RUTGERS, THE STATE UNIVERSITY OF NEW JERSEY

NEW BRUNSWICK

AN INTERVIEW WITH H. BOYD WOODRUFF

FOR THE

RUTGERS ORAL HISTORY ARCHIVES

WORLD WAR II * KOREAN WAR * VIETNAM WAR * COLD WAR

INTERVIEW CONDUCTED BY

SHAUN ILLINGWORTH
and
NICHOLAS MOLNAR

WATCHUNG, NEW JERSEY
AUGUST 18, 2004

TRANSCRIPT BY

DOMINGO DUARTE

Shaun Illingworth: This begins an interview with Dr. H. Boyd Woodruff on August 18, 2004, in Watchung, New Jersey, with Shaun Illingworth and …

Nicholas Molnar: … Nicholas Molnar.

SI: Dr. Woodruff, thank you very much for having us here today and for sitting down for the interview.

H. Boyd Woodruff: Okay, fine.

SI: To begin, could you tell us a little bit about your father? Can you tell us his name and where he was from, when he was born?

HBW: Well, my father was Harold E. Woodruff and he came from southern New Jersey, Hopewell Township, just outside Bridgeton, New Jersey. He came from a farm family. The family had been there since the early 1700s, farming various farms in this general area. He spent all of his life in agriculture, except [for] about five years when we lived in Buffalo, New York. During the Depression, things got pretty tight and, in order to earn some money during the winter, we moved to Buffalo, where he worked in a restaurant; actually, the portion of the restaurant that dealt with fresh seafood. … After the end of the year, he decided he was making money, so, we stayed on for about five years. … I guess his love for agriculture, finally, brought him to the stage that we went back again to Southern Jersey and he obtained a farm in the area where my granddad was still farming. So, he was a true agriculturist, mostly vegetable crops, asparagus, especially, and tomatoes with corn, to feed the animals that were there for service purposes, one cow, two horses. So, I really came from a farm background.

SI: What was it like growing up on a farm, where, even without the Great Depression and its influence, your life is based on the cycle of the crops?

HBW: You know, because of the Depression, especially in [the] New York City area, many people were suffering. On the farm, we had all we needed to eat, so, there was no question about that. There was little money, obviously, but at least food was there. … My dad eventually reached a stage where he had to do sharecrop farming and we moved from one sharecrop to another sharecrop farm, still staying in the general Hopewell Township area. He was very active in both the town and the school system, was on the school board, served twenty years or more. … He was on the Town Committee also for ten or fifteen years, so that he was very active in the community and lack of money didn't really cause any serious limitation. You could really have a lot of fun as a young kid without much money. … With the Grange and various … church affairs and socials and the like, we lived a very happy life.

SI: What was the 4-H like in those days?

HBW: 4-H, I was active in that. The main activity, really, was related to showing various things in the county fair. It was held in September and we were always selecting things to go there. Eventually, Dad would allow me to have an acre to raise whatever I wanted to raise. I did various things, but, mainly, I had some chickens and, through the chickens, I really got to know

the county agent, the county agricultural agent, very, very well, because he taught me how to vaccinate the chickens for diseases as well as other things. So, really, the reason I came to Rutgers was the county agricultural agent. He couldn't see me going anyplace else. He made sure that a lot of things happened that really brought me to Rutgers. … I knew I wanted to go to college, but thought I would go someplace in Philadelphia, because we could commute there by train, an hour's trip by train, but Mr. Ramaley, [the county agricultural agent], would have none of that. [laughter] He wanted me to go to Rutgers and I, of course, was really quite fascinated by the various things he taught me that I could do, the vaccinations and things of that sort. So, it was a good background for a good life, yes.

SI: Before we proceed to your college career, could you tell us about your mother and her family background?

HBW: Well, … her family name was Smith and she came from a family that lived in town. Her father had a part-time farm, fifteen, twenty acres that he farmed, but his main activity was serving as a butcher. … He'd served as a butcher in town for some period of time and he and my grandmother lived there until they died, in the same home, in Bridgeton. … Dad's father had homesteaded in the State of Washington during the period that he would have been going to high school. So, he had no high school education, because, where they were homesteading, there was no high school within a hundred miles, but, when he did return back home, he attended a short course at Rutgers and enjoyed that experience really very, very much. Mother did not go to college. She took a job, a secretarial job, after she graduated from high school.

SI: Did she work after you were born? Did she stop working when she got married?

HBW: … Yes, but, actually, moving to a farm home involves work. She hadn't been in a farm home in town, but moving to one, many responsibilities fall on a farmer's wife. During that period, my granddad had a dairy farm, as well as a regular farm, and Dad helped with that for some period of time. So, Mother got involved with a lot of things, like cheese making, with the excess milk. I don't think she worked at all after they were married, in terms of gainful employment. She just joined into the farm responsibilities.

SI: When you are working on a farm, there is a lot of work for every member of the family.

HBW: Yes.

SI: Southern New Jersey, at that point, it sounds like, was almost entirely agricultural.

HBW: It certainly wasn't like North Jersey. I had never been to New York City until I came to Rutgers, for example. … Our flow was to Philadelphia or to Baltimore. … That's the way the railroad trains went. There's no direct train line from Bridgeton to New York. You had to go to Camden, a ferry to Philadelphia, then, change, and so, that became our main city. Everybody down there, of course, sort of joked about the fact [that] we're below the Mason-Dixon Line, which we, in fact, were, and they also … point out, which I had never realized before, that back in the days when Lincoln was President, … a state could divide their votes. So, southern New

Jersey voted not for Lincoln; northern Jersey voted for Lincoln. So, they always joked about our area being a little bit of the South, but, in any case, it was an isolated area.

It was an agricultural area and the main manufacturing was glass, using the sand in that area. The agriculture was very important, because it was close to the city, so that, in those days, of course, you couldn't ship farm crops around the way we do now, and so, it was very, very important to have your asparagus [to market] early, maybe the first two weeks of the season, or three weeks [of] the season. You made almost all your money then, because that's when the prices were high and you could get it into the market immediately. The soil is relatively sandy in South Jersey, so [that] crops matured maybe a week or two before they could in northern New Jersey. So, it was an isolated area to be sure, but, on the other hand, a significant area, particularly for the Philadelphia-Baltimore complex, as a source of food.

SI: Can you talk a little bit about your early education, your elementary school and high school years?

HBW: Yes. I started school in Buffalo, during that five-year period we were there, and went through third grade there, and then, my mother simply could not take the Buffalo winters. She'd get sick every winter and, of course, in those days, you didn't have antibiotics or anything to treat infections. The doctor finally told my dad, "Look, you've got to move out of this country or you're not going to have her much longer." So, we set out to go to the southern part of Virginia to live. When we got to the southern part of Virginia, it was still Depression days, so, we had a tent to live in on the way down. We nearly froze to death in Virginia. [laughter] … It wasn't the middle of the winter, but it was approaching winter and it was very, very cold, and we'd never really done travels of this sort before. We had piles of blankets to put on top of us on our cots, but we didn't think of putting something underneath us. It was cold from the bottom coming up. [laughter] So, we kept on going, ended up in Florida, and we stayed down in Florida for one winter. I was in fourth grade there. Then, we came back to South Jersey and I went to the local school.

At that time, [in] Hopewell Township, all their schools but one were two-room schools, which covered the whole eight grades, but, in Buffalo and in Florida, they had two school years. They either started in September or they started in January, and I was in the January group, so that you would change grades in January. Well, they didn't have that in New Jersey. So, I either had to skip … a half year or go back a half year. One of the schools was in Shiloh, which is a … Seventh Day Baptist center, in South Jersey, and they did have an eight-room school, so, they allowed me to go to this eight-room school. I had to walk a couple of miles in order to catch a bus there, but [it was] designed to help me make up the half year I was going to miss. Then, finally, Dad was elected to the school board and became very active in it. They decided to build an eight-room school for the town and give up their two-room schools. So, my last two years, … in seventh grade and eighth grade, … I was in the new Hopewell Township School. Then, students from Hopewell Township went to Bridgeton High School. About forty percent of the students in Bridgeton High School came from the city and the others were from outlying areas, a far-ranging distance, actually all the way down to Port Norris, twenty miles away, and our area was maybe about ten miles away. So, my four years of high school were in Bridgeton High School.

SI: In interviewing other people who went to a one-room or two-room schoolhouse, I have been told that it often advances your education, because you hear what other grades are doing. Did you have that experience?

HBW: Well, … coming from a sending school, you got to know people from a wide variety of areas, yes. I mean, the people down in the Port Norris area were all involved with fishing and this is where, at that time, a tremendous amount of clams and oysters would be obtained from the Delaware Bay. So, you got to know those people very well. Seabrook Farms was an enormous conglomerate in Deerfield. It produced Birds Eye frozen foods. Students came from there. My aunt worked at Seabrook Farms and was treasurer there. In fact, it became very important for us, as students, when we entered Rutgers, because we students cooked our own food and she was able to get dented cans. They were unlabeled, but they were vegetables. So, we never knew what we were going to eat at night for a vegetable. We'd open an unlabeled can, [laughter] whatever it was, we ate it that night. … In any case, at Bridgeton High School, you did get to know people from a wide range of areas, just because of the sending district situation.

SI: What do you remember about growing up in Buffalo, and in the South?

HBW: Well, of course, Buffalo, cold weather, [laughter] really cold weather, lots and lots and lots of snow, and what I enjoyed so much [was] the fact it's only about twenty, thirty miles away from Niagara Falls. So, we used to drive there often. The Falls is really a beautiful place, especially in the winter, but, whenever visitors would come, of course, we'd take them out to see Niagara Falls. … What I enjoyed probably more than anything else [was] the factory that made Shredded Wheat, which was located in Niagara Falls. So, I always made sure we took the Shredded Wheat tour, because, when you ended [the tour], they gave you free Shredded Wheat to eat with supplements. [laughter] So, I had a good time there, but, you know, I was a … young kid, only through third grade. … I still know where the school is in Buffalo. … About the only thing I can remember about the school itself was the two or three times I got into trouble for running on the benches or doing things of that sort. … I remember, we always marched in. You'd have to be outside the school up to a certain time, then, everybody would march in to *The Parade of the Wooden Soldiers*, [*The March of the Wooden Soldiers*]. So, whenever I hear *The Parade of the Wooden Soldiers*, I think of us, as kids, marching into the school. …

It was an enjoyable period and we made the most of … living there, because, of course, in a new area, we were always going around seeing new things. … There's a park outside of Buffalo where there are remains of embedded leaves and small animals from many, many years in the past, so, we'd go out there and hunt around to see what traces of the past we could find. Both Buffalo and Florida were interesting places to grow up. … I must say, in the upper grades of grade school, we really had some excellent teachers. In seventh and eighth grade, only seventeen students were in my classroom, but the teachers were very, very good. They believed in an approach of teaching yourself and they would set up projects with two or three people working on the project. … When we were studying South America, we had the assignment of doing a report on the economic background of South America and how the people make money and things of this sort. … Maybe it's because the classroom size was small, I don't know, but they

really did a fine job of education. You know, it's not just book learning … and work learning, and that was fine.

High school teachers varied. … Biology was taught by the football coach and it had a bad reputation. The first year students were allowed to make a choice between general biology or agricultural biology. … I took agricultural biology. The teacher was Mr. Bowen. He would have us doing all kinds of experiments. … One time, he had a local farmer allow each student to be assigned to an individual tree. So, we had to prune these trees in the spring, but, then, the farmer kept a record throughout the year of how many apples came from each tree. So, in the end, we were all judged, basically, on the farmer's record. …

That freshman year teacher really got me interested in science, … in investigative science. … Then, the teacher that really convinced me to major in chemistry was my high school teacher, and very much for the same reason. She allowed us to do a lot of individual experimentation during the laboratory period, which was really quite fascinating. So, throughout my school system [experience], it's not only a case of having contact with varied people in Florida and in Buffalo and a farm community and those in town, but the teachers were truly exceptional teachers.

SI: Was there a vocational agricultural course in the high school?

HBW: … Yes, there was a vocational agriculture program. I didn't take it, other than the first year. When you came in, you either had the choice of agricultural biology or general biology and I took agricultural biology, mainly, I guess, on hearsay [laughter] that the teacher was good. … Beyond that, I simply took what … they used to call in those days a standard scientific course. That prepared you for the university. You had a choice of either a scientific course or the classical course. In one, you took Latin, the other one, you took French. That was the main difference. [laughter] …

SI: Were your parents encouraging you to do this?

