Kaj Ulrik Linderstrom-Lang, Scientist, Man, Artist

If anybody ever blended the rational, the human, and the imaginative routes to understanding into a harmonious life, it was the late Kaj Linderstrøm-Lang. Seeing each of these aspects in the large, he had by nature gifts that enabled him to include them all in the picture, without the disposition, at the same time, to intrude himself into it. At a time when humanists and laymen, and even some natural scientists, began to doubt whether knowledge in the natural sciences was "worth the price"—they referred, of course, to the menace of the new, destructive nuclear forces—Linderstrøm-Lang said these simple and forceful words: "To thwart the development of knowledge in natural sciences on account of our destructive weapons would be as irrelevant as to blame Prometheus for bringing fire to Man when the straw mattress catches fire. Any human being who wants to create something new is a sort of a menace."

Lang's wisdom, courage, and imaginative power were great, and it would be difficult—and will not be attempted here—to give more than an impression of his broad personality in a general article.

Early Development

Linderstrøm-Lang was born in Frederiksberg, Copenhagen, in 1896, the son of C. F. Linderstrøm-Lang. His father was a teacher of Latin and Greek. His roots on both his father's and his mother's side went back to rural communities, and Lang's great skill in handicraft and mechanics may have stemmed from this background.

As a boy he was, like many boys, captivated by the satisfaction of making various chemical mixtures, especially those which were more or less explosive or "colorful" to the eye or nose. He liked to draw and paint. As a young man, while studying at the Polytechnical School for a degree in chemical engineering, he wrote poetry and dramas. One of the latter was a "triangle" drama in the style of Strindberg. The influential Danish essayist and critic Georg Brandes, to whom he sent a manuscript, sent along the following letter: "By habit I use to return manuscripts without taking a glance at them. Yours I have read. It has the one virtue that it isn't dull. Whether you have talent or not I will leave you to decide for yourself." Lang decided that, since he could not feel any overwhelming literary talent in himself, he had better not count on having any, and he continued his study for the degree. He took his degree in chemical engineering, or, as he later used to say, in "ceramic engineering," in 1919. He then got a job "by chance" as assistant in the division of S. P. L. Sørensen at the Carlsberg Laboratory. Lang jokingly said later that he believed he took the job because working hours would not be too long and he hoped to use the evenings for writing and painting. But Sørensen had no interest in art and literature. He had, on the other hand, a very definite and persistent interest in science and also the ability to make young people enthusiastic. When, in addition, Niels Bjerrum entered the picture and became Lang's other teacher, retreat was out of the question. Lang became profoundly absorbed in science. Yet there were periods still when nothing in the realm of chemistry could capture his interest. He had a habit of taking up hobbies of three months' duration. But Sørensen understood the art of waiting, and he knew what he was waiting for. Gradually Lang learned to concentrate on chemistry.

Lang's duties in those days were heavy. When people in the laboratory in later years complained about routine duties, he used to tell them with a big grin that he had, during the years under Sørensen, been made to perform as many as 10,000 Kjeldahl analyses.

In 1924, the 28-year-old chemist revealed to the scientific world that he was not only a hard-working and exact analytical chemist but a brilliant and profound physical chemist as well. In that year he published an article on the interpretation and treatment of ionization data of proteins. The theoretical approach was based on the most recent work by Debye and Hückel. The Debye-Hückel theory, only a year old, dealt with an exact formulation of the interaction between ions of low molecular weight. Lang introduced now, with supreme mastery, exact mathematical physics into the realm of protein chemistry. The extremely complicated interaction between the charged groups of polyelectrolytes was subjected to a theoretical analysis, and the influence of this interaction on the titration behavior of proteins was evaluated. His treatment of the ionization of polyvalent electrolytes is apparently still used today. It enables workers in the field of proteins to make important quantitative predictions. Indeed, the treatment by Lang was used as a starting point in Kirkwood's theory of the dissociation of ampholytes. The importance of Lang's treatment of ionization of polyelectrolytes for present-day research in biochemistry and biology has been emphasized especially by Edsall.

