1. The Enigma of Tunguska

The summer of 1908 witnessed the arrival of an unknown space body and an explosion over the Tunguska forest in Central Siberia that could have flattened any major city on Earth. The Tunguska explosion has been publicized in the popular press and scientific journals for decades, yet both the general public and the science community still seem unaware of the complicated details of this event. The key publications are in Russian, so language has been a barrier to understanding the evidence of what took place. Most people think that the Tunguska event was explained long ago by scientists who study meteorites or that the incident remains unimportant as far as science is concerned. Neither of these assumptions is anywhere near the truth. And what has been discovered in recent decades raises startlingly complex questions.

Strange as it may seem, the Tunguska event did not begin with a big bang. Scientists recorded the occurrence of some unusual phenomena starting on June 27, 1908.[1] That was three days before the devastating explosion. Some specialists even suppose that these phenomena started as early as June 23 or June 21, but for these dates the supporting evidence is scarce. Optical anomalies in the atmosphere (strange silvery clouds, brilliant twilights, and intense solar halos) were observed in western Europe, the European part of Russia, and western Siberia. The farthest western point from where these anomalies were recorded seems to have been Bristol in England. William F. Denning (1848–1931), a noted British specialist in meteors, wrote in *Nature* in 1908 that on the night of June 30, the firmament over Bristol was unusually light and few stars could be seen.[2] The whole northern part of the sky was red-colored, while the eastern part looked green.

The anomalies increased in intensity during the three days prior to the sunny morning of June 30, 1908, when a fiery body flew over central Siberia, moving in a northerly direction. It was seen from many settlements in the region, its flight being

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accompanied by thunderous sounds. Because this region is remote and sparsely populated, the systematic gathering of eyewitness reports was only begun in the 1920s. However, we now have some 500 written accounts that contain more or less detailed descriptions of the flying body, its shape being mostly described as roundish, spherical, or cylindrical, and its color as red, yellow, or white. What is important is that no one reported a smoky trail, which is typical for large iron meteorites traveling through the atmosphere, although many witnesses saw vivid iridescent bands, like a rainbow, behind the space body.

When flying at 0 h 14 min GMT over the so-called Southern swamp, a small morass not far from the Podkamennaya Tunguska River (see Figure 1.1), the body exploded, releasing the TNT equivalent of 40 to 50 megatons (Mt) of explosive. That is equivalent to 3,000 atomic bombs of the kind dropped on Hiroshima in 1945.[3] There was a brilliant flash and a devastating blast. Had this occurred over London or New York an entire city would have been destroyed. Was it a meteorite? Unlikely. Was it a comet? Or was it something else, perhaps something that only advanced physics could explain?

FIGURE 1.1. The Southern swamp, where the Tunguska meteorite exploded. View from a helicopter (*Photo by* Vladimir Rubtsov).

In 1927, Semyon Semyonov, a local farmer who then lived in the small trading station of Vanavara, 70 km south-southeast from the epicenter of the explosion, the closest settlement to the catastrophe, recalled his experience: "I sat on the steps of my house facing north. Suddenly the sky in the north split apart, and there appeared a fire that spread over the whole northern part of the firmament. At this moment I felt intense heat, as if my shirt had caught fire. I wished to tear my shirt off and throw it away, but at this moment a powerful blast threw me down from the steps. I fainted, but my wife ran from the house and helped me up. After that we heard a very loud knocking, as if stones were falling from the sky."

The Evenks (or Tungus), the native inhabitants of the region, were also much impressed by what happened. Two Evenk brothers, Chuchancha and Chekaren, were at the moment of the explosion sleeping in their *chum* (a tent of skin or bark) on the bank of the Avarkitta River some 30 km to the south-southeast from the epicenter of the explosion. They had returned just before sunrise from a long trip to the Dilyushma River. Suddenly the brothers were woken by tremors and the noise of the wind. "Both of us were very frightened," Chuchancha in 1926 told the anthropologist Innokenty Suslov: "We began to call our father, mother, and third brother, but nobody replied. We heard a loud noise from outside the *chum*. Trees were falling. Chekaren and me got out of our sleeping bags and were going to get out of the *chum*, but suddenly there was a great clap of thunder. The ground trembled, and a strong wind hit our *chum* and threw it down. The *elliun* (the skins covering a *chum*) rode up, and what I saw was terrible. Trees were falling down, their pine needles burning. Branches and moss on the ground were burning as well. Suddenly a bright light like a second Sun appeared above the mountain where the trees had fallen. At the same moment a strong *agdyllian* (thunder) crashed. The morning was sunny with no clouds. The Sun shone as always, and now there was a second Sun. Chekaren and I crawled out from under the *chum*. After that we saw another flash of light while thunder crashed overhead followed by a gust of wind that knocked us down. Then Chekaren cried out: 'Look up!' and stretched his hand upward. I looked and saw new lightning and heard more thunder."