HBW: They encouraged me very much, as far as education is concerned. … Even though, as I mentioned, Dad had never attended high school, he was involved in the local education system, very, very actively, for many, many years. … So, they certainly did encourage me. Admittedly, I enjoyed it, so that I guess I made it easy for them. In other words, some kids get so involved in sports and things of this sort that parents have a hard time convincing them to do their academic work, but I always found academic work easy, [not] being a challenge, and I could get it done and over with easily. … Beyond that, I'd spend whatever free time I had reading. I just loved to read. My dad finally found the best way … to get me to do work on the farm was that we'd have a row, for example, of carrots. If I would weed a row of carrots, I could read a chapter of the book at the end. That worked well. [laughter] I'd do this weeding as fast as I could, to get to the end of the row, so [that] I could read one more chapter.

So, I always loved reading and, in fact, got into trouble a lot of times with it, because, back in those days, we didn't have any electricity, yet, in our area. … Electricity only came there when I was … in high school. … We had just standard lamps, kerosene lamps, and then, there's a

gasoline-type lamp that we had, too, but I'd get [to] reading and one of these lamps would start smoking. The parents would be out and they'd come back and there would be a dirty spot on the ceiling, because the lamp had smoked, and I'd been reading, so, didn't know what was going on. [laughter] So, I guess the fact that I read a lot really helped more than anything else.

SI: From your high school, did many of the students go on to college? Was it normal?

HBW: Well, a fair number went to college, but I think only two went to Rutgers, even though it was a big high school. It's just [that] North Jersey was not the place to go. I mean, it was mostly farm country and … students would go to the University of Maryland … or Penn State, both very popular, but I really don't know what percentage went to college. It would be normal for that period of time, whatever that might be. … There were enough families from the town, and from the glass companies, who had appreciable money that would permit their kids to go to college. So, it wasn't what you would call a blue-collar school. It was sort of a wide-ranging school, … but whether it was fifteen percent or twenty percent or twenty-five percent, I couldn't say at this moment. It was just normal, from a good high school.

SI: When you were living in the South, were you aware of segregation?

HBW: I wasn't aware of segregation there; I really think I was more aware of it in Bridgeton. We had one black farm worker who was permanent, who was there year-round, and he was treated perfectly as a normal, equal individual. In other words, there was no segregation situation there. In eighth grade, of the seventeen of us there, I think there were only two or three black [students] among those. Again, the high school had many more, because [there were] a lot of black workers, general workers, mostly individuals that would work all summer and have nothing to do all winter, but they still were able to get enough money to remain in town over the winter. Supplementing that, we had many migrant black workers that would come in for the summer only.

They were actually not migrant in the way you usually think of them. They were actually imported by the government. The Department of Agriculture would bring in hundreds of workers, usually from Puerto Rico, and they would put them up in camps that were in the Glassboro area, and you had your choice; you could either go in each morning and get a certain number of workers … to work on your farm or you had the option of giving them housing yourself and having a set number come and work with you all summer. You had to guarantee you would keep them all summer. … This is one of the reasons my dad had tomatoes and asparagus. Asparagus starts early, somewhere around March, and he would normally get, … oh, five to ten workers that would come down, start, and then, by the time the asparagus stops in July, tomatoes are starting. So, that would carry them through the year.

We had an old farmhouse on the property and it … was very old. The stairways had been put together with pegs, rather than nails, but it was a two-story one, had about six rooms, and the people would stay there. Dad had a terrible time about it. He didn't speak any Spanish, these people that came in spoke no English, and what the government did was have a roving man in a car with a radio system that went around. If you got in trouble, you would call and he would come and straighten things out. He spoke Spanish. Well, Dad had a difficult time, the first year

he had these people, … it was obvious something was wrong, but he couldn't find out [what]. So, he finally got the government representative there and he said, "Well, these people have never lived in a two-story house before and believe there are ghosts upstairs," and they were all so concerned about ghosts. … He said, "I don't know what you can do about it, but this is [their] culture." Well, Dad went downtown to the hardware store. He got the biggest lock that you could find and he locked all the doors that went upstairs and, from that point [on], there was no trouble at all. I mean, you would think that, as a ghost, they could still be able to get through, but the workers no longer worried. … The point, [why] I'm saying all this is, that group, which was a migrant group, in a sense, was not treated as equivalents. So, there was discrimination, but I don't think it's particularly the South-based discrimination, but it was more on [the basis of], as a separate group, their culture is entirely different from ours. …

I never ran into any particular obvious discrimination in the school system, other than an economic discrimination, and I wasn't aware of it at all in Florida, during the period I was there, but we were in Miami Beach. At the time, Dad was working in one of the hotel systems there, … so that there were black people around, but I just didn't have any feeling. … So, I don't think I could say that I was truthfully aware of discrimination, other than articles read in the newspaper. I never really ran into those problems. Obviously, jumping ahead, when I was at Merck, there was strong pressure to find PhD black people to join the organization. So, I did spend a lot of my time recruiting and going around, trying to find people that we could bring into the organization, so that you could not get charges of discrimination, but, personally, I really never ran into what I'd call serious discrimination.

SI: Was this program of bringing in the migrant workers a New Deal program?

HBW: … Well, it could have been, of course, because it was during the New Deal period, … but I don't know the origin of it, other than that it was a United States Department of Agriculture financed and organized thing. There was a certain time they flew everybody in and a certain time, in the fall, they flew everybody back. … Well, in fact, even the ones that came in who couldn't speak English, the representative made arrangements with Dad that he would give them probably about ten percent of their salary to live on, mostly to pay for rice, … and the rest would be sent home to the family. This was all arranged, so that the family would get it, and a couple of the fellows who did speak some English said, "The main objective of working in the States is, we always feel, if we have worked three years, we can move the family to New York." They'd get enough money that they could come to the US, but, unfortunately, to New York, and we always wondered what they would run into there.

I know we visited Puerto Rico and I expected it to be just terrible, on the basis of the background of these individuals and their desire to get away, to get out, and I found it such a wonderful place. You'd drive around in a car and everything is beautiful and, at least in these days, more recent days, people seemed to be employed, but, maybe, back in the days when it was not long after the Depression, it was pretty serious there, I don't know.

SI: Were you aware of the New Deal, particularly the WPA [Works Progress Administration], CCC [Civilian Conservation Corps] or the AAA [Agriculture Adjustment Act]?

HBW: Yes, aware of it. It's a stage, when you become older, you … become aware of politics. My family was always Republican, strong Republicans, and they … tended to be critical of many of the New Deal things that we take for granted now [laughter] and are glad exist. … As I think many people did in those days, you voted your party, you didn't vote for any specific aspect of the individuals, and so, during the New Deal period, the people that were there, … in our community, which was primarily a Republican community, everybody was opposed to it, but, on the other hand, you know your life has changed. There's no question about that. There's no question, in my mind, that Eleanor Roosevelt was one of the most important people of the age, so that things have changed. … I was clearly aware of the New Deal, but I think more in a critical sense than in a favorable sense, due to my family's interest.

NM: You mentioned that you traveled to the South. How did you get there, by train, by car, from Buffalo to Florida?

HBW: … We traveled from Bridgeton to Philadelphia by train, and that's the main reason that Philadelphia was our big city, why we didn't go to New York. There was no direct route from Bridgeton to New York at that time, still isn't, but, … going back and forth to Buffalo, we occasionally would take the train. We would come back once or twice during the year, but, usually, … we would drive down. My dad would drive us down for a vacation, and then, he would go back by train for [work]. We'd stay in South Jersey for maybe a couple of months. Then, we would drive back. … But, mostly, that was ordinary driving.

We did travel some, in the sense that my dad would always observe a holiday, for example, Fourth of July or Labor Day, and we'd get in the car and drive about as far as we could, there and back, in a day, so, maybe going to Washington, DC, or going out to West Virginia or things of this sort. We did a lot of that, because Dad would do the driving. Very often, my aunt who worked at Seabrook Farms would ask Mr. Seabrook for one of his big cars, which took eight or ten passengers. … The four of us, I had one sister, and, usually, [our] grandparents, we would all pile in this one car and my dad would drive us all around. So, that was our big, preferred holiday trip, always, to get one of those cars and go someplace. We all loved to travel. So, it wasn't that we were always home on the farm. We became well educated by moving about, seeing things.

SI: You mentioned that the county agent had a big impact on your going to Rutgers.

HBW: Yes.

SI: Do you know to what extent the Extension Service had an impact on your area?

HBW: Yes. Oh, it was very important, no question about that. My dad, right from the very beginning, used the first Rutgers tomatoes that came along, and the Extension Service played a very important part in the agricultural community, of getting new things and new ideas. Eventually, asparagus died out in southern New Jersey, because a disease came in that really killed it off, and the Extension Service was very active in getting peach culture introduced, … so, South Jersey became similar to Georgia, as a peach center of the USA. That was a county agent type of introduction. … For tomatoes, of course, there were one, two, three, I think four major can houses for tomatoes in Bridgeton, and then, Campbell's, was up in Camden, not that far

away. So, tomato culture was extremely important, and getting new tomato lines and the best method of fertilization were important objectives.

It was a very, very close relationship and a significant one; the same thing from the women's side. The women agents were really very active in teaching people how to can this, [how to] can that. We always had a couple of pigs, so that [we were] making sausage and all the various things that are involved with that, scrapple and the like. They would help, and particularly [with] preservation of foodstuffs. The sausage would always [be] put in big cans, … covered with lard, and we'd use that sausage all winter long. You'd keep it up in the attic of the house and it was there, the same way with hams. They'd all be smoked and held through the winter. So, the women's group was very important. My sister actually became a county agent. She went to NJC-Rutgers, also, and became the county agent for Salem County for awhile, and then, she moved up to New Brunswick and was in the headquarters office there, … up until she was married. …

It is not as important now, of course, because agriculture is not as important in the State of New Jersey, but it still is active. They're having a 4-H fair out in Somerset County this next week and the county agent was very active there. They're giving [him] some sort of a posthumous award. He died last year, but they're giving an award to him … for thirty years of service as the county agent in Somerset County. So, it is still an important function, although certainly not to the same degree that it was back when agriculture was important.

SI: You also mentioned that the church was the center of activity for you.

HBW: Church was the center of activity, … both from the religious side, but, also, the cultural standpoint. For example, we had an orchestra that would play during Sunday school for all the songs. So, we would be practicing often. Out of that, then, developed another orchestra group or a band group … for non-religious things, but it was the same people. In other words, the fact that you started doing it in a Sunday school [band] moved on to doing it more freely. So, we'd play for dances and things of this sort. … They always would have a variety of socials, the strawberry socials, festivals and others. We always had two or three treasure hunts during the year, so, it became one of the main social centers. I think the only other thing [that] was comparable was Grange; the Grange Agricultural Society did the same thing. They would have monthly meetings, but, then, there'll be various socials. So, between the Grange and the church, they were the main social centers for activity.

SI: I know that, in the 1930s, there were efforts to bring Jewish refugees from Europe to New Jersey and settle them on farms. Were you aware of that?

HBW: Yes. I was aware of it, because the groups were down near Cape May Courthouse. There were two or three centers there and we were aware of it, because it was not that far away from where we lived. … The hardware store and two or three of the stores in Bridgeton that we dealt with very actively, as farmers, agriculture people, were owned by Jewish people, so that there was a small number of Jewish people in the community, although not a large number, … but we certainly were aware of the new arrivals.

The main foreign element in our area was Italians, and they were centered mostly in Vineland. … Vineland was part of Cumberland County … and a lot of the farm workers were of Italian background. So, if you're going to ask, "Who were the foreigners in the area?" you'd say the Italians, but you would never particularly think of Jewish people as separate, and, of course, they were not necessarily farmers, many of them, anyway, but you would not think of them as that group. You thought of them more as the group that were running the stores that you were dealing with and, as far as I know, … we always had very friendly relationships. They were very trusting, from a viewpoint of financial matters. If you happened to be in one of the stores and you didn't have enough money with you, you could bring it back tomorrow. It was okay. [laughter] They were really a very active part of the community.

I learned a lot more about the communities later on, when I came to Rutgers. Of course, the dean at that time, Dean [Jacob G.] Lipman, had come from one of those communities, and Selman Waksman, under whom I did my graduate program, although he hadn't gone there, he'd come into the Metuchen area and worked in agriculture … when he had first came to the USA. Since then, I've written two or three biographies of him, describing his background. So, [I] learned a lot more about the Jewish communities than I knew before, but I did know they existed, yes.

SI: Can you tell us about the process of getting into Rutgers and getting a scholarship?

HBW: … When it became time to really seriously think about what you wanted to do with your life, which was probably junior year in high school, they started to press us a little bit about just which way we wanted to go. I had a hard time trying to make up my mind, initially, even to the stage of going to the library to locate two or three suggestions of what I might do and why I might do it. Well, I didn't know what I wanted to do and I looked into architecture, based on my library surveys. I'd [have] been the worst architect in the world. I'm glad I didn't go into it, [laughter] but, in any case, it was a worrisome period during the junior year. During the senior year, it was more settled, because, that year, I took chemistry and, right from the very beginning, I was enjoying it immensely, and so, I said, "Okay, I want to be a chemist," and … didn't change my mind from that point on.

