The Torch of Erwin Chargaff and the Fire of Heraklitus Devour Their Children**

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To forget is a risk—therefore let's remember!
Berthold Viertel (1885–1953)

A Prophet Counts for Nothing in His Father Land

Erwin Chargaff died on the 20th June, 2002. He was almost 97 years old, therefore he had experienced the 20th century almost totally in its ineffableness. However, he had much to say on the matter, for he had a clever, critical mind and was a resourceful stylist, with standards which have been more or less lost, or which are donned only on Sundays. It was this lack of character which enraged him, and his response brought him into disrepute with the closed peer-society of science as a regressive and everything else blowhards could throw at him. Even during his lifetime it was not possible to pay due tribute to Erwin Chargaff without rebuke. I did it—briefly—by congratulating this great, old pillar of biochemistry (not only of nucleic acids) on his 85th birthday in the then "Green Pages" of the German Biochemical Society (GBM). Immediately I received a rebuke from a notorious scientific philosopher: a proper person does not touch upon someone who dirties his own nest. I am not proper, and I have benefited from it, for to ignore someone of Erwin Chargaff's métier is to put on blinkers and follow only the well-trodden rut, driven merely by the opportunism of the time. Moreover, he was never a Mr. hundred percent, but someone of analytical and considered reserve who also knew that his far-reaching condemnations would return to haunt him. He had a serious desire not to resist the considerable influx of ideas and their associations and the temptation of pointed expression. He raised questions to be taken seriously, and received ignorant answers. A whole catalogue of comments on the attitude and behavior of major scientists can be compiled from the many critical utterances of insiders—who can justifyingly refute them with equanimity from the same position?

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[**] *Das Feuer des Heraklit* (The Fire of Heraklitus) is the title of Erwin Chargaff's autobiography published in 1979 by Cotta, Stuttgart.

"The Time when Everyone Believed in the Dignity of Man"

Erwin Chargaff came from the eastern fringe of the former Habsburg monarchy, Bukowina, in whose capital Czernowitz situated in range of hills above a Pruth ford he was born on the 11th August, 1905. His parents were prosperous bankers who gave their two children the middle-class upbringing assimilated from Germany which Society so valued. They were first made aware that they were Jews by the "racist" anti-Semitism of the Austro-Germans. The liberal family had viewed the many synagogues in Czernowitz only from the outside. Important for them were the centrally located theater, library, and the station in Ring-Strasse architecture, painted ocher like all official buildings, which led the way into the intellectual and liberal world. Bukowina was provincial, if also ambitious. At the time of Erwin Chargaff's birth it had been "Crown Land" for only 130 years, and before and since the corridor for all movement in the Danube basin between the Balkans and the Baltic, between Istanbul and Paris. The lethargy of the old Kaiser Franz Joseph reigned over a Leyden jar bursting with violent emotions. One gets a (humorous) impression from the descriptions of Gregor von Rezzori, also a native of Czernowitz who knew his "Maghrebinians". The surrounding agricultural region of Vlachs, Ruthenians, Poles, and Huzules began to migrate into the town in which with the "Schwaben" from Austria, the Jews from nearby Galicia and Bessarabia, and the Armenian and Greeks were the civic and industrializing element. From a few thousand at the start of the 19th Century it grew in that way to 50000 by about 1900, a third of whom were Jews of differing orthodoxy, from Hasidites in dozens of prayer rooms, to agnostics who, like the Chargaffs, went past the splendid temples, a quarter were Greek-orthodox Moldavians with their cathedral, an eighth Germans in their suburb of Rosch and the archbishop's palace, and a tenth each of Poles, Russniaks, and "etcetera". One can imagine the heady mixture of life-styles, languages, and smells—a lively town, and a focus of education with the Francisco-Josephina university, founded in 1875, (without sciences and medicine, but with a notable 1000 students in the four faculties, amongst them almost two thirds of "mosaic confession", of which in turn two thirds gave German as the mother tongue) and half a dozen, solely German-language daily newspapers which reached as far as Vienna, Budapest, and Cracow.

