FISHES FALLEN FROM THE SKY

THE ichthyologist of the American Museum of Natural History, Dr. E. W. Gudger, in his most interesting paper "Rains of Fishes,"[1] has grouped together many astonishing accounts of fishes falling from the sky. I wish to add some data on my own experiences with this subject.

The Yukaghir, living on the Siberian tundra between the Kolyma and Alaseya rivers, told me that the sky, regarded by them as a beneficent deity, to supply men with food flings fishes to the earth. When fish appear in the lakes in great numbers, the Yukaghir say that they have fallen from heaven. They know well enough that fish develop from spawning, but they say that fish originally had been and continue to be sent by the deity. When asked how they knew fish fall from the sky, the Yukaghir asserted that they often found living pike (*Esox lucius*) and a river species of salmonidae, called cheer (*Coregonus nasutus*), in dry places. Evidently, said the Yukaghir, it followed that these fish in falling from heaven failed to reach the water. I explain this phenomenon in the following way: The majority of polar lakes are connected by small rivulets which the fish follow when passing from one lake to another for spawning. In the course of the passage the fish jump over obstructions formed by stones and grass hillocks. In the summer when the rivulets run completely dry in places, the migrating fish may find themselves caught on dry land.

I wish to refer to another phenomenon connected with the above belief of the Yukaghir. When some tundra lakes during a rough and snowless winter freeze to the bottom, the fish die and in the spring rise to the surface. But the lake-fauna recovers soon and new fishes appear. Without any doubt, this phenomenon may be explained by what is known as anabiosis: some frozen fishes may come to life again after thawing, or by the appearance of new fishes from other lakes through the connecting rivulets. But the Yukaghir in such cases said that the new fishes fell from the sky.

I wish to mention here another phenomenon of this kind, although it has entirely different origin and causation. While spending the winter of 1909–1910 on Umnak Island of the Aleutian Chain I experienced volcanic shocks several times. Once I was awakened in the night by a particular subterranean noise and tremor of the earth; the floor of my log cabin shook. In the morning the shore was covered with a layer of stunned fish, sea-urchins and shell-fish about two feet high and two feet wide, but in several days these were carried to the neighboring hills and eaten by gulls and ravens. The presence of shells of echini and mollusca on the hills may lead some traveler to the deceptive idea that the hills were formerly the sea bottom.

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[1] *Natural History*, Journal of the A. M. of N. H., Vol. XXI, Nov.–Dec., 1921, No. 6, p. 637.

EINSTEIN AND SOLDNER

IN your issue of August 31 (1923), pp. 161–163, Dr. Robert Trumpler has explained Soldner's method of calculating the deflection of light passing near the sun and has called attention to the error in Soldner's work which had been pointed out by Lenard. In accordance with the Newtonian theory of gravitation a particle moving from infinity with the velocity of light c describes a hyperbola and the angle between the asymptotes is the deflection. From this theory it follows that the velocity *increases* as the particle approaches the sun; in fact, $v = c(1 + \gamma M/c^2 r$ approximately.

In his 1911 paper Einstein discussed the effect of a Newtonian gravitational field on a clock and came to the conclusion that a clock is slowed down as it approaches matter; in particular a clock at the distance r from the gravitating mass goes $(1 - \gamma M/c^2 r)$ times as fast as at infinity. If it is assumed further that the velocity of light is c at any point when measured in a suitable local coordinate system, then its velocity as measured in a natural system is $c\,(1 - \gamma M/c^2 r)$. Hence the velocity of the light from a star *decreases* as it approaches the sun. Einstein then makes use of Huyghens's principle to determine the deflection. Thus he uses the wave-theory of light, and not the corpuscular theory, as some of his critics contend. Einstein's 1911 theory is Newtonian in that he uses the Newtonian gravitational potential, but it is not Newtonian in the sense of Soldner. In his general theory of relativity the velocity is $c\,(1 - 2\gamma M/c^2 r)$, which accounts for double the deflection previously found. But here again the velocity decreases as the light approaches the sun and Einstein uses the wave-theory of light to calculate the deflection.

Dr. Trumpler called attention to the fact that Einstein used a different method from Soldner, but he overlooked the essential distinction between the two methods as is shown by his statement: "The fundamental assumptions on which Soldner's work is based are equivalent, as far as the present problem is concerned, to those of Einstein's 1911 paper, and Einstein's 1911 results must be and are in agreement with those of Soldner (after correcting Soldner's mistake)." They are so far as the amount of the deflection is concerned, but not otherwise. Consequently, Captain See's criticism published in SCIENCE for November 9 (1923), p. 372, is not valid, when the