The Tunguska explosion was heard more than 800 km from the epicenter, and within 200 km some windows facing north were

broken. The seismic wave was recorded in Russia at Irkutsk, Tashkent, Tbilisi, and in Germany at Jena. The shock wave leveled more than 2,100 km^2 of the forest. Over an area of 200 km^2 vegetation was burnt by the flash that produced a major forest fire. Minutes after the explosion a magnetic storm began, similar to the geomagnetic disturbances following nuclear explosions in the atmosphere. This was detected by the Magnetographic and Meteorological Observatory in Irkutsk. The storm lasted 5 hours. By the dawn of July 1 the strange lighting effects in the skies, which had started four days earlier, reached their peak and had begun to fade, although aftereffects persisted till late July.

Even this brief introduction to the Tunguska phenomenon shows its puzzling aspects. So, the lack of any serious reaction to it by scientists at the time seems more than odd. Some scientific journals did discuss the atmospheric anomalies, but the attention this whole subject received hardly matched the extraordinary event that had leveled some 30 million trees and devastated part of Siberia. Some local Siberian newspapers did, however, publish eyewitness accounts that led to journalists writing that a huge meteorite had hit the taiga. The very first but partly fictitious article entitled "A Visitor from Heavenly Space" appeared on July 12 in the newspaper *Sibirskaya Zhizn* (*Siberian Life*) that was published in the city of Tomsk. The reporter Alexander Adrianov wrote: "A terrible rumble and a deafening thud were heard 40 km away. A train that was approaching the station of Filimonovo was stopped by its driver, and the passengers rushed to view the cosmic visitor that had fallen from the sky. But it was impossible to examine the burning hot meteorite in any detail. Later, when the meteorite cooled, it was trenched around and examined by many people from Filimonovo. . ." Almost everything in this story is due to the imagination of the reporter. But this article was later seen by meteorite specialist Leonid Kulik, who was to play a major role in the story of the Tunguska event, and it motivated him to search for what was initially named the "Filimonovo meteorite."

The second newspaper article was published on July 15, 1908, in the newspaper *Sibir* (*Siberia*), and its author was more accurate: "On June 30, soon after 8 o'clock, there occurred in our region an unusual phenomenon of nature. In the village of Nizhne-Karelinskoye [some 450 km from the epicenter] peasants saw in the north-west, high

above the horizon, a blindingly bright body of bluish-white color that was flying above for about 10 min. The body looked like a tube. The sky was cloudless, but one could see a small dark cloud in the same direction where the luminous body was observed, low above the horizon. Having approached the forest the luminous body became blurred. There was an enormous mass of black smoke and a loud knocking, but not of thunder. The buildings were trembling and a fire of indefinite shape gushed out from the small dark cloud. All the village inhabitants ran from their houses in terror. Women were crying and everyone thought Armageddon had arrived."

In 1921, an expedition of the Russian Academy of Sciences, led by the just-mentioned Leonid Kulik, visited central Siberia to gather information about meteorites in general, and during this expedition Kulik collected new eyewitness reports of the Tunguska event. There seemed to be no question that it had been a huge meteorite, most likely of iron. A few years later, in 1927, Kulik discovered the huge area of leveled forest that marked the place of the Tunguska "meteorite" fall. Subsequently, several well-equipped expeditions were sent to the site, and Kulik continued to explore the area until World War II.

However, even the expedition of 1927 made the surprising discovery that at the actual epicenter of the explosion the trees were still standing and that there was no sign of a large meteorite crater. It seems strange now that at the time no real significance was attached to this. There was just a little shift from the idea of a single meteorite to a shower of meteorites from a body that broke up due to air resistance above Earth's surface. The forest was therefore supposed to have been flattened by the ballistic shock wave from the disintegrating body – by the air compressed by the body in flight. At the time, Leonid Kulik mistook what are called thermokarst holes for numerous meteorite craters. (Thermokarst holes are shallow depressions caused by selective thawing of ground ice or permafrost.) However, Kulik should perhaps not be faulted for this mistake. He was a specialist on meteorites and therefore looked for evidence of a meteorite – not for something else.

Nevertheless, as time passed, some scientists felt that the meteorite hypothesis was flawed. In spite of extensive searches for remnants of the meteorite, none were found. So, in the early 1930s, British astronomer and meteorologist Francis Whipple suggested

that the Tunguska space body had been the core of a small comet. The geochemist Vladimir Vernadsky, who was then famous both in the Soviet Union and in Europe, favored a lump of cosmic matter (something like a compact cloud of cosmic dust), while astronomer Igor Astapovich assumed that a meteorite body had ricocheted off a lower layer in the atmosphere. But it was the Russian engineer and science fiction writer Alexander Kazantsev who in 1945 suggested an even stranger explanation for the Tunguska event. He enraged the science community by suggesting that the data then available testified to the possibility of an extraterrestrial spaceship meeting disaster in the final stage of its voyage. At the time he said he had been much impressed by the similarities in the description of the Tunguska event and those describing the nuclear explosion over Hiroshima.