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The theater, in front of which the Schiller monument endowed by the Jewish Club, was a focus of interest and discussion. There were poets en masse within the younger generation (with Karl Kraus' "Torch" as marshal's baton under the jacket); each wrote for the other; they found encouragement and sponsorship and platform in the feuilletons of the press. Most are forgotten, and those remembered were yet to be born. The time between, from the enforced Romanianization (although with retention of educational standards) to the 2nd World War, after which Bukowina was divided between Romania and the Soviet Union, is described lively by the biophysicist Henryk (Heini) Eisenberg in his "peripatetic" reminiscences.[1] Today's town is called Chernovtsy and is a large provincial city in the Ukraine.

Vienna, the Spiritual Homeland

The change began with the 1st World War as the Austrians were forced to retreat before the Russians in the direction of Vienna, and with them a part of the upper classes of the border provinces, these included the Chargaffs. They left Czernowitz for ever, but retained the homeland accent and remained true to their educational ideals, sending the boy to the Maximilian Gymnasium, where he received comprehensively the Josephinic-humanistic education of the time up to his excellent graduation, and the remainder from the Viennese ambience. Vienna was culturally a very lively center in which many modernizing currents merged, mixed, and reinforced each other, and departed again. This applied especially to the aesthetic side: decorative secessional art, produced and reproduced music, poetry, writing, and theater, but also to classical and psychoanalytical medicine, which found a well-informed and devoted clientele, and the precise scientific philosophy in the shape of the theoretical physics of E. Mach and L. Boltzmann. These were imposing thinkers, capable of a holistic viewpoint. Arts and styles were daily topics of the aesthetic flâneurs in the many, mostly liberal, newspapers. Authors and musicians were stars, the Viennese school of scientific philosophy discussed method and association to the social sciences. The social conditions screamed for change. Young people found cultural stimulus outside of school, and were prepared by the schools to absorb it, to lay claim to it as their own, and to express it. The critical, stylistic, and aesthetic feuilletonists, of whom Karl Kraus enflamed the like-minded with the red volumes of his "Torch", had a public both willing and able to debate, including the young Erwin Chargaff, who looked upon himself as a life-long pupil of this sensitive analyst of words and values. Later he dedicated his collection of scientific essays on nucleic acid coquettishly and mystifyingly to this "teacher", whom clearly no natural scientist knew.

Bread-and-Butter Studies and the Parting of the Ways

The frivolously started war was lost, Austria was reduced to German Austria that had to undertake a precarious war of survival between black and red (the church triumphed, but finally, brown) in which fortunes and culture were lost. Erwin Chargaff, who left school in 1923 with the best grades so that he was exempt from study fees, could no longer drift, as planned, into the humanities in which he was interested, but had to take up a purposeful course of study, and to complete it as quickly as possible. With dialectic linguistics for which he had an affinity, like N. Chomski, he lived illegitimately; the choice of reason was chemistry with which the daily bread was most likely to be earned. His doctoral supervisor was "Tüpfel (spot test) Fritz" Feigl, with whom topics were plentiful, but (as everywhere in Austria) means were sparse, and who therefore distinguished himself in meticulous microanalysis. Educationally it left a lasting impression. Chargaff always remained a knowledgeable chemist of the pre-electronic days. The dissertation followed a straightforward course: the identification of oxidizable sulfur compounds by the catalyzed iodine–azide reaction in polar and non-polar solvents, also amenable to spot analysis, gave useful results which 75 years later appear predictable. In 1928 he concluded his studies with the fashionable sine-qua-non of the Doctor's title, in fact of philosophy (Dr. Phil.). The question of the future was answered by a scholarship with the lipid chemist R. J. Anderson at Yale University. He became a Research Fellow on the other side of the Atlantic in a new and, for him, strange research and social environment. Here he felt comfortable and successful, although his old-world snobbishness did not adapt, but there he married his Viennese bride Vera Broilo with whom he was to celebrate gold, diamond, and iron wedding anniversaries. The work on the fatty acids of tuberculosis bacilli went well and was successful. He was offered a position, but then withdrew from this country, which was "younger than the toilets in Vienna", and returned to "old" Europe. The bacteriologist M. Hahn (of E. Buchner's fame) had offered him a position at the Charité, and Berlin was the center of attraction in the "golden twenties", which were soon to end in the brown thirties. The research on the lipid composition of the tuberculosis and diphtheria bacteria and the lipid-transport proteins of blood plasma went well, cultural life flourished—for the time being. At the beginning of 1933 he had enough publications to think of "habilitation" and a respectable existence; then the Nazis came upon the scene and branded him "a racial Jew", he who to that day had never seen a synagogue from the inside and who shared the commonly voiced prejudice on "the" Jews. But he was clever enough to recognize the signs of the time. Since he had an invitation from P. Calmette at the Pasteur Institute he took his unsubmitted habilitation thesis, his wife, and belongings and spent two years in Paris, hungry, but free from what was occurring in Germany, and later in Austria. In 1935 he emigrated for the last time, across the Atlantic, to New York, where he spent the remaining 62 years of his life. He was by nature sedentary, and even more so through his love of books. In New York he was offered a position at the newly founded Department of Biochemistry of the Columbia College of Physicians and Surgeons, whose chairman H. T. Clarke was a man of character and vision, who seized the opportunity to build up a flourishing institute through altruistic deed and, thanks to Mr. Hitler's gifts, it became the cradle of experimental biochemistry in the USA, which until then was little

