Paul Erdös

Born: 26 March 1913 in Budapest, Hungary

Died: 20 Sept 1996 in Warsaw, Poland

Paul Erdös came from a Jewish family (the original family name being Engländer) although neither of his parents observed the Jewish religion. Paul's father Lajos and his mother Anna had two daughters, aged three and five, who died of scarlet fever just days before Paul was born. This naturally had the effect making Lajos and Anna extremely protective of Paul. He would be introduced to mathematics by his parents, themselves both teachers of mathematics.

Paul was not much over a year old when World War I broke out. Paul's father Lajos was captured by the Russian army as it attacked the Austro-Hungarian troops. He spent six years in captivity in Siberia. As soon as Lajos was captured, with Paul's mother Anna teaching during the day, a German governess was employed to look after Paul. Anna, excessively protective after the loss of her two daughters, kept Paul away from school for much of his early years and a tutor was provided to teach him at home.

The situation in Hungary was chaotic at the end of World War I. After a short while as a democratic republic, a communist Béla Kun took over, and Hungary became a left wing Soviet Republic. Anna was at this time made head teacher of her school but when the Communists called for strike action against Kun's regime she continued working, not for political reasons but simply because she did not wish to see children's education suffer.

After four months in control of Hungary, Kun fled to Vienna when Romanian troops advanced on Budapest in July 1919. Miklós Horthy, a right-wing nationalist, took over control of the country. He quickly moved against those perceived as Communists and Anna Erdös fell into that category due to her failing to obey the Communist strike call when Kun was in power. She was dismissed from her post and she was left in fear of her life as Horthy's men roamed the streets killing Jews and Communists. By 1920 Horthy had introduced anti-Jewish laws similar to those Hitler would introduce in Germany thirteen years later.

The year 1920 was not all bad for Paul, for his father Lajos returned home from Siberia. He had learnt English to pass the long hours in captivity but, having no English teacher, did not know how to pronounce the words. He now set about teaching Paul to speak English, but the strange English accent which this gave Paul remained one of his characteristics throughout his life.

Despite the restrictions on Jews entering universities in Hungary, Erdös, as the winner of a national examination, was allowed to enter in 1930. He studied for his doctorate at the University Pázmány Péter in Budapest. Awarded a doctorate in 1934, he took up a post-doctoral fellowship at Manchester, essentially being forced to leave Hungary because he was Jewish. During his tenure of the fellowship, Erdös travelled widely in the UK. He met Hardy in Cambridge in 1934 and Ulam, also in Cambridge, in 1935. His friendship with Ulam was to prove important later when Erdös was in the United States.

The situation in Hungary by the late 1930s clearly made it impossible for someone of Jewish origins to return. However he did visit Budapest three times a year during his tenure of the Manchester fellowship. In March 1938 Hitler took control of Austria and Erdös had to cancel his intended spring visit to Budapest. He did visit during the summer vacation but the Czech crisis on 3 September 1938 made him decide to return hurriedly to England. Within weeks Erdös was on his way to the USA where he took up a fellowship at Princeton. He hoped for his fellowship to be renewed but Erdös did not conform to Princeton's standards so he was offered only a six month extension rather than the expected year. Princeton found him [3]:-

   ... uncouth and unconventional...

and Ulam invited Erdös to visit Madison to help out. We shall return later to give further details of the strange life

which Erdös lived from this time on, devoted exclusively to seeking out and solving good mathematical problems. First we make some comments about his mathematics.

The contributions which Erdös made to mathematics were numerous and broad. However, basically Erdös was a solver of problems, not a builder of theories. The problems which attracted him most were problems in combinatorics, graph theory, and number theory. He did not just want to solve problems, however, he wanted to solve them in an elegant and elementary way. To Erdös the proof had to provide insight into why the result was true, not just provide a complicated sequence of steps which would constitute a formal proof yet somehow fail to provide any understanding.

Some results with which Erdös is most closely associated had been first proved before Erdös was born. In 1845 Bertrand conjectured that there was always at least one prime between n and 2n for n 2. Chebyshev proved Bertrand's conjecture in 1850 but when Erdös was only an eighteen year old student in Budapest he found an elegant elementary proof of this result. Another result on prime numbers associated with Erdös is the Prime Number Theorem, namely:-

.. the number of primes n tends to as n/logen.

The theorem was conjectured in the 18th century, Chebyshev himself came close to a proof, but it was not proved until 1896, when Hadamard and de la Vallée Poussin independently proved it using complex analysis. In 1949 Erdös and Atle Selberg found an elementary proof. Subsequent events are described in [15]:-

Selberg and Erdös agreed to publish their work in back-to-back papers in the same journal, explaining the work each had done and sharing the credit. But at the last minute Selberg ... raced ahead with his proof and published first. The following year Selberg won the Fields Medal for this work. Erdös was not much concerned with the competitive aspect of mathematics and was philosophical about the episode.

This result was typical of the type of mathematics Erdös worked on. He posed and solved problems that were beautiful, simple to understand, but notoriously difficult to solve.

Erdös did receive the Cole Prize of the American Mathematical Society in 1951 for his many papers on the theory of numbers, and in particular for the paper On a new method in elementary number theory which leads to an elementary proof of the prime number theorem published in the Proceedings of the National Academy of Sciences in 1949.

Whether a rather silly event which took place in August 1941 was to have any real effect on Erdös's life, or whether it was simply used as an excuse, is hard to tell. Erdös and two fellow mathematicians were picked up by the police near a military radio transmitter on Long Island. It was quite an innocent event with the three mathematicians being too absorbed in discussion of mathematics to notice a NO TRESPASSING sign. After a friendly session with the police it was realised that no harm had been intended. However, it gave Erdös an FBI record which was later used against him.

