A Self Shaped and Reshaped

The Statue Within. An Autobiography. FRANÇOIS JACOB. Basic Books, New York, 1988. vi, 321 pp. $22.95. Translated from the French edition (Paris, 1987) by Franklin Philip. Alfred P. Sloan Foundation Series.

"Scientific autobiography is a most awkward genre," Erwin Chargaff once noted in these pages. Most autobiographies of scientists, he said, give "the impression of having been written for the remainder tables of bookstores, reaching them almost before they are published" because scientists "lead monotonous and uneventful lives . . . and besides, often do not know how to write" (*Science*, 29 March 1968).

Chargaff made his observation in reviewing an exception to this rule, *The Double Helix*. And in fact, far from hitting the remainder tables, James Watson's account of his and Francis Crick's discovery of the structure of DNA has been reprinted at regular intervals in the past 20 years and was reissued (under my editorship, I must confess) in the Norton Critical Editions series, which also includes Machiavelli's *Prince* and More's *Utopia*.

Nonetheless, there is no gainsaying Chargaff's assessment of the generally low literary merit of the genre. Lacking the novelist's skills for conveying what it is like to lead such monotonous and uneventful lives as those of Raskolnikov or Emma Bovary, scientist-autobiographers are unlikely to engage the interest of an audience wider than their relatives, friends, and disciplinary colleagues. Watson did have the talent to make his readers feel what it was like to have been Honest Jim in the Cambridge of the early 1950s. His eminently readable story helped to dispel the widely held view of science as an activity carried out by selfless, disembodied (and therefore terminally boring) spirits moving inexorably towards an objectively true knowledge of nature.

Now another founding father of molecular biology has written an exceptional autobiography. Published in France in early 1987, *La Statue Intérieure* by François Jacob became an instant best seller; it now appears in English as *The Statue Within*. In the 1950s, Jacob elucidated the genetic status of proviruses and (in collaboration with Elie Wollman) worked out the mechanism of bacterial conjugation. Most important (in collaboration with Jacques Monod), he devised the operon theory of the regulation of gene expression. Jacob's seminal scientific contributions, like Watson's, were recognized by the award of the Nobel Prize, which he shared in 1965 with Jacques Monod and their *patron*, André Lwoff.

Jacob's literary talents are as unusual for a scientist as Watson's, but of a different order. He made his debut as a writer on subjects beyond the confines of molecular biology in 1970 with *La Logique du Vivant* (English translation, *The Logic of Life*, 1976), a scholarly, historico-philosophical account of pre-Mendelian studies on heredity, which stood in stark contrast to books of another awkward genre, namely the amateurish philosophizing essays produced by successful scientists nearing the end of the productive phase of their careers. Although *The Logic of Life* was not a best seller, it brought Jacob esteem from historians and philosophers of science. In the very same year, there also appeared Monod's *La Nécessité et le Hasard* (English translation, *Chance and Necessity*, 1972), epitomized by its author as an "essay on the natural philosophy of modern biology." Monod's book *was* a best seller, but its ultrareductionist stance recast doubt on the philosophical competence of molecular biologists.

In 1982 Jacob produced another surprise for his colleagues by once again transcending the borders of molecular and cell biology with three lectures on the theory of evolution, collectively entitled *The Possible and the Actual*, in which he examined the status and content of evolutionary theory "in order to define the limits beyond which evolution is used no longer as a scientific theory but as a myth." *The Possible and the Actual* established Jacob among evolutionists as a serious contributor to the clarification of the epistemological infrastructure of their discipline.

Jacob has now revealed an even less-suspected gift in the category of belles lettres with this beautifully written autobiography. Unlike *The Double Helix*, *The Statue Within* is not even wholly in the genre of scientific autobiography. The essential attribute of the protagonist of Watson's story is that he is a scientist. From the protagonist's experiences the reader gains an insider's view of how science is done. But the protagonist of Jacob's story, although it, too, ends with a scientific discovery of the first magnitude, is only accidentally a scientist; he could just as well have taken up some other line of work. Jacob's main purpose is not to show how scientists work or how he managed to make this or that contribution. Rather, his intent is to tell how he became the person that he did become: "I carry within, a kind of inner statue, a statue sculpted since childhood, that gives my life a continuity and is the most intimate part of me, the hardest kernel of my character. I have been shaping this statue all my life. I have constantly retouched, polished, refined it." There is no trace of exhibitionism or psychologizing in this open and honest account of his fears and doubts, his many failures and few triumphs.