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more than a clinical complementary bedside science. Thus within the space of a few years there came, for example, Konrad Bloch, Hermann Blaschko, Rudolf Schönheimer,—now Erwin Chargaff and later David Nachmansohn. Together with intelligent and enthusiastic graduate students of both sexes, and in the neighborhood of the Rockefeller Institute and the Chemistry Department, a free haven of material and metabolic biochemistry arose, ranging from active compounds to nucleic acids. After the lipoproteins, about which Erwin Chargaff wrote the first comprehensive presentation, the nucleic acids became the central focus of his research.

Rules Without Vision

Things began to move in the field of nucleic acids after O. T. Avery announced that protein-free nucleic acid from smooth, virulent Type III Pneumococci can transform rough, avirulent Type II strains. Today this appears to us as being the beginning of the awareness of the function of DNA, but few heard this drum beat. Amongst them was Erwin Chargaff, who commenced in his meticulous, analytical chemist's style to purify and analyze nucleic acids from different sources. It was assumed that the four constituent nucleotides were present as stoichiometric tetrads which, as a concession to macromolecular evidence, are aggregated. Similarly this occurred in the area of proteins until, at the end of the 1940s, F. Sanger provided the evidence for the polypeptide chain made up from numerous amino acids. The tetranucleotide hypothesis from Phoebes Levene may have been pleasing to chemists who thought in terms of integers and crystal structure, but biologists and biochemists knew of the diversity of nature, and their earlier data put the hard-edged procrustean bed of Phoebes Levene into question. To clarify the structure of nucleic acids, proper, quantitative analyses of pure preparations of uniform alkali-stable "thymus" and alkali-labile "yeast" nucleic acids (DNA and RNA, respectively) from different organisms and organs were needed. Erwin Chargaff took up this pioneering work. He had to miniaturize reliably the current methods and was able to adapt paper chromatographic separation coupled with spectrographic identification which had just been applied to protein analysis. That sounds simple today, but the information had to be obtained from wherever possible. It was good that the "Scientific Community" was at that time still open within itself yet at the same time a closed society; it had not yet been tempted by the wider community. On the contrary, researchers were eccentric, pitiful "egg heads". They did not even earn proper money with their art. If they were inventors, that would be a different story!

With the help of enthusiastic New Yorkers and dedicated Swiss co-workers the data in statistically parallel experiments from numerous, minute samples of nucleic acids from bacteria and animals and their organs were collected within five years (Figure 1) and, in 1950, were formulated with all due care as the "Chargaff Rules", which, in summary, state that the base composition of DNA and RNA is different, but species specific, the base relationships suggest a pairing of adenine with thymine and guanine with cytosine, and the sum of 6-amino bases is equal to that of the 6-hydroxy bases.[2]

