TIBOR GALLAI, 1912–1992

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Tibor Gallai (born Grünwald), who had a major influence on graph theory and combinatorial optimization, died on January 2, 1992, after many years of frail health.

Gallai was born on July 15, 1912, in Budapest as the second son of Dávid Grünwald and his wife Katalin (née Benedig). His brother, Gyula was born in 1909, and his sister, Ibolya ("Cini"), in 1916. The family lived by very modest means. An educated man, Dávid made their living by giving piano lessons. Gyula grew up to become an engineer. Cini emigrated to Bolivia in 1939 and died of a tropical disease two years later, at the age of 25, leaving an infant daughter.

Tibor's mathematical career started at high school when he became a diligent problem solver for the Hungarian High School Mathematical Monthly (where he competed successfully with Paul Erdős, among others). As a winner of the prestigeous Eötvös mathematical competition, he was admitted to the university* in face of the "numerus clausus" law which limited the total proportion of Jewish students in Hungary to 5%.

Gallai's mathematical interests were greatly influenced by the lectures of Dénes König, professor at the Technical University of Budapest, author of the first monograph in graph theory. Another source of inspiration came from the informal mathematical excursions and outdoor seminars held by a group of students including Pál Erdős, György Szekeres, Eszter Klein, Pál Turán, Márta Sved (née Wachsberger).

Gallai received his diploma as a high school teacher of mathematics and physics in 1936. By then, Jews were practically banned from the teaching profession in Hungary and Gallai had to start his career as an actuarial mathematician. After a year he became a "calculator" at a textile factory; finally, in 1939 he lost that job, too, and had to make his living by private tutoring and occasional teaching at a Jewish community school.

Tibor Gallai at 17, photo published in the Hungarian High School Mathematical Monthly, May, 1929

It was during these same years that his first mathematical papers appeared. He completed his doctorate in 1940 at the Budapest University of Science.

Grim years followed. Gallai survived the horrors of three years in forced labor camps. It was not until after the defeat of the Nazis in Spring 1945 that he had a chance to fully practice his beloved profession. He became a teacher in a Jewish girls' high school in Budapest. Out of the 26 students in his first class, three have subsequently become research mathematicians.

Devoted to spreading the joy of mathematics, Gallai, together with Rózsa Péter, wrote new high school textbooks proposed for nationwide use. The books, marvelous by all accounts, were thoroughly tested on Gallai's students but eventually did not gain acceptance, perhaps for requiring an initiated teacher.

In 1945, Gallai joined the Communist Party, the organization seen at the time by many as a force representing social ideals and uncompromising opposition to

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* See Paul Erdős's account on p. 207 of *Combinatorica* **2** (1982).

Nazism. These ideals seemed to fit Gallai well. All his life he lived in austerity and often contributed more to charitable causes than he could really afford.

Gallai married a fellow mathematician, Ibolya Dusák, in 1938. Their celebration of the liberation from Nazi terror was marred by the death at the age of five months of their only child, Julia, born on August 15, 1945.

In 1949, Gallai became professor of mathematics at the Technical University of Budapest. In 1958 he joined the Mathematical Institute of the Hungarian Academy of Sciences where he worked until his voluntary early retirement in 1968. He devoted the next fifteen years of his life to his wife Ibolya who died, after a long and debilitating illness, in 1983.

Gallai's remarkable strength and devotion is shown by his mathematical recovery after this traumatic experience. He completed the second part of his study of "signed cell decompositions", started 15 years earlier (T. Gallai: Signierte Zellenzerlegungen II, *Acta Math. Hungar.* **49** (1987), pp. 185–201). He also wrote a joint paper with P. Erdős and Z. Tuza (to appear in Discrete Mathematics).

Living a secluded life, Gallai seldom publicized his work at conferences. Many of his ideas, initiatives, concepts have become known in Hungary and abroad mainly through the work of his students whose rank includes B. Andrásfai, A. Gyárfás, G. Hetyei, J. Lehel, L. Lovász and L. Pósa.

A mathematician of extreme modesty, Gallai was always reluctant to receive any honors. In 1988 he was offered the degree of Doctor of Science by the Hungarian Academy of Sciences. As part of the process, he was presented a list of two dozen monographs and hundreds of papers citing his work. He was genuinely surprised, believing perhaps for the first time that he had made his mark in the history of mathematics. Gallai was elected to be a member of the Hungarian Academy of Sciences in 1990.

During his last days, he shared a hospital room with a noted artist with whom, reportedly, he discussed the music of Bach and Mozart.

Gallai was the creator or one of the initiators of a number of areas in graph theory. He was the first to emphasize the role of min-max theorems in combinatorial optimization, and introduced linear programming duality among the tools of this theory. His results were pivotal in launching the theories of critical graphs and perfect graphs; as well as the theory of hypergraphs as a generalization of graph theory. His work has greatly contributed to the emergence of the theory of "good characterizations", one of the chief precursors of the P–NP theory, central to the theory of computing.

COMBINATORICA devoted a special issue (Vol. 2, No. 3, 1982, pp. 202–332) to Gallai's seventieth birthday. A list of Gallai's publications up to that date can be found on pp. 204–205, along with comments by L. Lovász (pp. 203–204) and P. Erdős (pp. 207–212) on his mathematical work.

Much of Gallai's life remains a puzzle even to those close to him. A human being of uncompromising moral standards, a teacher of exceptional gift and devotion, the creator of many of the basic concepts used daily in several branches of combinatorics, Tibor Gallai will be dearly missed.

In writing this obituary, we have been greatly helped by Miklós Simonovits and members of the Gallai family: Éva and Alíz Bogdán and Gizella Gallai.

LÁSZLÓ BABAI and VERA T. SÓS