Lang's doctoral dissertation, which he completed in 1929, dealt with the fractionation and properties of casein and the changes brought about by the enzyme rennin. This interest in the properties of enzymes had already been awakened by a brief visit to the Willstätter laboratory in 1926.

From 1931 to 1932 Lang studied in the United States as a Rockefeller research fellow. He studied general biology with the late Thomas Hunt Morgan and chemistry and biochemistry with Linus Pauling and Henry Borsook. This visit to California meant much to Lang, both scientifically and from a personal point of view. In 1938 Sørensen retired and Linderstrøm-Lang was selected as his successor as the director of the chemical laboratory at Carlsberg.

The Linderstrøm-Lang-Holter Micromethods

From 1932 to 1935 Lang's endeavors were focused on a new and ambitious

project, the development of ultramicro methods of localizing enzymes among different types of cells in organs and even within single cells. In this plan he was undoubtedly greatly inspired by his close friend Heinz Holter, who had joined the laboratory. All the micro tools had to be "tailored" to the requirements of the project, and Lang and Holter used imaginative and very simple means. The Cartesian diver for the determination of ultramicro gas exchange was one of the best-known and most ingenious of these devices. This method, further refined by one of their pupils, Erik Zeuthen, enabled them to follow metabolic changes during the divisions of a fertilized amphibian egg. Another particularly noteworthy device was the specific gravity gradient tube (consisting of two mixtures of bromobenzene and kerosene) with the floating micro drop. This method permits the detection of minute (1×10^{-6} gm/ml) differences in the density of an aqueous solution as well as the detection of incredibly small amounts of proteolytic enzymes or other esterases. When a closely linear density gradient is established, drops are allowed to fall through the gradient. As is well known, the level at which the drops come to rest determines the density of the unknown solution. If the rate of fall is taken into account, one can even follow the catalytic action of esterases, such as peptidases, which produce minute density changes in the medium during catalysis. These changes are due to the hydrolysis of esters and acid anhydrides, around neutral *p*H, which liberates charged groups and thus brings about a packing of water molecules around the charged particles (a process known as electrostriction).

The methods which were used in the Carlsberg Laboratory rapidly spread to many other laboratories and made possible a great number of fundamental investigations, including determination of the location of enzymes in various cells or within a single cell.

Lowry's survey of nutrition in infants and children was based on these specialized and sensitive micro techniques. The Cartesian diver method furnished, as I have mentioned, new information about the development of cellular respiration in the dividing egg cell. All the methods are more or less novel in approach. They attracted the interest of innumerable scholars from all countries and will probably be admired for their simplicity of design by scientists in generations to come.

Molecular Dynamics of Proteins

In the late 1930's Lang returned to his main interest, the structure of proteins. His interest went beyond what he called the primary structure—that is, the amino acid sequence—although he always thought that this sequence governed the establishment and determined the type of a secondary structure. Lang's attention was focused on the interaction of the hydroxyl and sulfhydryl groups with neighboring groups in the same chain and with groups in other chains and, of course, with the α-helix. He furnished evidence for the breaking of hydrogen bonds in the globular proteins as the initial step in the enzymatic hydrolysis of peptide linkages.

Experiments with C. F. Jacobsen indicated that even in the conversion of chymotrypsinogen to chymotrypsin (especially to Jacobsen's highly active π chymotrypsin) a reversible denaturation process is involved. Moreover, in the splitting of α-lactoglobulin by trypsin a peculiar temperature effect was observed. By recording volume change (ΔV) versus mole peptide bond split, they observed that an initial process necessary for the opening of the protein molecule prior to the attack of the endopeptidase ("predenaturation") is relatively more rapid at 0° than at 30° or 40°C. With Jacobsen and Korsgaard-Christensen, Lang also studied the reversible denaturation of α-lactoglobulin brought about by urea. This process was followed by chemical and physical methods. The latter involved volume changes and optical rotation.

Lang described the reversible denaturation provisionally as an equilibrium between two states of the protein L_s, which is relatively stable, and L_l, which is unstable and denatures readily and reversibly. L_s predominates at higher temperatures; L_l, at lower temperatures. These notions, which originated as early as 1937–38 from his work with Hotchkiss and Johansen, probably played a significant role in the planning of his last experiments, on deuterium exchange.