As one can imagine, the meteorite specialists "were not amused." They at once objected to such a fantastic idea, and in 1951, a team of the most distinguished Soviet astronomers expressed their opinion in the popular science journal *Nauka i Zhizn* (*Science and Life*). "There is," they said, "no question that immediately after the meteorite fall a crater-like depression formed where now the Southern swamp exists. It was relatively small and soon became inundated with water. In subsequent years it was covered by silt and moss, filled with peat hummocks and partly overgrown with bushes. The dead trees standing upright can be seen not at the center of the catastrophe, but on the hillsides which surround the hollow."

This was what the then leading Soviet astronomers accepted, being absolutely certain that the Tunguska event had been due to a normal stone or iron meteorite. Consequently, they rejected even the most obvious facts, such as the location of the standing trees at the epicenter of the devastation. And they were equally certain that there had to be a crater at Tunguska. However, the first postwar Tunguska expedition, organized in 1958 by the Committee on Meteorites of the USSR Academy of Sciences, made everyone involved agree that the Tunguska space body had exploded in the air and therefore could hardly have been a normal meteorite. At least that much was accepted.

From then on the number of anomalies discovered at the site of the Tunguska explosion began to grow very fast. And the hypotheses

that the Tunguska space body was a meteorite or the core of a small comet met with considerable difficulties. Thus in 1962, the Committee on Meteorites turned the problem over to the Commission on Meteorites and Cosmic Dust of the Siberian Branch of the USSR Academy of Sciences. The problem of the Tunguska phenomenon was exiled to the place of its birth.

In 1958, the so-called Independent Tunguska Exploration Group was established under the leadership of young Siberian scientists Gennady Plekhanov and Nikolay Vasilyev. This group became responsible for the ensuing Tunguska studies and initially consisted of a dozen specialists, mainly physicists and mathematicians. Actually, this organization was conceived for the purpose of settling only one persistent question that by then had gained an embarrassing prominence in the Soviet Union. It was whether or not the Tunguska space body had been an extraterrestrial spaceship. But this led to the realization that the problem of the Tunguska event would require a lot more research, involving high-level specialists applying the latest know-how and technology. Consequently, within a few years, the "core" of this organization would consist of 50 scientists, while a 100 specialists would take part in fieldwork each year with an amazing 1,000 researchers from various scientific institutions all over the Soviet Union collecting and analyzing relevant materials.

In 1959, geophysicist Alexey Zolotov, a specialist in using nuclear physics to examine geological deposits, suggested ways of testing the main aspects of the spaceship hypothesis. He asked whether it was an explosion in the usual sense of this word that devastated the taiga of the Tunguska or was it a ballistic shock wave from a moving space body? If it was an explosion, was it a nuclear explosion or not? Alexander Kazantsev, the science fiction writer, believed it was nuclear, or something similar, while fully realizing that one could hardly imagine an alien spaceship carrying a nuclear reactor similar to those built in the United States and USSR in the 1940s. Still less could one imagine interstellar travelers having an atomic bomb aboard. Nevertheless, if significant traces of nuclear reactions were discovered in the taiga, the "meteorite model" would have to be reconsidered. Alexey Zolotov did succeed in answering the first question: Yes, it was an explosion and not a ballistic shock wave. In other words, the destruction of the forest was due to the energy of an exploding body, not due to the force of energy produced by such a body's motion through the atmosphere.

That, as we shall see, was very important. But the second question remained unresolved. There were nuclear traces on the site but they were too feeble for any conclusion.

In recent decades the Tunguska event has become a major problem for many scientists who have their own publications and research communities to consider, although scientists in the Russian "meteoritic establishment" are definitely not ready to consider the "spaceship hypothesis." They regard this as a terrible heresy, even though Vasilyev, Zolotov, Plekhanov, and others have examined the hypothesis with rigorous scientific research methods. So from 1946 (when Alexander Kazantsev publicized the Tunguska event by publishing his heretical hypothesis), there have been two groups in the Soviet Union that have led a not-so-peaceful coexistence. The natural explanation versus the artificial explanation has remained the keynote in the whole Tunguska affair during the last 60 years. This situation may surprise scientists in the West, but whatever model of the space body turns out to be correct, this competition between the two camps has at least been very productive. Without this controversy every astronomer would have automatically assumed that an icy core of a comet caused the Tunguska event – and nothing else. Some astronomers might even have been awarded the State Lenin Prize of the USSR for such an epoch-making discovery. This was actually planned in the early 1960s.