So, as the year went on, I began to look into what possibilities existed and the most likely thing, it seemed to me, was Drexel Institute in Philadelphia, which had an engineering [track]. I guess, maybe, because I came from an applied background, a farm background, I was interested in applied aspects, rather than theoretical aspects. So, I figured, "Well, an engineering place is the place to go." So, I'd visited there a couple of times. … Mr. Ramaley kept talking to me about going to Rutgers and majoring in agricultural chemistry. So, he finally took me up to Rutgers, to go around, see what was there and, while we were there, we went in to see Prof [Frank G.] Helyar, who was the Director of Resident Instruction at that time. He was a very friendly, very active person. … I had the third highest grade in high school when I graduated. So, I had a good record, academic record, and he, right away, said, "Well, no question, we can find a fellowship or scholarship for you to cover your tuition." Of course, back in those days, what was it? I can't remember now, 180 dollars a year, something like that, [laughter] but, in any case, [Professor Helyar said], "We'll cover your tuition," and then, I believe we went back a second time. The second time, he said, "Well, look, you know, we have some unused poultry houses. Using them, that'll take care of your living expenses, too."

So, these two things were fine and, on that basis, I just about decided that I would go to Rutgers Ag School and started to try to figure out how to get the money together to cover the books and the dormitory. … It was another agriculturalist, Dr. App, the man in charge of the scientific aspect of agriculture at Seabrook Farms, who was very friendly with people at Rutgers. He went up there one time and, when he came back, said, "Well, I've convinced Prof Helyar to give you a free room on the campus." There were about forty students living on the campus at that time, and so, I said, "Well, I can't go to college free anyplace else." [laughter] So, there was no question; this is the place I was going to go. So, I signed up for it.

When I got there, it turned out that … a problem had been caused, because all the free rooms had been filled when I arrived on the scene. … There were two students in most rooms. They stated they would add a third bed in one of the rooms. They put me in as a freshman in a relatively small room and [on] the third bed. Actually, they put a triple deck bed there and I had the top deck, but the other two were seniors. Well, they immediately objected to taking a freshman into their group. So, I was moved into another, rather large room with two other freshmen, both of whom actually had come from South Jersey. I didn't know them personally, but they came from within fifteen, twenty miles of my home. They were … graduates of Salem High School. … It worked out very, very fine. … So, this really is the history of how I got there, but I really got there mainly because other people made it possible for me to do so. … It was a very good experience. …

Freshman year was really fine. The three of us got along very well together and one was planning to become a veterinarian, so, he was going through the pre-vet course, and the other wanted to major in poultry science. … We were actually in the Poultry Office Building. We had [to do chores in] the poultry houses, as well as feed the chickens we had all brought, and so, we'd go down, every morning, to the farm. The walking trip down to the poultry farm was a long, long way, if you went by [the] normal route, because you had to go around, then, down and back again. … They had a large fence that surrounded the farm area and the fence had barbed wire at the top, one of these things that had four rows of barbed wire on top, but we finally learned how to climb over that fence, so that, in the morning, we would go down, climb over the fence, and we'd arrive at the poultry farm very quickly, take care of duties, then, come back, the same way. …

Initially, in freshman year, we'd walk downtown to the main campus for the classes. All were held downtown. I think the only one that wasn't was a lab in agriculture that Prof Helyar ran. It took us a half-hour, then, we'd walked back in the evening and cook our own meals in our room. …

[TAPE PAUSED]

SI: Please, continue.

HBW: Well, the freshman year, it was really very fascinating for me, because I went from a situation where, in high school, I had only one class that was tremendously interesting, chemistry, because of the way the teacher taught it, to the point [where] I now had five classes

and all of them were taught the same way. I mean, it was just wonderful. In botany, they had us out identifying trees. Chemistry was the largest class, about fifty in the chemistry class, lecture hall, but, still, again, because I enjoyed the subject, [it] was very good. …

The English class we had was initially a class where they went through grammar, for about three or four weeks, and then, you had to take a test and, on the basis of that, you either proceeded to literature or you had to spend the whole year on grammar. I was able to go to literature, and we got into *Beowulf* and other fascinating things. [laughter] So, that first year of college was just a real eye-opener for me. They had a visiting lecture program with excellent speakers, held in the gym, and a visiting symphony orchestra program, … all things I'd never had contact with before. It was truly a wonderful experience to come up to Rutgers. …

SI: Was there a freshman hazing period or orientation?

HBW: The only hazing period that we had was [when] freshmen had to wear the dink, the freshman hat, and anything beyond [that], I can't remember what it was. You had to greet upperclassmen with some special words, or in some special way, but that was the extent of it, and not enough that we really had any [problems]. … I wasn't in a fraternity, where that type of thing might happen. We basically had the equivalent of a fraternity. There were eleven of us in the Poultry Building and forty of us living out at the farm, so, it was practically a fraternity, without being a full fraternity, but I don't ever remember being inhibited in any way because of a hazing situation. We didn't object to doing the things they told us to do, to wear this hat. We did it. We did what we were instructed to do, but, beyond that, there was no problem.

SI: That is one of the Rutgers traditions that faded away after World War II. Do you remember any other Rutgers traditions that they instilled in you?

HBW: Not really. There were certainly traditions in sports, the basketball games and things of this sort, so that you have your shouts, your calls, … that type of thing, but there were traditions involved in that sense. … After the football game, you always sang the *alma mater* and the general things which are part of the college experience, but I don't particularly remember beyond that. It was amazing the volunteer things they did. One of the physics professor's wives taught a course in social graces. … When, I say, "Taught a course;" an evening, one evening a week, for maybe ten weeks or so, we would get together. So, we did that. We did, a lot of things of this sort, which in a small school, you can do. I can't imagine that type of thing going on at Rutgers nowadays. [laughter] …

Then, later on, in fact, I guess in senior year, the dean of the college, named [Frazer] Metzger, organized a program for people that might be interested in getting married, and this included things all the way from the sexual aspects, which were taught by the … zoology professor, to religious aspects, which Metzger himself handled, and social aspects. … Again, it was an interesting kind of experience that was available in a reasonably, relatively small school, which I think students now would think is beyond their expectations to attend such affairs. Not all, maybe twenty-five percent of us, went to these things, but they were opportunities that the University offered.

SI: Was there a lot of interaction between yourself and the administrators, like Metzger, Helyar and Clothier?

HBW: Certainly, with Helyar, there was a lot of interaction, and with Metzger, I guess, because I attended some of these things that he arranged. It was a fairly close feeling, that he knew my name. … At that time, chapel was compulsory fifty percent of the time. You could be excused for religious reasons, if you're Jewish or something of this sort. Otherwise, you were expected to attend half of the chapels, but they got the best speakers, really top-notch people, … people that were really well-known. So, again, I always said that the chapel services I went to were as good as some of the courses we attended, just because of the nature of the individuals that they scheduled. I really can't say a bad word about the Rutgers experience. It was just so beyond anything that I really would have expected.

SI: Do you remember some of the guest speakers that came in or what they talked about?

HBW: No, just don't ask me their names. I can't even remember the names of half a dozen people anymore, but these were people whose names were in the newspaper, well-known people were there. We used to have a problem, every now and then, with the WJZ transmission. [WJZ] was the main radio station, it was located in Bound Brook at that time, and the chapel system, for some reason or other, occasionally, would pick up WJZ. So, somebody'd be talking and, suddenly, you would hear music coming from WJZ. [laughter] … I guess it was too broad [of] a band that they were taking in.

SI: I guess your favorite classes were chemistry classes, or what were they?

HBW: Yes, but I can't fully say that. … I truthfully enjoyed many of the biology courses more than others, simply because … they're subject to experimentation. … Chemistry, as it has to be taught, I think, on the undergraduate level, is an established thing. … You have to learn the formulas, they have to arrange the structures, you have to learn how things interact together. It's not trial and error, but much of biology, at that time, at least, had not been defined, so that a lot of it was trial and error. The genetics courses, for example, were tremendously interesting. … We grew fruit flies on our radiator up in our room, doing experiments with fruit flies and things of that sort, and most of the biology courses were that general way. The worst course I took, you wouldn't believe it, considering what I am, but the worst course I took in all of Rutgers was a beginning bacteriology course, and that was pure memory, not a thing of experimentation in it, at all. … It was the way things were taught, obviously, that was the significant factor. …

In general, the biology courses were probably the more interesting courses that I took, although I still, I think, looked upon chemistry as being the final subject for my employment. … The best course I took in college was soil microbiology, and it was just a difference in the teacher and the way he taught it. … Soil microbiology was taught by Selman Waksman. Luckily, for me, it happened to be a year that the man who normally taught the course was away on sabbatical, so, Waksman himself taught it, but what he accomplished was that he showed me that biology is basically chemistry, I mean, that what happens in biology happens because of chemical reactions that go on in the body. …

I think [he] was the first person who really convinced me that you could meld together biology and chemistry, and I still remember the very first lecture that Waksman gave. Of course, there were only five of us, probably, in the class, but … he essentially went through what happens when sugar is given to a microorganism, how it's broken down. So, that's pure chemistry, a breakdown, but, then, he also showed the level of energy that you got from each of these steps of breakdown, and then, how much energy it takes to synthesize a protein. He really showed me … how one thing led to the other, and it was really fascinating. I know I came back and told my roommates that, "Hey, this is going to be the best course I have had in all of college," just, you know, on the first lecture. …

Even so, when I decided to go to graduate school, all of my letters had gone to chemistry departments, Middle-West, mostly, chemistry departments, because almost all the chemistry departments in the East are directed more towards medical school. I wanted the more applied areas, so, I wrote to a lot of Middle-West colleges, and had gotten back two or three proposals to come, when Waksman called me over and said, "Look, I've got a fellowship here at Rutgers. It'll be twenty-five percent higher in the amount of money you receive than anyplace else you can get anywhere; twenty-five percent higher than you can get anywhere else in Rutgers, too." He insisted that his graduate students would get a higher level than anybody else. It was always a big argument for him, but, in any case, [he said], "And so, that will be available. And it will be the type of thing that was taught in my undergraduate course, be very, very interesting for you," but I had decided I wanted to be a chemist. Now, I just couldn't bring myself to make that break, not become a chemist but become a biologist.

I went to see people … at the various areas of Rutgers, trying to make up my mind, and I went to see Dean Lipman, just before he died, and in fact he really answered it for me. He said, "Look," he said, "why don't you make your mind up on the individual you're going to work with? You take these various individuals you're going to work with, go back and get out a list of the papers that they have written. You read a few of the papers. You take the one whose papers you like best, who is doing the things that are interesting to you." Well, I did and it turns out Waksman had written … a book, with [W. C.] Davison, on enzymes and it was filled with chemistry. So, I finally decided to change to [be] a microbiologist, rather than be a chemist, but, in terms of interest, going back to your original question, I really think the biology courses were the ones that interested me more than chemistry, even though I had in mind that, "I'm going to be a chemist."

SI: Was that new, tying together biology and chemistry like that?

HBW: I think Waksman's course, which really occurred … toward the end of my college period, was what made it clear. By looking back on things, I think that's why I liked the biology courses. They were experimental courses, where ideas were presented, "But, we don't really know the answer," they said, "try to work a few laboratory experiments to see if we can get a step towards the answer." It was the fact that I could see, in biology, doing interesting things. In chemistry, I was learning many, many facts, but I still wasn't able to see how I could use those facts to accomplish advanced things. Now, had I become a chemist, I probably would have learned how to do it, because, certainly, there are unknowns in chemistry, too, but it's the nature of the beast, in a way, that chemistry has to be taught [this way], facts first and experiments after.

You have to get the background first and this takes a long time, to learn the background. Biology, it doesn't take so long to learn the background. You begin to do the experimentation earlier.

SI: As an undergraduate, what was your typical weekly schedule? Were there a lot of labs?

HBW: Yes, although I must give Prof Helyar credit. He insisted, at least when I talked to him, that I take enough cultural courses so that I'd be eligible for election to Phi Beta Kappa. He said, "There's no reason [why] you can't get into Phi Beta Kappa." He said, "Make sure you take enough cultural courses to do so." So, I did take the required number of cultural courses, history and the four years of English, just to make it possible to be considered that, but, mostly, I would have at least four courses in science. … As a senior, I was elected to Phi Beta Kappa

SI: You mentioned that you enjoyed this English course as a freshman. How did you like the humanities courses?