It seems natural to mention Lang's last contribution at this point because there was so close a connection between it and his work on protein denaturation and changes of secondary structure, a field Lang in his latest years referred to as "molecular dynamics." I am referring to his bold ideas and his subsequently successfully established techniques in connection with the two types of peptide-bonded hydrogen in proteins—the free, and those more or less engaged in hydrogen bonding. The latter, he thought, although bound to nitrogen, might not exchange instantaneously with water. Hence, it should be possible to distinguish between those parts of a protein which are permanently or frequently in a hydrogen-bonded phase and those which possess only a primary structure. This idea had become particularly meaningful after Sanger's complete amino acid analysis of insulin and the subsequent extensive analysis of ribonuclease by American workers. Harrington and Schellman, during their stay in Lang's department, had concentrated on the stability of peptide hydrogen bonds in aqueous solution, using native and oxidized ribonuclease as models. These studies heightened the importance of the deuterium studies. Moreover, they provided an independent technique complementary to that of hydrogen exchange.

The design of the deuterium-exchange studies was not easy since it required many small samples of deuterium-loaded protein (deuterium being exchanged for the hydrogens bound to nitrogen, oxygen, and sulfur) as well as rapid handling and highly sensitive methods. Lang felt that his ultramicro deuterium technique with the specific gravity gradient tube was the answer. The outcome of this important work is well known. He showed that in most cases the establishment of the α-helix as a permanent structure (or another type of secondary structure) requires the cooperation of the so-called tertiary structure. Lang would have been the first to mention that the success of the various physical methods used in this project was due to the contributions of a large group, including visitors from many foreign countries. Yet he himself spent days and nights on the tricky work required to get the technique on an exact and reproducible basis. In insulin and ribonuclease, the deuterium technique illustrated particularly well that of the two classes of peptide hydrogen, one group exchanges instantaneously with water and the second exchanges at varying velocities, but relatively slowly. The A chain of insulin or the "unsupported" ribonuclease (resulting from peroxidation of S—S bonds) are devoid of a permanent α-helix or any other permanent secondary structure, and all of the peptide hydrogen exchanges instantaneously with water. A most elegant study of one of the syn-

thetic polypeptides prepared by Katchalski's group, poly-DL-alanine, adds further knowledge about the nature of "motility" of proteins, as Lang called the rate of exchange of peptide hydrogen. He did not hide the paradox that polyalanine without any obvious tertiary structure (seemingly like oxidized ribonuclease or the A chain of insulin) exchanges a part of its peptide hydrogen relatively slowly. He assumed that a special "intrinsic" stabilizing factor is at work here—namely, that of hydrophobic bonds between methyl groups of D- and L-alanine residues, which are presumably distributed at random. The average distance between neighboring D and L hydrophobic groups in a polymer of this type would correspond to that of liquid methane. The random distribution of D- and L-alanine was shown by Lang from the behavior of the polymer toward leucylamino peptidase or carboxypeptidase, the action of which stops whenever a D-alanyl residue is encountered; that is, only one-half to one peptide bond per mole is opened.

An interesting study of the rate of exchange of peptide hydrogen in crystalline myoglobin followed. It was shown that in addition to the slowly exchanging hydrogen there was a small part which did not exchange, even at *p*H 7. This fraction could be induced to exchange in a weakly alkaline reaction; a *p*H of 8.5 would suffice to bring about an exchange. The possibility that this group represents histidine residues involved in the coordination of the hemin group was discussed.