After the expedition of 1961, Kirill Florensky (a noted geochemist and head of the academic Tunguska expeditions) asserted categorically that the problem of the Tunguska event had been solved. The space body was indeed a comet. Of course, everyone has the right to proclaim what he or she believes correct, but the spicy detail is that the scientists responsible for this outstanding scientific result were thought worthy of a "State Lenin Prize of the USSR." Being a laureate of this prize carried great weight in Soviet times, but in this case any prospects for serious Tunguska studies would have been closed for years to come. However, Gennady Plekhanov and his friends, not agreeing with "the comet solution," threatened to raise hell in the newspapers, and the establishment meteor specialists had to retreat. There was no further collaboration between the two camps.

In the 1970s, the author of this book worked for several years in the Russian town of Kalinin (now Tver) in the laboratory of Dr. Zolotov. It was a small unit in a big geophysical institute. The

scientists there called it the "Laboratory of Anomalous Geophysics." It had only four staff: Alexey Zolotov, Sokrat Golenetsky, Vitaly Stepanok, and myself, a recent graduate of Kharkov Polytechnical Institute. Golenetsky and Stepanok were looking for material and radioactive traces of the Tunguska meteorite, whereas I was mainly engaged in computer processing the collected data. When in Moscow we often met with science fiction writer Alexander Kazantsev and some Siberian Tunguska specialists with whom we discussed the scientific approaches to the Tunguska problem. Subsequently, while working on my dissertation on the scientific searches for extraterrestrial intelligence, I used the Tunguska "natural versus artificial" competition to illustrate the justification of the two approaches to such a problem and the need to investigate both with the same scientific rigor.

In 1992, a group of scientists, scholars, and engineers, living in different countries but equally interested in scientific research on anomalous phenomena of various kinds, established the interdisciplinary Research Institute on Anomalous Phenomena (RIAP). By mutual agreement it was established in the Ukrainian city of Kharkov, and one of the main research topics was – and still is – the Tunguska problem. The Tunguska investigations at RIAP are carried out in collaboration with the Independent Tunguska Exploration Group that still exists as an "invisible college" throughout the territory of the Community of Independent States. Consequently, Russian Tunguska investigators today have a niche in the new, postcommunist socioeconomic order. True, the large and costly expeditions of Soviet times are a thing of the past, but the National Nature Reserve *Tungussky* has been established by the Russian Federal Government, and the area of the explosion is not standing empty. Even tourists from abroad visit the region, mainly in summer, and conferences are organized by scientific institutions in Moscow, Krasnoyarsk, Tomsk, Novosibirsk, and other Russian cities. As for the scientific and popular science publications on this subject, there are, in Russian, hundreds of serious papers and some 50 monographs, all virtually unknown in the West. Although, from time to time, there flashes a spark of interest among Western journalists and TV people – more often than not generated by another flimsy "hypothesis" that has little to do with serious research – the truth of the Tunguska situation is never explained. However, the

subject is not unfathomable. At least the problem to be solved can now be well understood, and in this book you will find out about the discoveries made by past investigations as well as about the important questions we have to answer to discover the true nature of the Tunguska catastrophe.

During the twentieth century, the public has often read "The Great Enigma of the Tunguska Meteorite Has Been Solved!" But such statements were premature. Scientific research starts from *seeing a problem*. It is a crucially important stage on the way to real knowledge. With all due respect to Leonid Kulik and his fellow researchers before World War II, their iron meteorite model of the Tunguska space body was based on an inadequate understanding of the problem, so that the hypotheses most seriously considered during the last century may be wrong. However, we do now have the opportunity to solve the problem. For that we need to harness the facts already discovered and build an interdisciplinary picture of the Tunguska event. Of course, some essential bits of empirical information are still needed, and these will have to be gathered from the site. But the amount of data needed will not be very large because the road to a final solution of the Tunguska problem has already been paved by generations of Tunguska researchers.

Notes and References

1. In 1908, the Julian calendar was in use in Russia, but to avoid confusion, all dates in the book are given by the Gregorian calendar.
2. See *Nature*, 1908, Vol. 78, No. 2019, p. 221.
3. The TNT equivalent of the bomb dropped on Hiroshima was 13 kilotons (kt). Dividing 50 Mt (that is 50,000 kt) by 13 kt we obtain 3,846. Even if we limit the Tunguska explosion's TNT equivalent to 40 Mt, the result will be 3,077. But of course, the effect of one super powerful explosion is considerably less devastating than that of a group of less-powerful ones. Three thousand "Tunguska mini-meteorites," each of them exploding with the magnitude of 13 kt, would have flattened a much greater area of the taiga than happened in reality.