HBW: As I told you before, I enjoyed reading. I liked them, yes. If you asked the question, "Did you see anything in it that would lead to a lifework?" no, I wasn't interested in it from that viewpoint, but, from the viewpoint, "Are you interested in it as a topic?" yes, I enjoyed them. The only one, I guess, I could say I didn't enjoy too much was economics, and the reason for that, I think, was that I had the feeling that too little is known. It just seems that so much of it was guesswork, that I didn't, as an applied individual, appreciate it. … But, I think, of all the other cultural courses I took, I really enjoyed them, … not as a lifework course, but as something to enjoy.

SI: How did you see the Great Depression affecting Rutgers?

HBW: [The] Depression really didn't impact me. As I mentioned earlier, as far as the farm is concerned, certainly, my dad had problems, but you still had a life. You were on a farm, you had food. You could still get lots of enjoyment without spending a lot of money. In terms of my own situation, finances were no problem, because, I kept a record, I think I spent 450 dollars in four years of college, … that I didn't earn. In other words, I had all the earnings from the chickens and various jobs, but, in terms of money that I had to bring in, from the outside, 450 dollars gave me an education. … I'd serve as a waiter; I can't remember the name, the Catholic church that's right across from Old Queens.

SI: St. Peter's.

HBW: They really had big, big affairs there. They would have a lot of men's affairs especially and they'd ask Rutgers to provide student employees to serve the food. Well, I'd do that to earn some money, and so, we did a lot of odds and ends of that type. … I can't remember the name of the program that Roosevelt introduced, where students could work?

SI: The NYA?

HBW: NYA, [National Youth Administration], yes, and I had a variety of NYA jobs, some of them interesting. I mean, one of them, Prof [Clarence S.] Platt, in the Poultry Department, somehow or other, had come across a large number of newspapers from England that were [printed] in the 1700s and I had the job of reading these newspapers to try to find anything … about poultry that was in them. Well, I didn't go through them very fast, because I got so interested in reading everything else, but, you know, it was that type of an NYA job. One I disliked, I must admit, one of my secondary objectives, when I was a freshman, was that [I was] still a little bit uncertain about what I wanted to do, that maybe floriculture might be an interesting thing.

So, I purposely worked things around [so that] I could get a job to work in the greenhouses, in floriculture, greenhouses out at the Ag Farm, the first year, and I was assigned the job of picking off buds from carnation plants, so [that] only one bud is left. Well, those darn buds, … you'd pick them all off and, the next week, you'd go there, there'd be a lot more. [laughter] You had to pick them off again. … I did nothing for one term except pick off buds from carnation plants. That taught me, surely, I never wanted to be in floriculture, [laughter] but most of the NYA jobs were interesting. I mean, they were fine and you earned a little bit more money, but, essentially, money never created a problem for me and, therefore, I guess [the] Depression didn't mean that much to me.

SI: Between all of your jobs and your class work, did you have time for extracurricular activities?

HBW: Not really. My roommate became All-American in lacrosse and I did a lot of practicing with him, … but I was never a capable athlete to be involved in that. The only other extracurricular activities were things like the Ag Club where I was treasurer, officership in various things, and Alpha Zeta, … so that they [the activities] were … of that nature, not a sports nature.

SI: Did you go to the games and that sort of thing?

HBW: Oh, yes, I went to everything, yes, sure. I don't know what it is now, whether it's still free for students or not, but, then, it was completely free for students. … I certainly went to every football game that went on and probably every basketball game and a lot of boxing. I went to a lot of boxing matches, because one of my good friends was a heavyweight. … I went to the lacrosse games. … First year, I had no car there, but, then, during the end of the first year's summer, I was able to buy a Model A Ford for fifty-five dollars and I had that at college, … and so, it was easier, then, to drive downtown to do all these things. So, I did use that a lot. …

SI: You mentioned that your aunt gave you these cans of food. Did you take most of your meals inside?

HBW: Well, the first year we'd normally eat in the cafeteria downtown at noontime. That was in the basement of the Winants building. … We always prepared our own breakfast. We also cooked our evening meal. We had hotplates in the rooms and canned food from Seabrook Farms, and then, we had our own chickens, of course. [When] a chicken started to look a little

weak, as though it wasn't producing eggs, that chicken would go into the pot, to boil the chicken. We even learned to bake cakes. We discovered that, if you have a rectangular pan and you put one hotplate on the bottom and another one upside down on the top, it becomes an oven, so [that] you could even bake a cake. [laughter] We did that, and then, to make money, [in] the senior year, when almost all of my classes were at the Ag Farm and there was no place for people to eat out there, we would make and sell sandwiches for people there. There were not many, maybe half a dozen people, but, at least, if they had labs in the morning, labs in the afternoon, why, we'd make sandwiches for them.

SI: Was there any sort of social split between the people at the Ag College and the people at Rutgers College?

HBW: No, no. The Ag School was a significant part, in terms of numbers, of students of the University at that time and, … certainly, in terms of class officers and things of this sort, there was no [imbalance]. I think a lot of it, too, came from the fact that there was an intermingling of classes. For example, if you were taking biology, you were there as an ag student, but there'd be other people majoring in biology and maybe somebody's majoring in chemistry, taking biology. … Certainly, all the students were together for chemistry the first year. Anybody that took chemistry was together, so that there really wasn't a significant distinction, that I can see, between the Ag School and Engineering School and the general school. Now, of course, with the size, … you don't have that level of intermingling, but it was really a complete intermingling when we were there.

SI: During the time you were there, there was the Bergel-Hauptmann Case, "the Nazi Professor." Do you remember if that was in the news, or did you know anything about it?

HBW: … I think we had just read about it. It wasn't an active problem at this point. It was more just like you read other news items, and you know it's related to something you know about, or the like, but, no, nothing exceptional.

SI: Since you went to Rutgers in the late 1930s …

HBW: '39, I graduated.

SI: Did you know about what was going on overseas in Europe? Was it a topic of conversation at Rutgers?

HBW: I certainly knew about it once [the] war started, … which, of course, actually … would be in '39. … '39 was when Germany invaded Poland, … and I don't think I was too much aware of the build-up to it. … By that time, the fact [was that] it became very significant for us, because I came up to graduate school in July and in, I think it was September, there was an international soil science meeting at Rutgers, and we had … lectures presented by people from all over the world. …

Then, we'd gone on a field trip down to see Whitesbog, the blueberry section of the state, and while we were down there is when Germany invaded Poland, and we had Polish people there and

we had Germans there and, of course, everybody was just hanging around the automobile radios, rather than doing anything else. As a result of the invasion, the Poles couldn't get back home. In fact, the ones that were there, they all lost their families. The Germans, who stayed around for almost five months before they were able to get back, would occasionally come into the laboratory. So, it was a very positive introduction to what was happening in the world. From that point on, I was very aware, but I can't say that my activities were [affected]. Certainly, I would read about war activities in the papers, but it didn't have much impact on me, up to that point.

SI: Was there animosity between the Polish and the German scientists, that you were aware of?

HBW: It certainly was not evident, in the sense that they worked together. I think it developed very quickly, with these things happening, but, up until that point, they'd been working together very satisfactorily in scientific activities. … I'm sure that everybody has feelings of quality about individuals and everybody is somewhat prejudiced. I always had a terrible time trying to break my prejudice that a person that talked with a Southern accent was not academically qualified, and it's a prejudice that developed; where it comes from, I don't know. … I got over it, but there was a time when, if you had two candidates for a job and one of them spoke with a Southern accent and one didn't, I almost automatically would choose the one who didn't, because I mentally had the feeling that their education had qualified them more, and this happens between countries. People have feelings about countries, quality of individuals, based on countries.

The only people from Italy that I knew when I went to Rutgers were all farm workers and most [had] never gone to school, at most probably never got beyond eighth grade, and it was kind of a shock to see that [there were] the atomic bomb people with Italian names. … Your background prepares you for certain levels of prejudice that you have to break. … I'm sure that that existed between the Poles and the Russians and the Germans and others in Europe. … Certain countries felt other countries were below them and others were above them, but people learned to live with that and, certainly, in science, they had learned to live with that, because they were all scientists exchanging information. They weren't fighting over the cultural problems.

SI: Can you tell us about your first few years in grad school? What was the focus of your work?

HBW: Yes. … I came to Rutgers to start graduate school in July 1939. Waksman immediately said, "There are a couple of practical problems that I'd like to have solved and why don't you take these [on] as your initial projects?" So, it was a direct assignment. In other words, I had no input at all into the assignments.

One had to do with a problem in the area in Central New Jersey where they grow potatoes. Potatoes grow very well in New Jersey soils, but there's a serious disease called potato scab that will make them unsalable, they became so wrinkled and rough, but the disease is called scab [*Streptomyces scabies*] and is caused by a microorganism. The actinomycetes all … enjoy neutral or basic conditions in the soil. Acidic conditions are very inhibitory. So, if you make the soil acid, you can grow potatoes very well because the *S. scabies* is inhibited. The way to make the soil acid is to spread sulfur on the soil, and then, you depend upon microorganisms in the soil

that convert the sulfur to sulfuric acid, to make the soil acid. I was supposed to find which is most efficient: Do you inoculate the sulfur with the microorganism before you put it on the soil or do you … inoculate the soil first with the microorganism? In other words, what's the best procedure to make it acid? So, I started out with that project. It went along very smoothly. It was chemistry, of course, so, it was something I knew about.

The second problem was that there was a graduate student who had come from China, mainland China, and he'd come to Waksman and said, "In China, we use human feces as fertilizer." [He] said, "Problem is, we spread diseases that way." He said, "Can you teach me how to make composts of human feces without contaminating the soils, causing diseases?" So, Waksman said to me, "Now, you have two projects. Once the first one is completed, you work with this student." Well, I objected. I said, "Look, I didn't join the sewage department; I joined Soil Microbiology. I want to work with soil." Well, he answered that quickly and said, "Okay, you don't have to do that. You do a parallel program." He said, "You come from a farm, you've had horses, so, you use horse feces with your composts and the Chinese fellow can use human feces." I had to take the student down to the hospital to get human feces every day. So, I had to do that, but at least I didn't have to work with it. …

I started my project. Well, I worked on both projects about four months, solved the first one concerning the sulfur, and, in the human feces project, we came up with an approach which seemed to work well in the laboratory. We arranged the compost in such a way that the compost proceeded very, very rapidly. You put some nutrients in it, and, if you succeed, the composts get very hot and soon reach a temperature that's high enough to kill off the pathogenic bacteria. So, now, you have a safe compost. We thought we'd answered the problem. Well, just before my partner had to go back to China, we decided we'd run a test and see what the nitrogen content of the compost would be and discovered that the nitrogen content of the compost, under normal temperatures, was very, very high, and, of course, very fertile as a fertilizer. … The composts where the temperatures got very high had practically no nitrogen. So, we had compost, but it had … really no fertilizer value, and the question was, "What's happening?"

Well, it turned out that, … in converting nitrogen from organic matter to nitrates as a fertilizer, what is produced first by the bacteria … is ammonia, but plants can't use ammonia; it is toxic for them. So, there are other organisms in the soil which convert the ammonia first to nitrites, then other soil microorganisms that convert the nitrate. The high temperatures had killed off those conversion organisms. So, if you take the organic nitrogen, it would be broken down to ammonia and ammonia is volatile. It [will] go right out in the air, and there'd be no nitrate produced. We said, "The project looks like a failure." The two of us got together and we decided, "There's a way out of this. We'll make a two-layer compost. The bottom layer will contain the feces, human feces. The top layer will contain straw and other things, but it'll be loose. The bottom will be hot, the top will be cool, and, as the ammonia comes up through the compost, these converting organisms'll be in the top layer [and] will convert them over to nitrate and everything will be fine," but we couldn't do the test, because the man went back to China.

I never heard anything from him until after Nixon went over to China and they opened it up. We could again have contact. He wrote to me and said, "I wanted to tell you that, once I got back to China, we worked this problem out. It is the way we do all of our composting in China now.

We make a double-layer compost, the lower layer, human feces, the top layer, plant type materials, and this is the safe way to do it." So, it's really exciting to realize that even the second project reached a practical conclusion.

After four months, Waksman came in, all excited, and he said, "Look, two things have happened." One of his former students, Rene Dubos, had run a special experiment to try to get a microorganism out of the soil which will kill other microorganisms, and he'd isolated, from a soil microorganism, a substance called tyrothricin, which would kill pathogenic bacteria. Therefore, he had an antibiotic. The word wasn't known then, but he had a substance that had antibacterial activity. So, Waksman was excited about that, because it was his student who'd done it, but, simultaneously, he had heard, through Merck, that the British had finally succeeded in purifying penicillin in such a way that [it could be tested] in animals. … Penicillin originally had been discovered back in 1928, but no one could purify it and, finally, the British group at Oxford had been able to purify it sufficiently so that they could show that it would kill pathogenic bacteria. If it were injected into … mice that had been infected with bacteria, it would cure the mice.