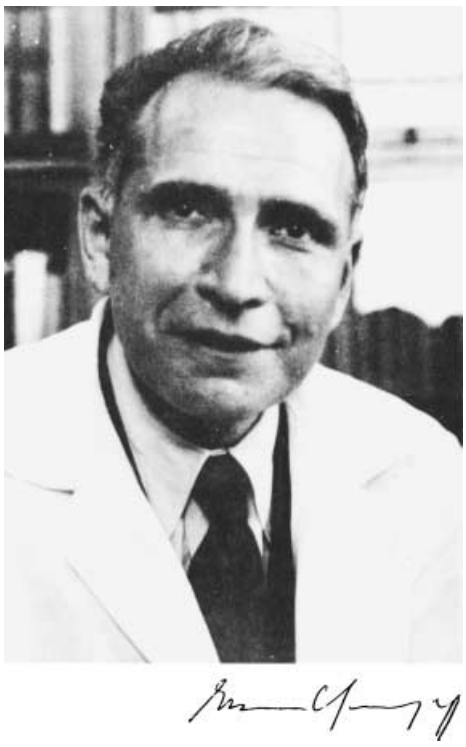

Figure 1. Chargaff at the time he formulated his rules (around 1950); reproduced with permission from *Annu. Rev. Biochem.* **1975**, *44*.

Voilà—the framework of the double helix which was also used by Watson and Crick, as were the structural data of Rosalind Franklin. The pathway to this symbolic structure was as twisted as it is itself. It outshone the leading lights and dazzled the Nobel committee. The ways of such bodies are inscrutable, but seldomly wholly challengeable. These dioscuri (Watson and Crick) were of sterner stuff than the extrapolation-shy physical and chemical-data collectors. Therefore, the hurriedly introduced work area is no longer called chemistry, but molecular biology. For Ernst Chargaff there remained other prizes (Bertner, Heinekens, etc.), medals (Pasteur, Neuberg, Mendel amongst others), and honors (Collège de France, Stazione Zoologica, the Universities of Basle and Vienna).

What Is Life?—Warning Anxieties

How far such disappointment intrudes into one's behavior in life is known only to the individual and surely not to the little man according to his own disposition: jealousy, enviousness, pessimism, tantrums.

Erwin Chargaff did not behave like this, for through Karl Kraus' precedent he was already a "critic of the system", and more so after the dropping of the atomic bomb on large civilian communities. The fanfares of victory sounded shrill and unworthy, no matter how much he had wished it, and he had made no secret that the perpetrators should have to face a deserved punishment. But, that now, after abusing the nucleus of the atom such equally frivolous and ill-prepared hands wanted to usurp the nucleus of the cell frightened him deeply. Nature does not deserve it. It has a dignity which is inviolable,

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just as mankind demands for itself. Mankind was ill-equipped to handle its technical progress and to leave alone that which is irreversible, such as the genetic program of an organism. Had not the pharmaceutical industry already turned the human body and mind into a tool to manipulate according to intent and desire—ostensibly at one's own will, or is it the will of others? Now the heredity material is falling into the same grasp, to be handled according to wish and reward. At this point intellect and the strands of tradition went their separate ways. On the one hand, the forward looking, enterprising manager, on the other, the caretaker, trying to reconcile the ways and means; Old World tradition against New World pioneering spirit (Figure 2).

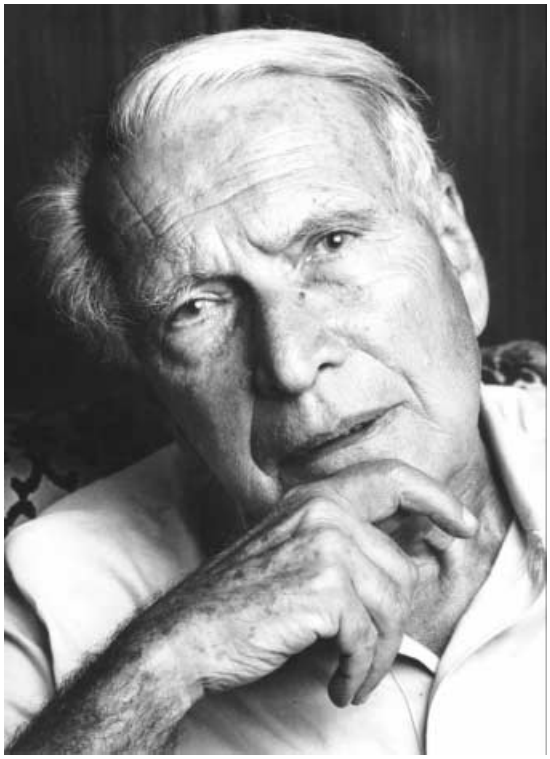

Figure 2. Chargaff, the thoughtful skeptic. Copyright© Herlinde Koelbl 1989.