So much for Lang's introduction of "molecular dynamics" and "motility" as important disciplines into the biochemistry of polymers. These are already classical pioneer studies. The student is referred to Linderstrøm-Lang and Schellman's most recent discussion of these problems in the new edition of *The Enzymes*. Here Lang gives the general essence of the problems in a concentrated and powerful form. The reader will find comparatively little reference to and discussion of Lang's earlier denaturation studies in this article. It bored him to repeat himself or to "lobby" for his own work. He wanted renewal, fresh ideas, and relentless sober evaluation. A number of our important problems in molecular biology (including biochemical genetics) are summed up in this paragraph from the review: "The important point is that the ordering forces of the peptide hydrogen bonds appear to be slightly over-compensated by the entropy of unfolding so that the final decision rests on the side-chain interactions which depend themselves on the nature and sequence of the amino acids present. Since sequences are in general quite aperiodic these forces will be favorable in one part of the molecule, unfavorable in another, so that the protein molecule will often consist of a number of regions of varying structures and stability. . . ."

Discovery of Subtilisin; Study of Catalytic Centers

I have yet to review two other lines of development initiated by Lang. The discovery of the enzyme subtilisin and its many fascinating activities was, according to Lang, facilitated by a tradition at Carlsberg stemming back to Sørensen, and that was, never to throw anything away. A half-year-old sample of ovalbumin which did not smell too bad because it was covered by kerosene was worked up by Martin Ottesen, who obtained some "queer crystals"—rather large plates. Ovalbumin crystallizes in needles. Lang and Ottesen decided that the "strange" observation was worth some time and labor. They soon found that the conversion of ovalbumin to "plakalbumin," as they called the novel protein, was due to an enzyme from *Bacillus subtilis*. Subtilisin, as it was called, was found to catalyze the liberation of a peptide from ovalbumin through a process much like chymotrypsinogen activation. The protein moity had an electrophoretic mobility different from that of ovalbumin (Perlmann). The amino acid sequence of the peptide was studied. For this purpose a technique somewhat different from Sanger's was used—the formation of dithiocarbamate between added carbon disulfide and the terminal amino group. This interaction liberates hydrogen ions. By continuous addition of base to keep the *p*H constant, the process can be followed quantitatively. This prompted the idea of constructing the *p*H stat, which is now used widely all over the world.

From the plakalbumin-subtilisin interlude came other important work, such as a study of the nature of the catalytic centers of proteins. There is, for example, the enzymatic splitting of ribonuclease (Richards and Anfinsen). Certain subtilisin preparations act in such a fashion as to split a polypeptide segment from ribonuclease. Subsequent mixing of the two separated, inactive components can restore enzymatic activity (Richards).

Biosynthesis of Proteins

Finally, I must mention an area to which Lang made important contributions as a theoretical biochemist, and that is the problem of the mechanism of biosynthesis of proteins. Lang was equally interested in the Bergmann-Fruton-Hanes approach of transpeptidation and the Lipmann-Chantrenne approach of coupled reactions. Concerning the transpeptidation, he pointed out that it is misleading to give any kind of "standard value" for the free energy of hydrolysis of a peptide bond. The ionization constants (at a constant *p*H around neutrality) are highly important, and these constants are again strikingly influenced by the presence of polyelectrolytes (see Lang's work of 1924). In the most favorable case, the uniting of two long peptide chains, the ΔF of the hydrolysis is as low as -1160 calories (a dipeptide has a ΔF of hydrolysis of -4100 calories). In the coupled reactions, the discovery of acylphosphate, and especially Lipmann's acetylphosphate, were guiding events for some of the planning on experimental studies on peptide biosynthesis at Carlsberg. Chantrenne, who worked at the Carlsberg Laboratory in 1947 and 1948, developed several elegant model reactions, the importance of which Lang emphasized strongly. Chantrenne's work is the first demonstration of the importance of disubstituted acyl compounds in the synthesis of peptide linkages. Lang mentions also in his Lane Medical Lectures (page 106) that Chantrenne drew attention to the possible importance of nucleic acid in the transfer of acyl groups to amino groups because of their rich content of singly and doubly esterified phosphate groups. This was pointed out as early as 1948 in Chantrenne's article in the Carlsberg publication. Lang may have taken pleasure in the later discoveries of adenylamino acid and ribonucleic amino acid complexes by Hoagland, Zamecnik, and Berg. Hoagland was a former Carlsberg pupil. The field of coupled metabolic reactions was relatively unfamiliar to Lang, but he admired the development here very much. He reminded the metabolically minded biochemist that a major factor

in the large ΔF of hydrolysis of acid anhydrides is the release of protons and the establishment of a large concentration gradient with respect to protons; we live, after all, in a very dilute "atmosphere" of protons.