He was tremendously excited and said, "Look what these British have done." He said, "I know that my favorite organism, the actinomyces, will do better." He said, "Drop everything you're doing and start isolating some streptomyces and see if you can find an antibiotic that's better than penicillin." So, from that point on, for the remaining part of the three years I was there, I really was working with antibiotics, and only with antibiotics. Within two months, we had our first antibiotic. … I went into Waksman's department in July. It was in November that we had our first one. We named it actinomycin and it was probably the most active antibiotic that has ever been discovered. It's extremely active, also turns out to be extremely toxic, too. So, it had no value, from a practical viewpoint, but Waksman, of course, was tremendously excited about having a pure antibiotic. Max Tishler, at [Merck], crystallized it, so we had it pure, and got all kinds of publications from it and got newspaper headlines, of course, news columnists came in, and, from that point on, antibiotics became a big thing at Rutgers.

As it turns out, actinomycin probably has had more value than anything that I ever discovered, because, a number of years later, a German said, "Look, this thing is so toxic, maybe it could have anti-tumor activity," and he tested it in mice and found some anti-tumor activity. … Sloan-Kettering then picked it up, to work with it further, and what has turned out is that it is a cure for one childhood type of cancer. It's called Wilms disease. It's a kidney cancer of children, young children, and was a hundred percent fatal, at the time. It would kill the children within a year or two. Now treated [with] actinomycin, it yields a ninety percent success rate. There are not that many children, maybe a few hundred, that get this disease per year, but, now, actinomycin yields a cure. …

From that point on, I simply would work with antibiotics. … Streptothricin was another antibiotic [that] came along later. It had a very broad spectrum of activity, did things that … penicillin would not do. It covered the gram-negative infections. We didn't have animal facilities in the Soil Microbiology Department, but the Dairy Department did and it was shown to be active there, dosed to infected guinea pigs. Merck took it up, started to build a factory for it. It then turned out to be too toxic for final use in humans. While you could cure the infection, you would damage human kidneys so much that … most treated patients would have died. …

So, it couldn't be used, but, on the other hand, Merck had started to build a factory for it. Then, streptomycin came along, probably about four or five months after I left Rutgers to go to Merck. Streptomycin is purified in exactly the same way that streptothricin was purified. Merck had the plant halfway built, so, … streptomycin just moved, zip, zip, zip, into Merck and, you know, into a factory and out to cure tuberculosis, so that it became really a very exciting, progressive period of working on antibiotics, from one step to another step to another step and to success.

SI: What was it like to work with Waksman? How receptive was he? What kind of interaction did you have with Waksman?

HBW: … For me, it was absolutely wonderful. First, Waksman, at that time, spent half [his] time, every day, in the laboratory. … He and I shared the same bench, the laboratory working bench. It meant that, during half the day, I was doing whatever he told me to do, as his assistant. In the morning period, I could do anything I wanted to do, but I learned just an amazing amount from him, simply because of that close association with him, and then, after antibiotics came along and he got very, very busy and he no longer worked in the laboratory, antibiotics were still his first priority and interest, so, I was always the person he came to see first. … Every day, he made the rounds, to see all the students and talk to all of his students, but I was always the first one he saw, because that's where his prime interest lay. So, I did learn a tremendous amount from him.

He was also a very interesting man. He wanted to make certain that his "kids," his students, as he called us, would become not just scientists, but be culturally aware of what was going on. He was fascinated by the United States, so, he made sure that we visited Philadelphia to see places associated with the beginning of the United States. In his mind, that was such an important thing. He wanted to make sure everybody would do it. He would take us into the Bowery, in New York, to show us what it was like in the Bowery area. … He had a summer appointment at … Woods Hole [Oceanographic Institution] and he taught there and … another marine laboratory in Bermuda. He'd go there. … I would always meet him at the airport when he came back, or at the ship, sometimes. He'd bring back either a special rum or special food. He'd immediately have a party for all his students. …

He has obtained a questionable name because of the Schatz relationship, but, certainly, during the period that I was there, he was a very helpful individual, no question about it, and very aware of his students and what was going on. [Editor's Note: Dr. Woodruff is referring to a controversy that emerged between Selman Waksman and Dr. Albert Schatz, then one of his graduate assistants, over credit for the discovery of streptomycin.] Mainly, because of the fact that I was in his laboratory, [on] a number of occasions, I was present when people would come over from the Rutgers administration to try to talk him out of the amount of money that he was giving his students. He was giving them seventy-five dollars a month, instead of sixty, which was the standard per month graduate student amount, during those days, but he would simply sit there and refuse. He said, "My students should have enough money that they can live and, if they have a girlfriend, take the girlfriend out to a movie." He just insisted that this was the level he was going to give for all of his projects.

My project was supported by Rutgers. The other students were supported from outside sources. For example, his relationship with Merck came out of Merck's desire to make citric acid, … so that he got a fellowship from Merck to work on citric acid, and then, after antibiotics came along, of course, he got other fellowships, … but all of the money that he had for students, other than mine, was from outside, and he said, "Well, I should have control over it then." He insisted on that, but it was just that he felt that students should be more educated than just [being] scientists, they should have other opportunities as well. So, my experience was really, absolutely, first-rate.

SI: It seems like he was very receptive to your ideas and inputs.

HBW: Well, he certainly overwhelmed me with his own suggestions, let's put it that way. He wrote all the papers that we published himself. He would ask me to write up sections, which he would abstract or change around. A few things that I did, that he had not suggested, he included in the papers, but, in all fairness, I think I would have to say that at least three-quarters of the things I did were things at his direct suggestion and probably only a quarter were things that I did myself. …

[TAPE PAUSED]

HBW: … He certainly listened to them, discussed them and, in a number of cases, he included them in the papers that he wrote, but he did write all the papers. I didn't get any experience, really, in preparing papers.

SI: We were reading *My Life With the Microbes* in preparation for the interview.

HBW: Yes.

SI: Waksman credited the war with putting the pressure on to do the research on antibacterial microbes, but, from what you have said, it sounds almost like it was there before that.

HBW: Yes, it was before it, but … the war, of course, was in progress by the time this was done. It had only just started, … because it was in either August or September, I can't remember, that the first invasion occurred. … I was working with antibiotics four months later, but the emphasis on antibiotics was solely mine. In other words, when I was there, I think there were eleven projects going on in his department, … every one completely different from the other, having no real relationship, one to the other. … I was there three years; by the third year, at least half the people, and probably more than that, were working on antibiotics and, almost immediately after, a hundred percent of the people were working on antibiotics. … I think that major shift, from maybe only one working on antibiotics to everybody working on antibiotics, did come from the fact that he became aware that antibiotics were so important, there was such a great need for them, and the fact that he'd been able to find them, he'll be able to find more of them.

Yes, I think that shift occurred because of his awareness, but I think the initial entry into the antibiotic field came about, mainly, by the fact that, suddenly, here's an antibiotic that came from a soil microorganism. His interest was soil microorganisms and this was a tremendously important thing to him, that Dubos' tyrothricin was a soil microbe antibiotic and that he should

do more because of that. It was supplemented by the penicillin story. The penicillin story was not that complete. It was more hearsay, because the Oxford studies hadn't been published yet, but the hearsay was there, that the Oxford people had been able to do, essentially, the same thing that Dubos had done. Penicillin's source had not been a soil microorganism. It was *Penicillium notatum*, a mold floating in the laboratory air. Molds were not Waksman's prime interest, but the fact that something like this could come from a soil microorganism was what interested him. Soil microbiology was his love, there's no question about it, and anything that had to do with a soil microbe was of interest and here was a big thing and he decided to go into it. … I doubt that the war situation had much to do with that very initial foray into the field, but it became important later.

SI: Can you tell us a little bit about the process of discovery? I have always heard the story about penicillin, how Fleming left the window open. What surrounds the actual discovery?

HBW: Yes. Penicillin was that. It was an accidental discovery. The important thing was, of course, that Fleming, when he saw it, decided to do something about it, because many people had seen the same thing before and threw their plates away. … Waksman himself had seen the same thing before. He has a publication that describes it, but they never did anything about it, … so the big thing with Fleming was that he recognized it as having possibilities and he should do something about it.

Now, what was done in the discovery of tyrothricin, however, was purely a planned experiment, and I think that's one of the reasons that Waksman was so interested in it. Waksman had been asked by people at the Rockefeller Institute to recommend someone that would help them find an enzyme that would hydrolyze the coat, the capsule coat, that exists on the *pneumococcus* organism, because they were convinced there that was what made the *pneumococcus* organism pathogenic, the fact that it was protected by this exterior coat. … Therefore, when it infected a … person, the person had no way of killing it, because it was protected, by the coat. They wanted to find out, if they could remove that coat, would the microorganism still be pathogenic or not? … They asked Waksman if he could recommend someone who could find an enzyme that would do that. So, Waksman recommended Dubos to do so and Dubos, as part of his studies at Rutgers, had done similar things. He'd found enzymes that would do things, breakdown plant polysaccharides and things of this sort, and he did it by constantly enriching the soil. He added a little bit, then, added a little bit more, a little bit more, and the soil microorganisms become trained to breakdown the product that he was adding. So, Dubos did this. He … isolated the polysaccharide coat from *Pneumococcus* and added it to soil and, eventually, a soil microorganism was present that would dissolve [the coat]. When the people at [the] Rockefeller Institute removed the coat, then, injected the coat-free *pneumococci*, they were nonpathogenic, so, the coat was proved to be the protective substance. … Then, Dubos got the idea, "Well, if that works with a coat on a microorganism, will it work with the whole microorganism?" So, then, he started to add whole microorganisms to soil, and he kept doing so over a long period of time, and then, plated the soil out. … He discovered that there were many microorganisms in the soil that were actually killing, able to kill, the *pneumococcus*. So, he felt, "Well, I've trained them to do so," and then, from that point on, they isolated the killing agent and named it tyrothricin. …

Waksman, of course, was tremendously excited about this. "Here, Dubos has used a technique learned in my laboratory to find a new killing agent." So, what he assigned me to do [was], he said, "Look, go back, do what Dubos did. However, don't use a gram-positive organism, such as Dubos used, use a gram-negative one, like *E. coli*," which is an indicator for typhoid organisms and other pathogens, "and add those to the soil and see what happens." So, this is what I did. I started out by having big pots of soil that I'd gathered and I grew the *E. coli* and added a certain number, several billions, actually, of organisms to the soil and, a week later, I added more. … Every week, I would add the same amount to [the] soil. It is possible to isolate the *E. coli* and separate [it] from other soil microorganisms, a very simple test. You get just *E. coli* coming out. So, I plated my enriched soil out. Two days after I would add the *E. coli*, I'd plate the soil out and see how many *E. coli* were there. Well, initially, there were billions, but, then, it started to go down, down, down. … After about four months, five months, if I added *E. coli*, … two days later, none was present. They'd gone completely. So, they were being killed off very rapidly, and that's when I plated it out and found actinomycetes that did a very similar thing to what Fleming observed, when he found a *penicillum* which killed pathogens. We grew the *actinomycete.* … The active agent was solvent soluble, so, it was very easy to get it out and we got it very, very pure, but, then, the final crystallization was done up at Merck.

So, we actually used a planned study. … I think that's why Waksman was so very interested in it, we were using a planned study. Years later, I did experiments to show it probably wasn't necessary to do the planning at all, because any soil, without being enriched, has *Streptomyces griseus* in it, which is capable of making streptomycin. So, we did three or four months work in order to get this. It was probably unnecessary and, the same thing, any soil has organisms that'll produce actinomycin, so, you probably don't have to go through all the enrichment. … On the other hand, the enrichment made it easier, in the end, because, instead of having a few there, you had a lot of them there. …

I think Waksman's great interest in it was that this is not a chance phenomenon. This is not the Fleming story all over again. This is a result of a planned experiment and, with that being possible, you ought to be able to isolate dozens of these things, by putting in soil … TB organisms, for example. You should be able to get organisms that are capable of killing all these different things. So, he saw it as a very interesting scientific project at the very beginning. Very soon, of course, when the royalties started rolling in on streptomycin, [laughter] he also saw it as a very practical application. … Certainly, he was very aware, being European, of the problems in Europe with the war and the like, and that was a very important point, too, became an important point for him to expand the effort.

SI: You mentioned that there was some tension between Waksman and the administration over how much he was paying you, and so forth.