Ulam left Madison in 1943 to join other mathematicians and physicists at Los Alamos in New Mexico working on the atomic bomb project. He asked Erdös to join the project but, although he was interested enough to be interviewed, Erdös gave answers to those interviewing him which he must have known were not what they wanted to hear. Erdös was simply too honest in saying that he would wish to return to Budapest at the end of the war. This episode does give the feeling that Erdös never wanted to work at Los Alamos, but was simply amusing himself.

In 1943 Erdös worked at Purdue University, taking a part-time appointment. Although it was a difficult time with great uncertainty about the fate of his family in Hungary, yet mathematically Erdös flourished. He had heard nothing from his family between 1941 and the time when Budapest was liberated in 1945. The Jews in Hungary had suffered incredible hardship from 1944 with many being murdered, and others deported to Auschwitz. It is

unlikely that the full extent of the horror was understood by Erdös in the United States at the time. However, in August 1945, Erdös received a telegram giving details of his family. His father had died of a heart attack in 1942. His mother had survived while, quite remarkably, a cousin Magda Fredro had been sent to Auschwitz but had survived. The family had suffered terribly through the Nazi campaign against the Jews, however, and four of Erdös's uncles and aunts had been murdered.

Near the end of 1948 Erdös was able to return to Hungary for a visit and there he was reunited with his surviving family and friends. For the next three years he travelled frequently between England and the United States before accepting a temporary post at the University of Notre Dame in 1952. It was an inspired offer which gave Erdös complete freedom to rush off to do some joint research whenever he wanted. Erdös could not bring himself to accept the same generous offer on a permanent basis, which both the University of Notre Dame and Erdös's friends tried hard to encourage him to accept.

During the early 1950s senator Joseph R McCarthy whipped up strong feelings against communism in the United States. Erdös began to come under suspicion from authorities who saw imaginary problems everywhere. When asked by US immigration, as he returned after a conference in Amsterdam in 1954, what he thought of Marx, Erdös made the ill judged reply:-

I'm not competent to judge, but no doubt he was a great man.

This was followed by a line of questioning about whether he would ever return to Hungary. Erdös said:-

I'm not planning to visit Hungary now because I don't know whether they would let me back out. I'm planning to go only to England and Holland.

So, was it only the fear of not being let out of Hungary that stopped him going there. Erdös replied innocently:-

Of course, my mother is there and I have many friends there.

Erdös was not allowed back to the United States but no reason was given. The files indicate that the official reasons were not the answers Erdös gave to the above questions, but the fact that he had corresponded with a Chinese mathematician who had subsequently returned from the United States to China and also Erdös's 1941 FBI record.

He spent much of the next ten years in Israel. During the early 1960s he made numerous requests to be allowed to return to the United States and a visa was finally granted in November 1963. By this time, however, Erdös had become a traveller moving from one university to another, and from the home of one mathematician to another. However, he did have a home of sorts with his friend Ronald Graham. Erdös and Graham met at a number theory conference in 1963 and soon began a mathematical collaboration. It was Graham who provided a room in his house where Erdös could live when he wanted, he also stored Erdös's papers there and, in many ways, acted as a secretary to Erdös.

Although somewhat over the top, the following quote from [12] shows the high regard in which Erdös was held by his fellow mathematicians:-

Never, mathematicians say, has there been an individual like Paul Erdös. He was one of the century's greatest mathematicians, who posed and solved thorny problems in number theory and other areas and founded the field of discrete mathematics, which is the foundation of computer science. He was also one of the most prolific mathematicians in history, with more than 1,500 papers to his name. And, his friends say, he was also one of the most unusual.

Erdös won many prizes including the Wolf Prize of 50 000 dollars in 1983. However he had a lifestyle that needed little money and he gave away:-

... most of the money he earned from lecturing at mathematics conferences, donating it to help students or as prizes for solving problems he had posed.

In 1976 Ulam gave this description of Erdös:-

He had been a true child prodigy, publishing his first results at the age of eighteen in number theory and in combinatorial analysis. Being Jewish he had to leave Hungary, and as it turned out, this saved his live. In 1941 he was twenty-seven years old, homesick, unhappy, and constantly worried about the fate of his mother who remained in Hungary. ... Erdös is somewhat below medium height, an extremely nervous and agitated person. ... His eyes indicated he was always thinking about mathematics, a process interrupted only by his rather pessimistic statements on world affairs, politics, or human affairs in general, which he viewed darkly. ... His peculiarities are so numerous it is impossible to describe them all. ... Now over sixty, he has more than seven hundred papers to his credit.

Article by: J J O'Connor and E F Robertson

Some Quotations

Mathematics is not yet ready for such problems.

[Attributed by Paul Halmos.]

The American Mathematical Monthly, Nov. 1992

A Mathematician is a machine for turning coffee into theorems.

Why are numbers beautiful? It's like asking why is Beethoven's Ninth Symphony beautiful. If you don't see why, someone can't tell you. I know numbers are beautiful. If they aren't beautiful, nothing is.

Television is something the Russians invented to destroy American education.

Why are you a physicist? Why aren't you a mathematician?

I cannot compute Cm for m > 3. This may be due to old age, stupidity, and laziness.

Property is a nuisance.

There'll be plenty of time to rest in the grave.

Quoted in D MacHale, Comic Sections (Dublin 1993)

My mother said, "Even you, Paul, can be in only one place at one time." Maybe soon I will be relieved of this disadvantage. Maybe, once I've left, I'll be able to be in many places at the same time. Maybe then I'll be able to collaborate with Archimedes and Euclid.

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