Beer, Rockets, and Other Fireworks

During his 21 years of directorship at Carlsberg, Lang's laboratory was visited by an immense number of brilliant scholars, young and old, of every nationality. He played also a great role in the careers of young Danish scholars in the natural sciences and in the field of medicine.

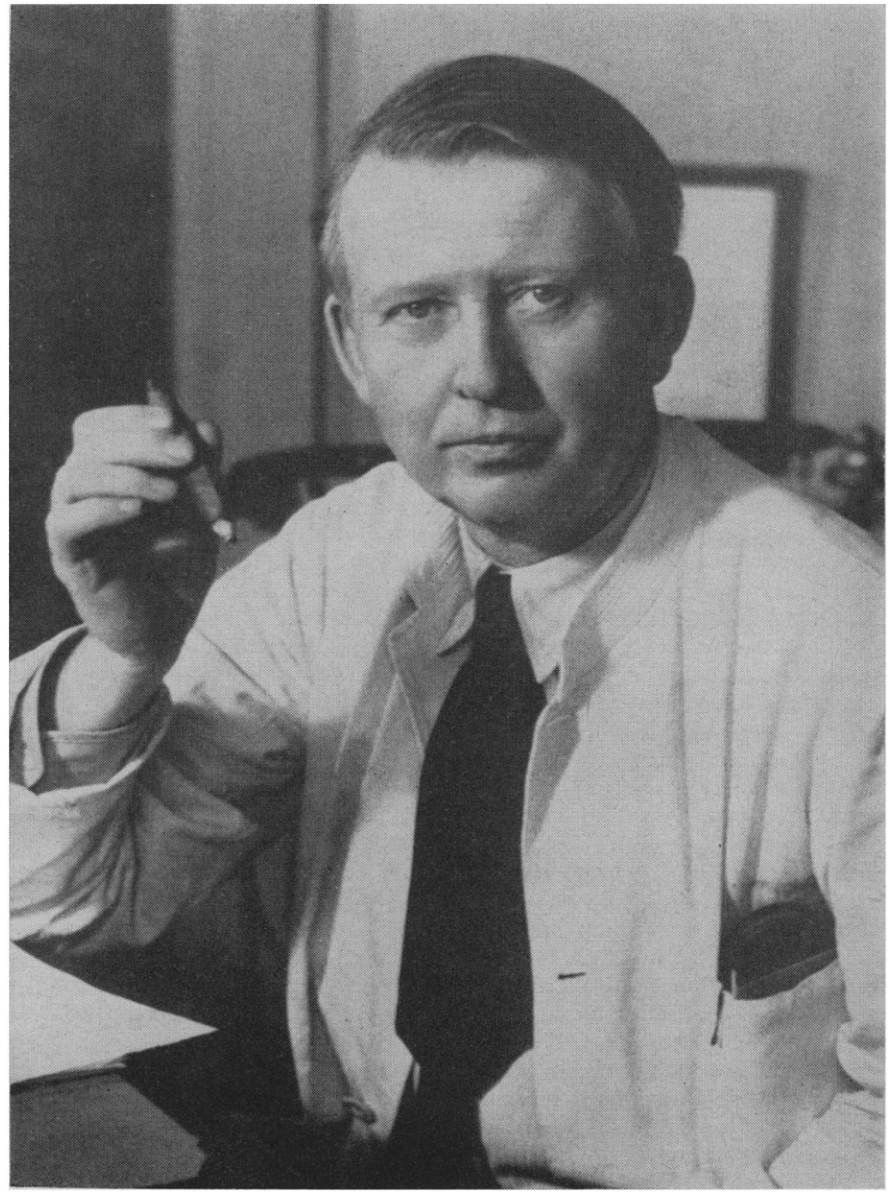
Although Lang lived in the villa attached to the institute, he always joined in the daily lunch in the laboratory. The common American myth that there were special pipelines from the Carlsberg breweries to the Carlsberg laboratories need not be discussed here. The fact was that the members had access to many interesting kinds of beer, including the powerful Easter brew, and the Stout porter, besides, of course, the popular daily pilsner "Hof." Lang was not bothered in any way by a bottle of strong brew, even in the middle of the day. He and Holter used to wrap the tin foil of the cap around Danish "Tordenskjold" matches, which were then allowed to ignite on the launching site, the top of an empty bottle of "Hof." The "Carlsberg rocket," which emitted a vigorous sulfhydryl scent, traveled well beyond the boundaries of the lunchroom. Among the topics of conversation at these daily symposia were science, literature, politics, puns, and good stories. Of the latter, Lang had a huge arsenal; his stories possessed not only wit but a humor characterized by warmth and freshness. His delightful rendition of a grotesque poem about the feeling of thirst for beer, which he translated into English himself, "When the beerhound howls," will be long remembered.