HBW: Yes. They used to come over, mainly on the basis [of], they said, "Look, you know, other students are complaining. 'We're only getting sixty dollars. Waksman's students are getting seventy-five,' and, for the good of the University, this differential shouldn't exist. They should be the same." … I think it was three times, … when I was there, these people came in and tried to get him to change his mind, but he wouldn't do it. [laughter]

SI: Do you think, in general, the administration recognized the importance of his work and gave him a free hand?

HBW: Yes and no. At that point, when these discussions were going on, … about two years before, there'd been a very strong effort [that] existed when they had to cut down on the staff of the Ag Experiment Station, that only those who were working on practical objects for farming should be retained and the first people let go should be those who are working on theoretical things that had little effect on agriculture, and Waksman very nearly lost his job, at that time. … Dr. Martin, the man who eventually became director of the Experiment Station, was the one that really preserved Waksman's job, because he felt that theoretical work was very important. …

So, I'm not sure that the University administration downtown had become convinced that Waksman should be given anything he wanted because he was an important individual. I think that became true maybe in another five years, when streptomycin came along, yes, but, pre-streptomycin, which was when I was dealing with him, I don't think he was held in that high regard by the administration people.

SI: This new, and I guess, in some ways, revolutionary, relationship with Merck occurred while you were a student.

HBW: Well, yes, but that occurred, initially, before I was an employee there, when I was an undergraduate. There was a man; a new director who moved into Merck. Merck was a chemical company. The only thing they did, really, was to make chemicals. There was no real biology going on there at all, … in the early days. Then, Mr. Merck decided that he should have a research department and that the research department should be looking for new medicines. Therefore, they needed biologists to test the medicines, but, primarily, they needed chemists to make the medicines, and their first project had to do with vitamins. So, most of the emphasis was on vitamins in the early days. … They had a physical chemist and they had an organic chemist and they had an applied chemist, as the three directors.

They brought a fourth director in and he had a business background, … as he had come from Commercial Solvents Corporation, which was really a fermentation company. He was convinced that microbes could play a useful place in Merck. So, he was always trying to find something biological that could be introduced at Merck and he came upon citric acid as a good idea, because citric acid was almost an exclusive product of Pfizer Company, at that time. It was made by growing *Aspergillus niger* on sugar solution; it converted sugar to citric acid. Pfizer didn't believe in patents. They only believed in secret processes. So, nobody knew what they were doing, how they were doing it. … The man's name happened to be Woodruff, no relative of mine at all, [laughter] but Mr. Woodruff said, "Look, we can make a grant at some biological laboratory to find some microorganism other than *Aspergillus niger*. It can then be used to make citric acid. We can get patents on it and we'll be able to compete with Pfizer and make citric acid." Well, he convinced Randolph Marjor, who was the director of research, that that's what they should do. So, he was assigned the job of finding some laboratory to do that, and I don't really know how he came in contact with Rutgers, but he did. …

Someone had indicated to him that Waksman was the chief experimental microbiologist there and he should go down, talk to Waksman. He did. Well, Waksman immediately saw this as a good, interesting objective for him, and so, he suggested that they set up a research project. … He would obtain a graduate student and assign this [to the student]. So, probably a year before I went there, all this was signed and sealed but not yet delivered. Waksman, then, circulated around his contacts and said that he had this project available, "Could anyone suggest a good student?" Well, one suggestion was from a friend he knew at the University of Wisconsin, Edward Karow, who had taken a course in, actually, a major, in plant physiology, and he came in the same day that I arrived and he was assigned the job of finding such a microorganism. … He did find one. It was a brown one, rather than a black mold, and so, it could be patentable, and it did make very good yields of citric acid. …

The big thing that he did, which was the real breakthrough, is that all of the citric acid, up until that point, had been made in flasks, or shallow cultures in trays. … The mold was grown, and then, … after the citric acid was produced, the liquid was drained out, more liquid was put in, so, the mold was preserved and it produced more. You could just keep reusing the mold, but Waksman had heard of work that had been going on … in Holland on growing molds in submerged culture. … In Holland, they had done so by putting them on shaking machines, where the flask was constantly rotated, and the mold would grow not just on the surface, [but] from the top all the way down to the bottom, grow very much faster. So, this looked like it might be a possibility. So, what Ed Karow did was not only find a new microorganism, but to produce citric acid under submerged conditions. … Merck decided that, "Okay, this looks wonderful. We'll go ahead and build a pilot plant to do this," and they got in another man from [the] University of Wisconsin, a graduate, Lloyd McDaniel, to set up the pilot plant. They had just a small pilot plant. It was equipped with a stirring tank, instead of a shaking machine, but probably only ten or fifteen gallons, you know, a small unit, and they set that up at Merck. …

It was there when [Howard Walter] Florey and [Norman] Heatley came over from Oxford to try … to convince companies in the United States to make penicillin, because they had found that they had been unable to make enough to cure any patient. They'd been able to make enough to apparently cure them, go from death's door to normal people, and then, they would run out of material and the patient reverted to the disease and died. So, they came to the US to see if they could find somebody who could make it. … The problem was, it would take, probably, oh, … at least a hundred gallons of fluid, grown in these surface cultures, to cure a person. … All of the commercial companies would say, "Yes, it's interesting, but it's completely impractical." I mean, a hundred gallons to cure a person, the cost would be enormous. It just couldn't work. So, they were turned down as they went around through the country. Mr. Merck was always very optimistic; he was a businessman who would have liked to have been a scientist, [laughter] I think, is what it comes down to. Penicillin was something with tremendous interest and he was *gung ho* for it. He didn't turn them down. He wouldn't take it on, but he wouldn't turn it down, and he said, "Well, it still sounds interesting." … He actually assigned his laboratory people to start working [on it], to see if they could do anything, and Merck had this submerged citric acid facility. So, it was decided that they would try to produce penicillin, submerged, at Merck.

Florey and Heatley had gone out to the Northern Regional Research Laboratory, which is in Peoria, Illinois, to try to convince the government laboratory to work on penicillin. … The main

objective of that laboratory is to find use for agricultural products, waste products, and one of the big waste products that exist is corn steep liquor. It is the residue that's left after you convert corn into cornstarch and it's a tremendous residue, a terrible waste product to dispose of. So, the first thing they did, [at] the Northern Region Research Laboratory, was try to grow penicillin on corn steep liquor, instead of on proteins. It not only produced penicillin, but produced ten times as much penicillin as the people in England had been able to produce. Well, Florey and Heatley came back to see Merck, again, and Mr. Merck, asked, "Well, look, have you made progress?" and they said, "We've increased the yield tenfold." … Mr. Merck said, "That's impossible. In any chemical process, you might raise an eighty percent yield to ninety, but you can't increase something ten times. It's impossible, from a chemical standpoint." … [They] said, "No, it isn't. This is possible in a biological system. It's impossible in a chemical system, yes. A hundred percent's top. If you get fifty percent, so, you might be able to double it, but, in a biological system, you can increase it tenfold." Mr. Merck said, "If that's so, we'll do it. We'll take it on as a project." [laughter] That's what sold him, and Merck then went full force into doing so. Pfizer and Squibb then joined in. The three agreed that they would all work together on penicillin, and that, in fact, is how I got involved, because … Dr. Waksman was employed to be a consultant on the penicillin project at Merck. …

They were having trouble producing penicillin and Waksman finally came to talk to me. I was scheduled to graduate in June and this was in January. He said, "Look, you've got six months to go. You go up to Merck and work on the penicillin project there. At least you can tell me what's going on, so, when I come up, I'll be prepared to talk to them." So, I went up to Merck in January of 1942 and, immediately, started to work on submerged penicillin culture. … That was the point where Waksman really was converted from a citric acid consultant over to an antibiotic consultant, particularly for penicillin. … Merck succeeded because of the rapid work done there, producing the product used to cure the first patient in the United States, the wife of a professor at Yale University who had blood poisoning, as we used to call it. She was really at death's door. [Editor's Note: In March of 1942, Anne Sheafe Miller became the first person successfully cured by penicillin.] Norman Heatley, from Oxford, had stayed on for about six months. He worked in the same laboratory I was in at Merck. He got a call from Yale and [they] said that they had this patient who was at death's door and could Merck do something about it? … The Merck directors indicated, yes, they would be able to release penicillin. … They did so, the penicillin went to Yale, and they called Heatley on the phone, who had come from England, to get instructions [on] how you go about curing the patient. [laughter] Well, Heatley was a chemist. He didn't know much about anything to do with curing a patient, but, anyway, he gave them instructions what to do, and I know he said he had the worst weekend in his life after that. It was a Saturday when they called, because he didn't know whether he killed the patient or saved the patient. It turned out she was saved. So, it all worked out well, but, in any case, it became a very interesting project. …

All these things are based on luck. Merck was lucky they had a submerged tank on hand for citric acid when they wanted to try it. So, it was an obvious thing to try. … Every one of the companies that worked on penicillin made one advance right after the other, but, all through the war, they worked together. They forgot about the anti-trust rules. … Every month, each company would write out everything that had been done at that company and it was circulated to all the other companies, so [that] everybody kept up-to-date. It's really impossible to say that

anyone made any specific discovery, because it was just these eleven, or I can't remember, fifteen companies, all working together, and some universities as well, on the project.

So, for the first year that I was at Merck, I was involved almost entirely on the penicillin project. Then, of course, by that time, streptomycin came from Rutgers, leading to a new factory. Then, one of the Merck chemists, Tom Wood, came over and said they were working on antipernicious anemia factor, a substance in liver extract that will overcome pernicious anemia in people, and said, "You know, we're having a terrible time trying to isolate this from liver extract." The only way of telling whether they had an active substance was to find a patient who had pernicious anemia and have the extract tested. There was no animal test. No animal gets pernicious anemia. So, they were having a very slow time trying to purify the material, and he said, "You know, molds make antibiotics; do you think they would make antipernicious anemia factor? Do you have any cultures that we could test, to see?" and he said, "We'll apply the same isolation technique we've used on the liver extract and see what happens." Well, I happened to have … six cultures in my laboratory, growing. So, I gave him all six and one of them, when he went through the extraction technique, actually produced a product that was more active than he could get out of liver extract. … He was a very astute person. He noticed that not only did the activity appear great, but the extract was pink in color. So, he finished isolating it using color as a guide. He got red crystals out and they were pure vitamin B12.

For Merck, that was very important, because there were three companies working on the antipernicious factor simultaneously, Merck, Lederle in New York State, and Glaxo in England, and all three companies crystallized vitamin B12 within the same month. Merck did it early in the month and Lederle was one week later and Glaxo about three weeks later, but Merck got the full patent rights, because it was the first one, and they succeeded in doing so simply because a microbe made it. …

SI: It sounds like everything was moving extremely rapidly from theory and testing to production. Today, there are a lot of clinical trials and the FDA [Federal Drug Administration] to deal with. What was the procedure then?

HBW: … That first phase, I think, can go just as fast now as it ever went. Getting approval to market a product does, now, take much longer, because you have to run maybe at least two years of tests to prove that the substance is not toxic and it won't cause cancer and all these various things. Everybody jokes and says, "If penicillin were discovered today, it would not be a product," because penicillin has enough disadvantages. It's allergenic and it has killed some people by a major allergic reaction, and it would be classified as a toxic substance and probably would not be approved, so that it has become harder to get things approved at the present time than it was back in those days. On the other hand, things have been done, or were done, back in those days, that clearly did kill people. I can't remember which company it is; one of the pharmaceutical companies has disappeared, simply because, in making a perfectly safe agent, they added a toxic substance as an excipient, and it proved lethal when it was prescribed. So, long-term toxicity studies simply weren't run then.

We were lucky as could be at Merck, because the streptothricin that I had isolated [was] active in animals. We'd tested it appreciably in mice against infections. It cured them beautifully. So,

Merck decided, "We'll go into clinical trials," and they did. I think they had four patients that were sick. … They were seriously ill. All four patients were dosed with streptothricin and they all stopped urinating. Not a one of them produced urine and the assumption is they were going to die. Well, fortunately, all four of them recovered. It took awhile, but all four recovered, and then, we went back and started to look at the substance in more detail. … When we ran mice tests, the mice were infected, they were injected with the drug, the controls died from the infection, the treated ones were alive a week later, and the mice were discarded. The experiment was completed. If they'd kept those mice six weeks, every mouse would have died, because streptothricin has delayed toxicity. It's not toxic when you inject it. It gradually destroys the kidney and the people could have died from uremia, just as the mice would die if we held them long enough. These people, fortunately, weren't dosed with a high enough dose to kill them, but they came close to it.

So, it's very important, now, to have these long-term toxicity tests and safety tests and things that need to be covered before you can get FDA approval, but, back in the early days, they did not exist. So, things were much faster then than they are now.

SI: Moving into the war period, you went to Merck right after Pearl Harbor. Do you remember where you were when Pearl Harbor was attacked?