Jacob's quasi-cubist treatment of time is ingenious. What might first appear as random diachronic jumping among events that occurred at disparate times turns out to provide a temporally multidimensional synchronic view of these events. For instance, chapter 3 ends on 21 June 1940, with Jacob the medical student standing on deck of the Polish S.S. *Batory*, having narrowly escaped from the German occupation of France, wondering, as the shore of Brittany sinks below the horizon, when, if ever, he will see the coast of France again. Chapter 4 starts with Jacob standing on deck as the coast of France *rises above* the horizon. Has the *Batory* turned around? No, it is now 1 August 1944. He is on board a landing craft returning to fight the Germans, as a medical officer in Le Clerc's 2nd Armored Division. What has happened to Jacob meanwhile? Patience! All will be told, but not until Jacob has described how, a week after landing in Normandy, he lies near death, hit by a German fragmentation bomb while giving aid to a mortally wounded comrade. Although the reader can presume that Jacob survived, the story of his convalescence does not resume until 60 pages later, at the beginning of chapter 5, after we have learned how Jacob, having debarked from the *Batory* in England, joined de Gaulle's Free French Forces and was shipped to sub-Saharan Africa, whence he marched with Le Clerc's ragtag band of anti-Vichy soldiers from the Chad, through Libya and Tunisia, to Algeria and Morocco, fighting the Italians and the Afrika Korps along the way, in a campaign that, he says, reminded him of the cops and robbers games of his youth.

Immobilized, staring at the ceiling for weeks on end in a succession of military hospitals, Jacob reviews his past life, wonders what he ought to do if he ever gets out. His father and other relatives and friends who survived the war come to visit him; so does his first love, whom he still loves, but

only to tell him that she plans to marry another man. Jacob skillfully uses this truly "monotonous and uneventful" period of his life to recount various past events. Finally discharged from the hospital and the Army, still partially crippled and with metal splinters in his body, he is lonely, unable to make up his mind about the future. He tries journalism, filmmaking, work in a penicillin production facility. He decides to complete his medical studies, to which he is admitted despite his lack of the necessary formal qualifications, thanks to his military record.

By the time he receives his medical degree in 1947, Jacob realizes that practicing medicine is not for him either. He meets a young geneticist with wartime experiences similar to his, who is studying mutations in yeast in the laboratory of Boris Ephrussi. Jacob is amazed to learn that such vanguard scientific work can be done by people who do not seem to be any cleverer than he. So why not become a research biologist? After several unsuccessful attempts to be accepted by laboratory *patrons*, including André Lwoff at the Institut Pasteur, he is finally taken on by Lwoff. The year is 1949. Jacob has never been able to figure out why Lwoff caved in—maybe he happened to be in a good mood that day because he had just discovered prophage induction. "Had I been he, I would surely not have accepted into my laboratory a chap like myself."

Jacob has been saved. The remodeling of his inner statue from the dispirited, floundering war veteran into the world-famous molecular biologist begins. It proceeds slowly at first, with Jacob wondering how he will ever penetrate that mysterious universe of science, its folklore, its language. (When I met Jacob in the following year, I still thought I knew more than he did and patronized him with advice about his research projects.)

The final third of *The Statue Within* does bear some resemblance to scientific autobiography, describing the ambience of what we called "Lwoff's attic" at the Institut Pasteur, its permanent and transient occupants and the problems that exercised them during the perinatal stage of molecular biology. These descriptions are mainly brief sketches lacking a didactic purpose. They are not meant to provide a deep understanding of Jacob's classic experiments that led to our present understanding of the regulation of gene expression. (The predicate "classic" is mine. An untutored reader could infer from Jacob's modest narrative merely that he and other folks in the attic found some of his results and theories exciting, but not their extraordinary significance for biology.) He does not show the inner statues of the other scientists through encounters and associations with whom he is resculpting his statue. Except for Lwoff (whom Jacob could never bring himself to address in any way other than "Monsieur") and Monod, who now take over the dominant roles previously played by parents and relatives in the remodeling of the statue, Jacob's colleagues are merely limned with a few incisive phrases. For instance, a seminar presented in the attic by the "short, stocky . . . featherweight boxer" Sol Spiegelman is described in terms of a *corrida*, with Spiegelman as *toro*, the "imperturbable" Lwoff as *presidente*, the "elegant" Monod as *matador*, and with Roger Stanier (the Canadian "debonair giant"), Melvin Cohn (the "uninhibited young American"), and Martin Pollock (the Englishman with the "handsome, insolently aristocratic" face) as *banderilleros*, while the crowd of *aficionados* of enzyme induction shouts "*olé*!" at each pass.