Lang was certainly a complex and many-sided person. He showed amazingly little interest in building up his own reputation, hence people learned to appreciate his power and greatness rather slowly. As one of my friends, referring to Lang's modesty, expressed it: "It is possible that some people saw him as less great than he was, simply because he was so aware of the enormity of the things outside of himself."

Scholar and Statesman

Lang was elected a member of the Royal Danish Academy in 1935. Later, innumerable other high academic honors were bestowed upon him (*1*). He was an active member of many important commissions for the promotion of science and technology in Denmark and of international commissions on science and education. Lang was chairman and later president of the Danish Academy for Technical Science. He never forgot that he was an engineer by training and constantly took an interest in the basic education of young Danish engineers. A source of constant inspiration for him was the work of I. C. Jacobsen, the founder of the Carlsberg breweries and of the Carlsberg Foundation, who was not only an ingenious brewer, but also a devoted public servant. Lang felt that Jacobsen's idea and work for the support of basic sciences through the Royal Danish Academy had produced one of the earliest examples of a wisely organized scientific council. It was only natural that Lang later should become an influential member of the Danish State Scientific Council. He emphasized on many occasions his particular debt and gratitude to the Rockefeller Foundation.

Lang had a unique ability to com-



Kaj Ulrik Linderstrøm-Lang

municate with people of all professions, and he was very much the wise statesman, not the least in international scientific and educational affairs. He possessed leadership, supreme ability to make just evaluations, and idealism. He was one of the founders of the International Union of Biochemistry and was elected president of the union in 1958. Great initiative and hard work were required to establish this union, and Lang carried one of the main burdens.

His assignment as guest professor and lecturer at the Rockefeller Institute in New York in 1957 meant much to him, for it provided contacts with American students and a chance to meet distinguished scholars. Lang was also a popular participant in the Gordon Research Conferences in Proteins. The most recent of these meetings was dedicated to his memory. His stay at Stanford University as Lane lecturer will also be recalled.

Linderstrøm-Lang was never a pessimist, not even when it came to the question of mankind's survival in an atomic age. However, he was far from being a light-hearted optimist in this matter. He felt a rationalistic approach is necessary in any case, but he also felt that a much more revolutionary and fundamental human approach must be found before man can hope for a great future. He greatly favored extending friendship toward scholars from behind the Iron Curtain. But he insisted that this should be true friendship and that these scholars should not be treated with an unnatural reverence. They should have an opportunity to see the many unplanned and funny happenings as well as the serious sides of life in another country. Many of them are persons who are deeply interested and fully able to absorb such impressions. Lang established friendships with several Russian scholars in the field of physics, chemistry, and biochemistry and valued these contacts highly.

He was, as I have mentioned, scheduled to serve as president of the International Congress of Biochemistry in Moscow in 1961 and looked forward to this event very much. Lang, Maaløe, and Westergaard had arranged an international symposium on genes and the specificity of proteins, to be held in September 1959; Lang was to have been general chairman. When I visited him in early May he was, in spite of severe suffering, occupied with plans for this meeting.