HBW: … Oh, yes. I was visiting my wife-to-be down at Princeton that Sunday. I was a graduate student, still, and I had gone down just to spend the day with her. … When we got back to the place where she was staying, she had an apartment in a house, the man of the house said, you know, this had happened. It was on [radio], so, we spent the rest of the period listening. … By that time, however, we had advanced far enough in our work … at Rutgers that, I believe, Waksman was beginning to be convinced that he would be able to find something that would cure infections. As a result of Pearl Harbor, Waksman contacted, I don't know whom he contacted, but the government authorities, to try to enlist. He felt that he could serve as an enlisted person in microbiology, against infection in some way, a very important thing. … They said, "No, what you're doing is far more important. You're trying to find drugs that may be useful to us in the future and what you should do is simply go back and work harder on your present objective," and so that he did, really, intensifying the effort, one of the reasons that he enhanced the number of people working on the project.

I don't really remember when the first draft occurred. I've forgotten it completely. I remember the group of graduate students that were there getting together to listen to the draft numbers being called and to find where we were [in the lottery]. I was in the middle, in terms of the draft numbers. Waksman, for all of us, applied for exemptions from the draft and the New Brunswick board, automatically, would approve them. It always surprised me, to an extent. They approved them for me, working on a project that would be directly applicable to the war effort, but they also approved it for individuals that were working on citric acid or things that were non-[vital]. At that time, in the early stages of the war, I think they had the feeling that, out of these research areas, there were going to be important things developed, and, at that stage, they didn't have a need for men that was quite as severe, as it would be later. Of course, I'd gone through ROTC, the first two years, at Rutgers, because that was compulsory. … By the time I switched to Merck, my effort was on penicillin. It was very, very clear what the objective was there, to try to

get enough material together to have available when the invasion of Europe occurred, and that was the whole object of what was going on. None of the penicillin could be used for … civilian people at the time. It was used by the Armed Services for individuals that were not in harm's way. I mean, if one got sick in a training program, they used the penicillin, but most of it was simply accumulated to make sure we had enough, on time, when the invasion took place, and we were successful in getting enough together.

Now, as you look back over these things, … you always have dual feelings; I surely did. You feel an obligation to do whatever is best for the country, and, certainly, I was convinced what I was doing was best. On the other hand, I was very embarrassed, during that period, by the advantages that I had, compared to my associates, those who went into the services. I could get married and live a normal life. … My wife taught school. We lived in Princeton, because she was teaching school there. On the other hand, I had that relationship, while people that got drafted into the service did not have such advantages. One has a dual feeling. I benefited when others were not benefiting. If you looked at it from a different viewpoint, at least from the kind of student I was when in ROTC, I would have been almost useless, I believe, to the Army, in active service. [laughter] I'd [have] been assigned to a laboratory or something equivalent, obviously, but, if I look at it from the viewpoint, "Where would I have done the most for the country, serving in a laboratory, doing analyses, or doing what I was at Merck?" I had to look at it from that viewpoint. Yes, I was doing what was best for the country, but I always had this feeling in the back of my mind that I was unfairly benefited by the war. It's an odd feeling.

SI: Did anyone ever, on the street, say, "Why aren't you in uniform?" or something like that?

HBW: Well, I believe that's the time it gives you more of a feeling, … is when groups get together at Memorial Day and other similar occasions, and you see the articles about what percentage who died during the initial invasion and, if you're young, you realized that you'd never experienced anything that was like that or even approached that. It is a strange feeling. Certainly, I had a number of contacts with the government hospitals during the streptomycin period, because individuals would come back with tuberculosis and they were trying streptomycin and various ways to handle that. … I'd go out to the meetings, to see the different approaches that they were taking with streptomycin, and, again, you realize that what you're doing, or what you have done, is having an advantage, just as I feel about actinomycin and cancer. … On the other hand, you could never completely take away the fact that you have a feeling that you had benefits that maybe were more than you deserve.

I've had some feeling for the military since. One of our sons got his PhD in statistics, … but he had a low draft number and the only way he could stay in graduate school was to enter ROTC, which he did, while at Brown, and got his commission. So, he had an obligation, after he graduated, to go into the Air Force, and he did so. It was interesting. The Air Force, almost immediately, got in touch with him and said, "Here, we don't have many PhDs in the Air Force, … but we have an important statistics program out at Wright-Patterson, in the Dayton, [Ohio], area, and would you be interested in coming out to teach statistics, and then, to do research work on using statistics, … advising students there?" So, he did that. He ended up actually staying in for his twenty-year period in the Air Force. … After he did the teaching, he did a lot of other things, but he, in a way, I think, was always very much like I was, not particularly adept,

physically, and you wouldn't think about him as being a typical Air Force individual, just as I wouldn't have been a typical Army individual. … On the other hand, he had a very, very interesting life in the Air Force, doing things that, I guess, were significant, helping students determine efficiency, how many shots you have to use for this thing, and so forth. … So, I'm sure, had I been pulled into the draft, … I would have ended up in some position that I could [have] contributed, but, I guess, I have to realize I probably contributed more by doing what I did.

SI: Yes. You mentioned that the focus of your work was to produce enough penicillin for D-Day and beyond.

HBW: … Yes.

SI: Was that something that you just found out later, or was it something that, everyday, they were reinforcing this fact?

HBW: Well, the focus was that. … There were two focuses, actually. The focus, number one, was the one that was set out by Florey and Heatley when they came over to the US. … They said, "Look, here's a drug. We're convinced it's good; we can't prove it. Would you make for us," I can't remember what it was, I think it was a kilo, they used to say, "a kilo of drug to give to us, [so] that we can find out whether this is a good product or not a good product?" So, the initial objective was always stated to make a kilo of drug for Oxford to really prove the product, but … the US got involved in the war. … As soon as the US got involved in the war, well, the Army said, "We have a different focus, and this is to accumulate enough product which we can use. We don't care about the British objectives. We want it." So, the focus changed to making as much product as we could to fulfill the military's need in the United States, and that would be existing need, plus, the anticipated future need. So, the focus did change. … Florey never got his kilo of penicillin, but he got enough sent to him, so that they were able to prove that the drug was truly an effective agent, and his objective was met. It wasn't met quite as efficiently as he would like to have seen it, but he was still happy, because I visited him a number of times thereafter at Oxford and he was always tremendously appreciative of the fact that Merck, Squibb and Pfizer had gotten into it right at the beginning and took what looked like it was going to be a lost cause and truly made something out of it. …

Even though he, at times, spoke a little disparagingly about the fact he'd never got his kilo, he still was very appreciative of what was done, but there was a change in focus from that initial one, which existed when I went to Merck, over to the other, when the headquarters offices really took over the assignment. … They appointed a "czar," really, to be responsible for all of the material that was made and who would make the decision, … when it could be released and when it could not be released, when it could be stockpiled, and things of that sort.

SI: Can you tell us about how the pressures of the war and this mission affected Merck's operations? We have interviewed other Merck employees. For example, they talked about tremendous facilities expansion.

HBW: Well, there were two major factors in the war that affected Merck. Of course, they had to keep all their standard things going, the products they were producing. So, the factory continued with its standard operations, meeting the medical needs, but, from the research viewpoint, there were two things. One was antibiotics, which became a very major activity at Merck. The other had to do with what eventually became cortisone, which was the adrenal steroid hormones, and chemists had been working on the adrenal steroid hormones for some period of time. A few of the hormones had been isolated and the effect on the body had been established, but a rumor started that the Germans were able to fly airplanes higher than anybody else in the world and the reason for it is that they had been injected with a new adrenal steroid. So, this became a major endeavor, to try to attain more adrenal steroids, so that it could be determined whether one was giving the Germans an advantage. …

A chemist from Princeton, Lew Sarett, joined Merck, at the same time I did, and he had done his thesis work at Princeton on adrenal steroids. So, his job at Merck was to isolate adrenal steroids, and they succeeded in getting one out, that was tested, to see if it allowed one to exist in lower oxygen concentrations. [It] had no effect at all, but, at the Mayo Clinic, one of the physicians out there had had the idea that adrenal steroids might have some effect on rheumatoid arthritis. So, he asked for a sample and a sample was sent to him and it was absolutely amazing. They made a movie of it, which I saw. They had about four patients that were absolutely bedridden. They couldn't move and they injected them with this cortisone. … Two days later, they were dancing, running around, just unbelievable, absolutely unbelievable, so, everyone thought that it solved the problem completely. Well, it turned out, of course, that was temporary activity. Cortisone can't be given indefinitely, because it has its own side effects. So, the disease isn't wiped out quite to the extent that the movie showed it, but, on the other hand, it was a major development, which came about solely as a war effort, because of rumors that were not true, the rumors that adrenal hormone would allow people, our pilots, to be more productive than the German pilots.

So, during the early war days, that was a major war effort, side-by-side with the antibiotic effort, and then, it took on a development of its own, of course, entirely, because of the advantages of the steroid hormones by knocking out the effect of the body in attacking its own tissues. There were other war efforts that went on, but they were the two major ones that I know of.

SI: In terms of your relationship with the military and the government, how did that actually take place? Did they send people into Merck to work with you?

HBW: They sent no one in[to] our laboratory to work with us. The individuals who were involved with decision-making would visit Merck's supervisory staff.
The individuals from Washington who would come up, … for example, the "Czar" that I mentioned, who would release penicillin for various uses, he would come and have meetings with Merck. … I would be in those meetings, when discussions went on, because he wanted to know how much we could make. … There were, certainly, other individuals from the military who would come up, but, as far as my contact, [it] was always a general meeting, no direct contact as far as laboratory functions.

SI: Was it much of a transition for you to move from an academic setting to a corporate setting?

HBW: Not really, because of the applied objective, which goes on in an ag school, really. [laughter] … I think the transition, probably, was greater going from the initial transition in the first four months, from an agricultural objective over to a more medical objective, but, once my objective was a medical objective, going to Merck was basically the same as operations in the Rutgers Ag School. Yes, there were a lot of minor irritations at Merck. For example, in purifying streptothricin, we used alcohol. Well, at the University, they used straight alcohol. They had permission to do so. … Companies do not. They have to use denatured alcohol. So, it took me awhile to find [that] certain things that I got freely at Rutgers were not available under industrial conditions, and the whole ordering system is much more complex in industry. I mean, at Rutgers, if you need a flask for something, you call up and ask Arthur H. Thomas to send it up. At Merck, you go through about three steps of bureaucracy before an order can go out. [laughter] So, there were differences in the nature of how you do things, but there were no differences in objective. I believe the objectives, at both places, were very clear.

SI: In terms of labor, at Merck, did you notice more women coming into the company? Also, did the labor laws that existed during the war affect you?

HBW: No, the labor laws didn't affect us. The thing is, microbiology is different from almost all other sciences in the fact that you start out with about fifty percent women and fifty percent men majoring in microbiology. So, we probably had more women in the microbiology department at Merck, the whole time that I was there, than men, because we would have assayists. … For running the penicillin assays, we probably had five or ten people and they were almost all women, and, also, vitamin assayists, had one man, I think the rest were women there. The person that was in charge of … the biological laboratory that deals with animals, the pathogenic bacteriology section, was a woman, and I think all of the ones we ever had there were women, PhD women. … Right from the very beginning, I think we've been used to having about equal, fifty-fifty, women and men. …

What I mentioned earlier is having an appropriate number of black individuals at advanced stages within the laboratory; that was a company objective. They simply said, "Look, New Jersey has twenty percent blacks, we should have twenty percent blacks [in the company]." We never really reached twenty, but we got to a fairly decent number. … We got people from veterinary schools and places of that sort. The problem is, there are so few black people that go through the chemistry departments in universities that it's very, very difficult to reach the percentage that we were trying to reach, but we worked towards it and we were able to do it, in part, by getting people from the veterinary field and other fields. … Beyond that, I don't know of anything. …

None of our laboratory people have been unionized at Merck, so, we never had that problem. Merck had some strikes, but the strikes were an inconvenience, but they always allowed the laboratories to continue to operate. A number of people would go in and stay in permanently, food brought in to them, but the strikes never reached the stage that they shut down the laboratories. … We didn't really face any major labor problems.

SI: Are you talking about during the war or after the war?

HBW: Not during the war, after. … A lot more women became available during the war, so that the lab assistant functions and similar activities were almost entirely taken over by women during that period. We had a number of wives who had not worked before, who worked during the war, because they felt that they should do so. … A lot of the functions of sterilizing equipment and things of this sort were done by them during the war. We never really ran into a shortage of people. Merck's salary scale and reputation as an employer was always quite high, so, there, you know, was always an adequate number of people available.

SI: Do you remember rationing and how that affected you, either gas rationing or food rationing?