By 1954, Jacob has been granted a D.Sc. by the Sorbonne, on the basis of a thesis presenting his fundamental discoveries about the genetic nature of proviruses. But he still feels that he has jumped on a moving train without a ticket. He sees only one way to avoid getting caught by the conductor: "Charge, head lowered. Attack on all fronts." So he begins his collaboration with Elie Wollman. Within three years, they have discovered that the bacterial genome is circular and that it is transferred in a linear order from donor to recipient cell in bacterial conjugation. With Wollman gone to Berkeley (for a stay in my laboratory), Jacob joins forces with Monod to apply his recently acquired insights into the mechanism of bacterial conjugation to the problem of enzyme induction with which Monod has struggled for the past decade. With the visiting American Arthur Pardee ("baby face, timid eyes behind glasses hiding the remarkable experimenter") they carry out the PAJAMA (Pardee-Jacob-Monod) experiment, which leads to the concept of the repressor as the regulator of gene expression. Jacob realizes while sitting in a movie theater some months later that the site of regulatory action of the repressor must be a particular stretch of DNA, the "interruptor," later to be designated "operator." Thus the operon theory of the regulation of gene expression is born. Monod is not enthusiastic about this idea at first but, eventually warming to it, proposes some critical tests. That day in 1958, Jacob says, "marked a turning point in my scientific life": at last he has a ticket to show the train's conductor. He and Monod design and carry out experiments that validate the repressor-operator interaction concept.

Jacob travels to Pasadena with Sydney Brenner ("squarish head, his eyes blue beneath blond brows, enormous, hirsute, shaggy . . . a Frans Hals [portrait] . . . behind his slightly sarcastic, even satanic visage, his smile revealed a child's face") to collaborate with him to try to validate experimentally the notion of a metabolically unstable messenger RNA guiding protein synthesis. The idea of the messenger RNA emerged some months earlier as a necessary adjunct of the operon theory, in discussions with Brenner and Crick in Cambridge. Matthew Meselson's laboratory at Caltech seemed to be the best place to demonstrate its existence. After several weeks of unsuccessful experiments, Brenner suddenly discovers the source of their troubles. In a final, simple experiment, done in extremis just before leaving California, they achieve their goal: messenger RNA does exist. Back in Paris, Jacob and Monod put the final touches on their historic paper "Genetic regulatory mechanisms in the synthesis of proteins" and mail it off to the *Journal of Molecular Biology* on Christmas Eve 1960.

As Jacob is walking home in the snow through the Luxembourg Gardens, he recalls the inner statue of little François. He is thinking of his childhood Christmas holidays in Dijon, of the park where he used to play alone, frightening himself by populating it with robbers, savages, and wild beasts. As he is leaving the Luxembourg Gardens, he suddenly thinks of an experiment he could do on the mechanisms of cell division. A very simple experiment in fact. It would suffice to. . . .

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Levels of Representation

Consciousness and the Computational Mind. RAY JACKENDOFF. MIT Press, Cambridge, MA, 1987. xvi, 356 pp., illus. $27.50. Explorations in Cognitive Science, vol. 3. A Bradford Book.

In the early years of this century, a group of German psychologists at Würzburg claimed that thinking is not always accompanied by imagery, whereas another group of psychologists led by Edward Titchener at Cornell argued to the contrary. This clash between two opposing introspective philosophies—Kantian and Humean, respectively—became known as the "imageless thought" controversy. It was interminable and irresolvable, and its principal result was behaviorism. The study of consciousness