Linderstrøm-Lang was, in the deepest sense of the word, a philosopher, seemingly rationalistic if one did not know him, but essentially a supreme humanist and artist. It is true that the scientific way of evaluating life was basic to his nature. His description of Sørensen's reaction to a spiritualist meeting is a classic. "As a matter of fact, to talk reason ought to be natural for a scientist. Not because scientists are more reasonable by birth than other people, but because science is reasonable, science is rational. I really think that it should have a mission here. In order to show what I mean, permit me to tell a story about my most beloved and admired teacher and predecessor at Carlsberg, S. P. L. Sørensen. Sometime in his middle-age he took part in a spiritualistic session. Where and why has escaped my memory. But there he sat at a table together with a group of others—quite distinguished people, so he told me, and most of them disbelievers like himself. In the course of the evening the circle succeeded in producing several uncanny raps while a weird and ghostly atmosphere pervaded the room. One of the participants left the table and was set to guard a purse which contained an unknown sum of money. The spirits were then supposed to tell the magnitude of the sum—only the number of crowns, I think, because after all the means of communication, the table-legs, were imperfect. The table rapped 9 times, and sure enough there were 9 crowns in the purse, neither more nor less. The light was dim, the bookshelves creaked, the wind whined in the chimney, and the people present were more or less prepared beforehand through eery stories of ghosts in other sitting rooms. I was therefore inclined to believe Sørensen, when he told me that everybody got pale around the gills and wanted to go home to bed after this first encounter with the transcendental. But Sørensen said the divine words: 'Now we do this 10 times,' and actually forced the participants to repeat the experiment again and again. The result was entirely negative—which of course may have been luck in the opposite direction. But that is not the point of the story. Its moral, as I see it, is the victory of scientific reasoning and method over emotional evaluation. In everyday life we are all too frequently satisfied with our own judgement based upon entirely insufficient observations and coloured by our personal fancies. In a wider connection it is the appeal to rationalism and even to tolerance which I find so stimulating in Sørensen's story."

To refer to Lang's words about Prometheus, there is no doubt that he considered science thoroughly healthy for the human mind. And how he pursued it for at least 40 years! Perhaps he loved mathematical physics more than anything else. Statistical mechanics and quantum mechanics were in many ways the *basso continuo* in his thinking (see his little humoresque about the "Statistical mechanics of houseflies"). Bohr's words about complementary and holistic features of elementary particles were notions Lang frequently emphasized in his wonderfully written short essays about science and society. He agreed with Bohr that predictions about individuals are made meaningless by the inevitable interaction with the investigator, quite apart from considerations of the essence of the individualistic features. Lang believed that the future of society as a whole might, however, be described on a statistical basis, although he said that he did not envy the social scientists when it came to deriving laws of society from history and social experiments. English and American history interested him greatly, especially the periods of Jefferson and Lincoln, during which ideas, lofty as well as realistic, developed. As an individual he genuinely understood the ancient and lasting truth that we are both spectators and actors in the great drama of life. He reminded us that a renunciation of laborious scientific self-discipline leads easily to cheap mysticism, intolerance, and race prejudice, and that that is the road to hatred, cynicism, and destruction.

Linderstrøm-Lang was a man of strength, warmth, and profound imagination but not of illusions. During the hectic 1930's he felt intensely that soon he would be called upon as an actor in the great drama. He joined the young men of the Danish resistance movement during the Nazi occupation of Denmark. From the beginning he was a dedicated fighter against Nazism, which he felt to be one of the major scourges of mankind. In 1943 he was taken from his home to a prison of the occupation force and kept there for several weeks. When he had occasion to refer to these events later, he did so good-humoredly. But the fate of children and of peaceful people destined to be eliminated, and of the upright Danish people, young and old, who paid

with their lives in this fight, made a lasting impression on him. He admired the rebellion of the individual on behalf of "life" more than anything else, and his admiration was far from passive. That is why it warmed his heart to see a number of American scholars stand up on behalf of their Constitution during the spell of political neurosis in America five or six years ago. During this period Lang used to tell his many American friends that, along with the Four Freedoms, there is one very precious freedom that America must not lose, and that is a young man's freedom to make a "goddam fool of himself." He had a special liking for young men and women who were not afraid or ashamed of groping in their search for understanding. No wonder that he won the undying admiration of his students. Lang did not have any illusions, either, about the nature of the suppression of thinking in Communist states. Every instance of enforcement of "ideological biology," he felt, was a threat to the future.

