The protagonists of Goethe's science novel compare their changing attractions to chemical bonding,

IN RETROSPECT

Elective Affinities

Matthew Bell reassesses German polymath Goethe's haunting 'chemical romance'.

In 1809, German national poet and polymath Johann Wolfgang von Goethe provoked outrage with his novel *Elective Affinities* (*Die Wahlverwandtschaften*). Many readers were horrified by its almost playful treatment of adultery, which still carries a charge. But what makes it worthy of reappraisal is how it puts science at the centre of human concerns — and humans at the centre of science. Goethe emphasized the primacy of human perception in understanding nature as a holistic entity, in contrast to the

quantitative methods and mechanical Universe of the Enlightenment era.

Today, the basic phenomena of biology and physics have been described, and the complexity of the Universe and the human brain are testing reductionism. Multiple perspectives and big data are needed to crack the challenges of energy, food and population. People are at the centre of research

Johann Wolfgang von Goethe.

Elective Affinities (*Die Wahlverwandtschaften*)
JOHANN WOLFGANG VON GOETHE
J. G. Cotta: 1809.

— where Goethe felt they must be. A reappraisal of Goethe's science reminds us how

key advances emerged outside the mechanical tradition of Descartes and Newton.

Goethe began his scientific studies in the late eighteenth century. Biology was largely an observational science, dependent on skill and patience; Goethe's notebooks are full of meticulous descriptions of plants, mammals and insects. He raised theoretical questions about the nature and origins of life and the development of species, for which the mechanical model had no plausible answers. Resisting the urge to jump to conclusions, Goethe focused on amassing data and seeking patterns. He painstakingly documented the relations between parts of organisms and the similarities between species. From observations of hundreds of skeletons, he developed an influential model of mammal anatomy. In seeking a principle underlying organic nature, he is seen as a founder of modern biology; Charles Darwin mentioned him in the 'historical sketch' in the 1860 second edition of *On the Origin of Species*.

Elective Affinities weaves together many of these strands. The title comes from the work of Swedish chemist Torbern Bergman, who devised the eighteenth century's most accurate chart of what was likely to bind with what — a forerunner of the periodic table. Bergman's theory of 'elective affinities' seems to describe the shifting relationships of the protagonists, Eduard, Charlotte, Ottilie and the Captain. In this sense, the novel can be read as an exercise in reductionism: like elements, the characters seem to have no choice but to make new bonds when a reagent is introduced. Even their names reinforce this. Both Eduard and the Captain were christened Otto, so the repetition of 'ott' in the names of the characters emerges as a sign of affinity.

Early on, the Captain and the married Eduard and Charlotte discuss Bergman's theory and its application to relationships. They are not merely objects in Goethe's experiment: they consciously experiment on themselves. Goethe believed that experiments and the experimenter are one — and that a human is the most precise apparatus.

The novel is set on Eduard and Charlotte's estate. Eduard persuades his wife to invite her orphaned niece Ottilie and his friend the Captain to stay with them as an 'experiment' (*Versuch*), establishing empiricism as a metaphor for human relations. The Captain and Eduard begin to improve the estate, leaving Eduard less time with Charlotte; they compare

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this change in their bonds to a reaction. Eduard jokes that Otilie will form a 'compound' with Charlotte, but himself comes to see an affinity with her. Charlotte and the Captain are drawn to each other. When Eduard and Charlotte make love, their minds are occupied with thoughts of these others. It ends tragically. Charlotte gives birth to a son (another Otto), whom Otilie accidentally drowns; Otilie starves to death, followed by Eduard.

Beyond its reading as a human analogue of chemical reactions, the novel is infused with aspects of Goethe's science expressed in his quixotic *Theory of Colour*, published the following year. Goethe believed that Newton's experiments with prisms were flawed. He contended that white light was the fundamental phenomenon, and that colours were produced by interactions between light and darkness, perceivable by the naked eye — incorrect, but an accurate record of how we perceive colour. However, it is Goethe's argument that Newton valued representation of phenomena in symbols over the phenomena themselves that has resonance in *Elective Affinities*.

