4*) have reported no differences in total strontium content in different human bones. It appears either that there is a species difference or that uncontrolled environmental factors mask this effect in man.

The concentration of strontium-90 apparently reached a maximum in the 2-year-old animal and remained about the same thereafter, although it was somewhat lower in the older animals. The 2- and 3-year-old animals were born immediately before the initiation of the test ban in 1958. The maximum level of strontium-90 in their bones by birth date precedes by 1 year the maximum level found in U.S. milk and the maximum deposition rate (*5*).

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Proposed Explanation of Luminous Particles Observed in Glenn Orbital Flight

Abstract. It is proposed that the luminous particles observed by John Glenn in his orbital flight are condensed nitrogen and possibly oxygen. Irradiation by the sun would produce excited trapped radicals, which would radiate in ways consistent with the observed behavior of the particles.

One of the most surprising new phenomena observed by Glenn in his orbital flight on 20 February 1962 was the swarm of luminous particles near the space capsule. These particles have been described by him recently (*1*). Several critical facts observed by him should be summarized here. (i) The particles were luminous after "sunrise"—that is, after they were exposed to radiation from the sun; (ii) they were light yellow-green in color; (iii) their luminosity was observable for approximately 4 minutes after sunrise.

Two questions are of main concern: What are these particles, and where do they come from? I propose that the particles are solid nitrogen, possibly with some oxygen admixed; that they become luminous when radiation from the sun produces free radicals in the particles; and that the luminosity ceases when the particles are warmed up sufficiently by the radiation.

Solid nitrogen which is bombarded by x-rays and ionizing particles becomes luminous (*2*). The luminosity is related to forbidden transitions of nitrogen atoms (^2D to ^4S), and of oxygen atoms (^1S to ^1D) if any are present (*3*). In addition, molecular transitions from nitrogen and oxygen molecules are observed. The luminosity is light yellow-green; the exact hue depends on the chemical composition of the solid, on its temperature, and so on. The luminosity continues as long as the radiation continues, because a steady state is quickly reached. If the temperature rises above approximately 35°K, the luminosity disappears. It should be noted that pure solid oxygen does not become luminous if it is bombarded, but that oxygen species radiate if they are trapped together with nitrogen.

It seems most likely that the luminous particles observed by Glenn are indeed systems containing trapped nitrogen (and possibly oxygen) atoms. No other systems seem to have all the requisite properties. The present hypothesis is easy to check. Small, pocket spectroscopes carried along on the flight would suffice to show whether the luminosity lies in the regions of the spectrum appropriate for trapped nitrogen and oxygen atoms.

The second major question—Where do the particles come from?—is much more difficult to answer. They may exist independently at the altitudes involved. Indeed, Vegard proposed many years ago that such was the case (*4*). Or they might be produced from leaks of gas from the capsule, from gas trapped in various portions of the vehicle, and so on. This question will, however, be much easier to answer once the proposal made here has been verified or proved false.

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Aragonite in the Resilium of Oysters

Abstract. Aragonite (orthorhombic $CaCO_3$) composes some of the fibers of the resilium of *Crassostrea virginica* (Gmelin).

The ligament of oysters consists of two kinds of conchiolin, but is divided into three portions, adjoining lengthwise. The outer layer [outer layer of Trueman (*1*) = lamellar ligament of Newell (2)] is nonfibrous, more translucent than the other layer, and dark brown; it makes up the two flanking portions of the adult ligament, anterior and posterior to the resilium, and is strong under tension and bending stresses. The inner layer [inner layer of Trueman = fibrous ligament of Newell] is fibrous, semitranslucent, and whitish-gray, and has light brown growth layers; its very fine fibers are nearly normal to its ventral or growing border. It makes up the resilium, which is the median one of the three portions; it is strong under compression, but weak to tension. The resilium is calcified, as a simple test with hydrochloric acid will