Lang was in many ways a poet; his language was sensitive, subtle, and deeply humorous. It could express rebellion, but it could also, and more often did, express sublime ideas, and it always had warmth. He was as fluent in English as in Danish, and his love for British and American slang added warmth and color to his lectures delivered in Great Britain and the United States. He and his wife Gerda radiated unlimited generosity and hospitality. Lang had the "gift of feast." Their friends will long remember the songs and speeches at the colorful dinner parties in their beautiful home. He particularly loved humor in art. Among the songs he could be persuaded to perform were Danish folksongs, Bellmann's songs, drinking songs, and romantic songs. Above all else he loved the music of Mozart and Schubert, and as a violinist, he was an enthusiastic and spirited performer of chamber music; especially with his friend Thomas Rosenberg, whose fine musicianship he admired so much. Lang was a painter of special talent, being influenced by modern Danish painters and by Cezanne. His home contained many fine works of his own creation, and he was generous in giving away his fine paintings.

Spirit, generosity, and courage are qualities that will always be associated with the Lang family. Never were they worried about security for themselves. Lang possessed in full measure the spontaneity to help those who needed comfort and encouragement. He had no fear of opening his heart and sharing other people's sorrows and tragedies, although this surely added burdens to his own life. This combination of wisdom and compassion was unique. How many of us can expect to know a person of his stature in our life-time?

We who knew him will always remember his poetical and at the same time boyish face, with the warm smile and the deep blue eyes. His photograph catches something of his expression—a great light from a depth of laborious and unlimited human experience and understanding. His death is an immense loss to a large international community of scholars and students.

HERMAN M. KALCKAR
McCollum-Pratt Institute and
Department of Biology,
Johns Hopkins University

Note

1. Linderstrøm-Lang was a member of the Royal Danish Academy of Arts and Sciences; a foreign member of the National Academy of Sciences (U.S.), the American Philosophical Society, the Royal Society (London), the Academy of Sciences of the U.S.S.R., and the Karolinska Institute (Stockholm); and a council member of the Institut International de Chimie Solvay. He received honorary degrees from the Universities of Copenhagen, Oslo, Ghent, and Brussels; New York University; Cambridge University; and the Polytechnic School of Copenhagen.

Science in the News

Student Loyalty Oaths: Chances Nil for Outright Repeal; Compromise Possible

The attempt to repeal the affidavit requirement of the federal student loan program should reach a climax in the Senate very soon, perhaps next week. This is the affidavit which requires students, in order to be eligible for a loan, to swear they do not believe in, support, or belong to a subversive organization. The students are also required to take a loyalty oath ("to support and defend the Constitution"), but it is the affidavit requirement that has led nearly 30 colleges to withdraw from the program and many more to issue formal protests.

A year ago a bill to repeal both the oath and affidavit requirements was brought up in the Senate. During the debate its sponsors, Senators Kennedy and Clark, reluctantly accepted amendments reinstating the oath and attaching a penalty for taking it under false pretenses. Senator Mundt had offered a substitute measure which also did away with the affidavit but which made it a crime for members of subversive organizations to accept loans. Kennedy and Clark refused to go along with this. They gambled on passing their bill without further compromise and lost by the fairly close vote of 49 to 43.

This year Kennedy and Clark will bring up a bill similar to the amended version of last year's, eliminating the affidavit but including a penalty for falsely taking the oath. They say they are optimistic about its chances of passage in the Senate, but a good many people find it hard to locate the source of this optimism. For the bill failed last year, and although supporters say that the colleges have recently been more active in applying pressure to Congress, it is always more difficult to pass this sort of law in an election year.

Outlook in the Senate

At this writing the feeling on Capitol Hill seems to be this: Kennedy and Clark will make a fight for their bill, but they will end by going along with an amendment by either Senator Mundt or Senator Prouty making it a crime for a member or supporter of an organization he knows to be subversive to ac-