Goethe's novel can be seen as an attempt to show the consequences of the urge to abstraction. The narcissistic Eduard interprets isolated phenomena, such as headaches on the right side of his head and the left of Otilie's, as symbols of affinity, and hypothesizes from that. Goethe believed that scientists should critically observe a broad spectrum of phenomena before theorizing. Eduard, driver of the tragic plot, is Goethe's personification of the flaws that he found in the science of his day.

Although *Elective Affinities* scandalized nineteenth-century readers, its theme and penetration sparked a cult following among writers. George Eliot — whose unmarried relationship with Goethe scholar George Henry Lewes was itself a scandal — admired the novel, and it may have influenced her harrowing *The Mill on the Floss* (1860). Characters and plots in Ford Madox Ford's *The Good Soldier* (1915) echo it, and protagonists of John Banville's *The Newton Letter* (1982) are named Edward, Charlotte and Otilie.

Goethe called for a "gentle empiricism", believing that advanced human development (*Bildung*) was essential to the perception of nature's wondrous realities. *Elective Affinities*, by questioning the fruits of reductionism, challenges us to recall that no observer can ever be impartial. ■

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Calvin Bridges experimented on fruit flies to make fundamental discoveries in genetics.

GENETICS

Genius on the fly

Ewen Callaway reviews a biopic of Calvin Bridges, the wild-living, wild-haired genetics pioneer.

Calvin Bridges is best known for three things: his pioneering work on genetics in the early twentieth century, his womanizing and his gravity-defying mop of hair. *The Fly Room*, a biopic told through the eyes of his daughter Betsey, also shows the scientist as a sometimes dedicated, often distracted father who struggled to balance intellectual curiosity with family obligations.

The Fly Room came from a chance encounter between geneticist-turned-filmmaker Alexis Gambis and Betsey, now in her nineties. It is bookended by interviews with her, but focuses on a period in the 1920s, when ten-year-old Betsey visited her father's workplace: the famed Fly Room at Columbia University in New York City. The film was partly crowdfunded through Kickstarter. Researchers including neuroscientists Joseph LeDoux and Stuart Firestein have supporting roles.

Bridges, portrayed by a wild-haired Haskell King, was a star disciple of evolutionary biologist Thomas Hunt Morgan (played by Firestein). Under Morgan's leadership, Bridges and a cadre of Young Turks characterized mutant fruit flies — most famously, white-eyed varieties — to map the locations of genes and to understand how they are transmitted. Bridges' work established that trait-determining genes are carried by chromosomes that parents pass to their offspring. He also worked out how chromosomes — X and Y — determine the sex of fruit flies.

"It was not unusual for six of us to carry on in this small room," Morgan remembered in an obituary of Bridges, who died in 1938 from

The Fly Room
WRITER/DIRECTOR:
ALEXIS GAMBIS
Imaginal Disc: 2014.

syphilis. To feed the flies, near-rotting bananas were a constant presence.

Those bananas dangle from the ceiling in the film's fictionalized Fly Room, where Bridges and other prominent figures in genetics sort dead flies and trade rude witticisms. Betsey crashes this world after her mother, Gertrude, sends her to spend time with her father. None of the scientists knows what to make of the curious girl, who carries her box camera everywhere. Bridges is annoyed to have his sanctum disturbed. But he warms to Betsey and puts her to use in the Fly Room, counting and characterizing flies. He becomes so comfortable having his daughter around that he neglects to hide his after-hours philandering.

Much of the film unfolds in the Fly Room. The set designers have paid close attention to detail: for example, the microscopes are the binocular version that Bridges invented.

Bridges left his family; Morgan moved his lab to the California Institute of Technology and Bridges joined him. *The Fly Room* makes no attempt to provide an authoritative history, leaving many details to the epilogue. In an interview, 95-year-old Betsey says that she never wanted to be like her dad. An apt sentiment about a father who was flawed — but who laid the groundwork for the modern science of heredity. ■

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