Honi Soit Qui Mal y Pense (The Shame Is His Who Thinks Ill of It)

Nature is apparently easy to dupe in its naivety if its mechanisms have been recognized, in which the individual parts do not "play a role" but have an inscribed, developmentally optimized function which is governed and controlled by all other simultaneously and like-wise positioned functioning events in non-linear networks and layers "Chaos" like to unpredictable effects. Interfere here? Erwin Chargaff shuddered when he saw and heard the people who intended and endorsed it, the people who "wanted to eat, sell, and worship the cake all at the same time". During the years of this intent he viewed the future with increasing gloom. And he said it and he wrote it, always more pessimistically and often carried by his love of pointed phrasing, with caricaturistic oversubtlety. That occupied him, for whom Karl Kraus had held the torch of discrimination of truth and propaganda, for the last 30 years of his life after he retired as Director of the Biochemical Division of Columbia University (Figure 2). In ever new analyses and critiques, in aphorisms and essays he attempted to make himself understood and to make clear what moved him to become the little boy from the fairy tale, whom not only the first encounter with a fairy showed the way from the arts to science, but who also had retained the eye of the child who did not see the emperor's new clothes. He knew from the experience of history that effective change came only through criticism from inside, and he signed it with his name. He equanimously consoled himself that he had "caused himself some damage, but not very much". He battled as a scientist against the dogma of the infallibility of scientists to which they were not entitled, not against the entity of science. "What is true is not tentatively true, until revoked". For this he received literary prizes (J. H. Merck Prize of the Darmstadt Akademie; Vienna Literature Prize) and was also honored elsewhere as remonstrator; by the like-minded. But it was no use. He changed nothing. Quite the opposite, he was denigrated as an old fool, a negator of progress, and an enemy of technology, at best derided as Narcissus of the world's end and as Tolstoyan character. He demonstrated the obstinacy of the doer and the helplessness of Cassandra, which he knew well. Now his window on the 13th Floor, 350 Central Park West, New York, is dark, the warning beacon against and for prejudiced and reckless chargers through creation, and we have lost someone who was worth listening to, to reflect upon—and now to mourn (Figure 3).

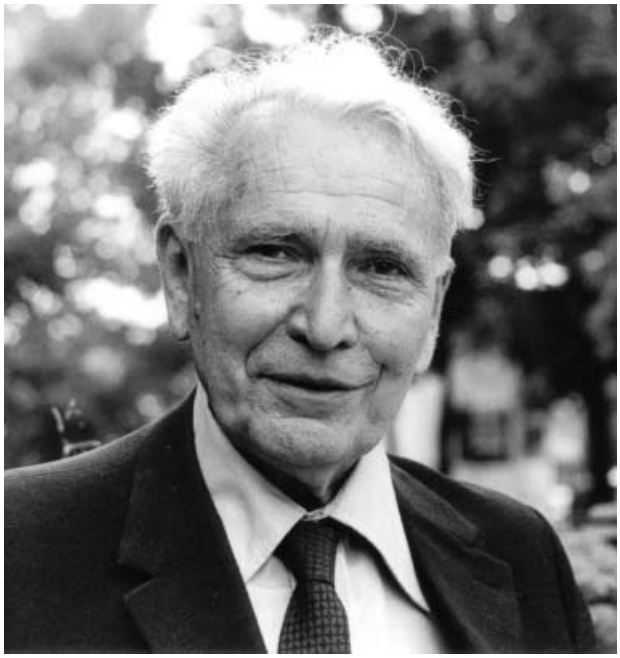

Figure 3. Chargaff a few years before his death. Copyright© Isolde Ohlbaum 2002.

[1] H. Eisenberg, *Comprehensive Biochemistry, Vol. 37*, Elsevier, Amsterdam **1990**, pp. 265 – 348.
[2] E. Chargaff, *Experientia* **1950**, *6*, 201 – 209.

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