HBW: Well, it affected us, but only from a personal viewpoint. Of course, we established carpools. Four people would go in to Merck, so that we essentially changed to the carpool approach. … For a number of years, we carpooled. The gas rationing, the only gas ration I had was that for local people, … no special allotments, and so, we would take the train where we'd want to do something, rather than the car. We knew the car was really reserved to get back and forth to work, and the grocery store and few things of that sort, but we had no special privileges, let us put it that way. …

SI: Were you aware of any black market activity in the area?

HBW: Not with respect to gas. You'd sometimes hear rumors about it with respect to foodstuffs and things, but we never were hampered severely by rationing. I think everything worked out fine for us. My wife and I did have a little bit of an advantage. My dad still had a great, big garden that he had going, so, whenever we happened to visit them, we'd come away with a lot of freshly grown vegetables, [laughter] but no real problem.

In fact, the most severe problem we had [was], one year, when I went over on a sabbatical to England, in 1954. … I didn't realize how strict the rationing was, still, there. When we got there, things like orange juice, there was practically [none]. Our kids were young then, very, very difficult to fill their needs because of rationing still in progress. So, you began to realize what the people there had lived through at that time. I rented a house when we were there. We had a house here, at the time, in Westfield, that had a coal furnace. … It took twelve tons of coal per year. … We ended up in Cambridge, the 1st of January, so, I wanted to get enough coal to keep us going for the half year. They allowed me five hundred pounds of coal. So, compared to twelve tons, I had five hundred pounds. [laughter] We actually had only one fire going in the house. We had a small living room and I got a coal fire going in the fireplace and I was able to keep that going day and night, but that's the only room we heated in the house, the living room. The kitchen had no heat whatsoever and, bedrooms, we had a plug-in electric heater that we plugged in for while we were getting undressed. That was about it, but it let you realize how many restrictions people were under in other parts of the world, compared to the great freedom that we had here, even during periods when rationing existed in the USA.

NM: You just mentioned that you went overseas to England. I read that you also visited other countries. Could you tell us about that?

HBW: Yes, it was something like fifty countries that … I visited, very broadly, the countries of Europe. I think I visited just about all of those, and we worked, of course, for nine years in Japan. So, we had that contact there. … I visited up and down the … eastern part of Asia, most of the countries, back and forth there. I set up research programs in Australia. I was responsible for a veterinary laboratory in Australia, so, we had that. South America, we've really only been in maybe three or four countries there. I've been down to Argentina and Brazil, when we've introduced the antibiotics, to get those introduced there, and visited Columbia during a cruise. … Science, really, is worldwide, of course, so that we visited international meetings very frequently and you have contact with people there, so [that] you go to see them thereafter.

Merck, initially, on penicillin and streptomycin and vitamin B12, at the time they were discovered, … had no facilities abroad, research facilities abroad or manufacturing facilities abroad. So, we licensed the processes for penicillin, streptomycin, vitamin B12, to about ten countries around the world. … By licensing them the processes to manufacture, we also had an agreement that we would share research for ten years, and what we would do [was], we would visit their laboratories every other year and they would visit us every other year, to exchange information. So, of course, I visited all of these various countries that we were involved with. … For example, two of the things we introduced in Spain were penicillin and streptomycin, and we earned royalties as a result of that. We had no way to spend the royalties, because *pesetas* weren't worth anything outside of Spain. So, we decided one of the ways of using *pesetas* was to set up a research lab in Spain and do all of our searching for new antibiotics in Spain, that is the initial searches. So, we did set up that laboratory and I sent two or three of our people over. In the meantime, I'd go back and forth to visit, just to introduce new screening techniques in[to] that laboratory. Then, we did the same thing in Japan, but we did it on a somewhat different basis, with a university there … to do that type of activity, so that I have visited a great deal around the world as a result of microbiology, what goes on in microbiology. …

We've made very good friends in all these countries. … Norman Heatley, who was one of those involved with the penicillin, we became very friendly with him, and so, we'd always visit him whenever we'd go over to England. … The Rhone-Poulenc Company, the group in France, and Farmitalia in Italy and Kabi, Sweden, all these were companies that had licensed processes from Merck, where we not only became very friendly from a scientific standpoint, but we became very friendly from the personal standpoint, too, Japan especially. Japan, we were over for nine years, … with two objectives in mind. One was to be responsible for getting new Merck products licensed in Japan, through their Food and Drug Administration, especially the chemical part of it, and, also, to see what could be done about finding new products, discovered in Japan, which Merck could license to sell around the world, other than in Japan. So, I would visit laboratories over there, to try to do that.

We did end up with four major products, really major products, that had been discovered in Japan that Merck got exclusive rights to. … I don't know whether you've ever had Pepcid, by any chance, or not. It's something that people advertise for heartburn. It's in the regular drugstores now. That's one of the Japanese discoveries that I brought over to Merck and Merck had it for about ten years as an exclusive product for prescription, and then, it was released to drugstores and it's actually distributed now by Johnson and Johnson and Merck together, as a joint [venture], because Johnson and Johnson handles that type of distribution better than Merck

does, and another product that is called Avermectin. It's the most widely used agent for worms in farm animals now. If you have dogs and … worry about heartworm, this is used exclusively to treat that.

It's also the drug that's used, given away free by Merck, in Africa to prevent river blindness. It's a very major disease in Africa and Africans have no money and Merck said, "Well, we will make the drug free, freely available, no cost whatsoever, but you have to figure out how to distribute it to these people that are out in the boondocks." … Jimmy Carter, President Jimmy Carter, accepted the responsibility, through the Carter Foundation, for making those arrangements. So, he made the arrangements with the heads of the various governments to set up the way that the drug gets to the individuals, but it is the very same drug that is sold for animals in the rest of the world. Merck makes a lot of money on it. Five hundred million dollars a year in sales, just for farm animals, but … it's the same drug that's used, given away free, in Africa. Avermectin came from a microorganism that was found on a golf course in Japan by our cooperating Kitasato Institute. We asked for two thousand unusual microorganisms from their collection, and they did so. … One of those organisms produced this product, … avermectin, which is in very wide use. So, the contact with Japan has turned out to very well, from Merck's standpoint, obtaining major products to supplement the products that are discovered locally.

We became very friendly with the Japanese people there. In fact, we'll be getting together with them Sunday. We're going up to Anchorage and [will] take a cruise down the coast to Vancouver. … Every two years, we've been getting together with a group of these people that we met in Japan. They're not all Japanese. There's some British and some from other areas, but [we] get together just for old time's sake. So, we'll be doing that this weekend.

NM: Did you see any of the war's devastation in the countries that you were traveling to in the 1950s?

HBW: Yes. The devastation we saw, mostly, was in Europe. We went over to the International Microbiological Society meeting that was held in Denmark. … I don't know; it was right after the war, 1947, in any case. … We initially went down to Switzerland to take a little vacation beforehand. We took a train. You couldn't get to Copenhagen … by land at that time. The only way you could get in was by flight, because the railroad lines had all been broken. We did take the train up to Amsterdam and we went through Rotterdam. There was a stop in the middle of absolutely nothing. You can't believe it. I mean, the war had been over, but everything was just leveled. You might be in the middle of one of these … fields out in the West, where you see nothing, because there wasn't a house, there wasn't a building. There were the remaining roadways, but that's all. … I hadn't realized the level of destruction that had occurred in these major cities, from air bombing, and the like. … In France, a lot of the areas that the train went through were still very, very badly damaged. The level of destruction was just unbelievable. By the time we got to Japan, of course, Hiroshima and Nagasaki had all been rebuilt, so that [only] the remains are there of the things they left purposely from the atomic bomb. Tokyo, which was actually more destroyed than Hiroshima, was completely rebuilt, no remains of the war there. …

I hesitated very much going to Japan. They wanted me to go, because they were having trouble with getting new products introduced over there, but I had never developed a friendly

relationship with any of the Japanese that had visited us. I think it was primarily a language problem, more than anything else. They were fearful and just didn't seem very friendly, is the best way to put it. … On the other hand, I was tremendously respectful of their scientific abilities in Japan. Merck had licensed a Japanese process to produce glutamic acid, MSG, that is, which is a discovery that was made in Japan. It was obviously an enormously important discovery. … We'd also licensed the ability to make lysine as an animal feed supplement from [the] Japanese, both of them made by microorganisms, but very creative type of research. So, I expected to find some really very creative research when we got over there, but I just hadn't … expected a friendly relationship. Well, when we arrived on the scene, I guess, on home grounds, people are very different than they are when they travel. We found them very, very pleasant, … had a really, truthfully, wonderful relationship there. I can certainly say some of our best friends are the Japanese, still, from those days.

NM: It sounds like you visited and revisited these countries. At what point did you start to see the rebuilding process?

HBW: … They're different years. … I used to go back to France, and, certainly, the reconstruction went very rapidly there. That first trip that we were over there, which was right after the war, it was still obvious destruction as the … train went through the various cities, but, going back a few years later, that did not exist. … I guess you expect that type of thing to happen, but the thing that was more interesting to me was our relationship with Spain. When we set up the research facility in Spain, to search for antibiotics, it was a very … primitive, maybe that's the right word, country. Some of the people were living in caves, in the hillside, no houses at all. … The big thing, in fact, that the company had, that we were cooperating with, was the fact that they had showers, so, any worker that would go there would have showers. The general population really had very little access to water. You go back to Spain now; … everybody's rich. Now, you don't see the level of poverty that you can find here in America, … so that in these countries that were extremely poor at one time, they have benefited enormously. …

It's not only a case of just repairing war destruction, it's a case of [the] economy changing tremendously to allow these countries to do that. … I know it hasn't occurred to the same extent in South America, but it has occurred some. The poverty in Rio, for example, was pretty unbelievable, too, and I haven't been down to Rio recently, but they tell me that a lot of that has changed. … I have a niece who was a missionary in Mexico City and her effort was all with the people … that simply moved into the city and settled on land on the hillsides, where they didn't own the land. … When she first went down there doing that, maybe ten, fifteen years ago, poverty was very, very severe. The kids didn't get any education or anything of the sort. Nowadays, … almost all those children are accepted into the school system. So, it's happening in Mexico, too, a change in the economy where conditions are getting much, much better than they were before. … I couldn't say I really saw the recovery of things from the war. We either saw it destroyed or we saw it fixed. …

SI: Did you ever go behind the Iron Curtain?

HBW: … I've been in Moscow, maybe three, four, five times, but only, really, in the airport area, and we went to St. Petersburg two years ago, but that's the only time I've really been there.

… I've been beyond what was the Iron Curtain, in the Czech Republic for example. … Actually, several times, we've been there. We've made good friends there, have gone over there to visit them. There are very good microbiologists and they've had several international meetings in Prague that we've attended, and then, traveled around that area as well. … If you assume that Czechoslovakia is reflective of the Czech Republic, yes, we've seen conditions improve there, very, very greatly.

SI: Throughout your career with Merck, how have you worked with Rutgers? What is the relationship like?

HBW: I've always been very closely associated with Rutgers, because of my association with Waksman, as much as anything else. They set up the Waksman Institute for Microbiology and, of course, Waksman was there, actively directed it for awhile, and then, Oliver Lampen came in, but Waksman still continued on. … As he got older, very frequently, he would call me up at Merck on the phone, "Oh, I've got something exciting to tell you. Please come down right away, instantly." So, I'd drop everything. By the time I got down there, he'd forgotten what he wanted to talk to me about, [laughter] but he just enjoyed talking over old times, is what it came down to. So, I did have a lot of contact. Also, I was very friendly with Robert Starkey, who was the other professor in the department, who later headed the Microbiology Department in the Ag School, after Waksman left to go to the Institute. So, we'd get together there, and, through the Theobald Smith Society, which is the state microbiological society, where we had a lot of contact.

More recently, I've gotten involved with setting up the museum that they have in Martin Hall. That has, really, two points. One was that it was the hundredth anniversary of the establishment of the first program in soil microbiology in the United States, which occurred at Rutgers, and, secondly, to emphasize … what has developed out of the lab, and, of course, a lot of the emphasis goes to Waksman and the Nobel Prize. So, I was fairly active, for a period of time, maybe a couple of years, getting that together. They employed some topnotch organizers, people that were responsible for arranging the Museum of Science in New York City, and they were really very good, coming up with good ideas. We had many problems, how to resolve things, because microbes grow fast and die fast. … The question was, "How are you going to demonstrate things like Petri dishes where actinomycin is killing microbes?" Well, … in Japan, almost all the restaurants, out in front, have wax models of everything served in the restaurant. So, we went to one of the wax modeling manufacturing companies in California and they made Petri dishes with microbes. They really did a beautiful job of making permanent things to demonstrate microbiological processes. So, I was busy handling that. I was not active in the [Rutgers] Alumni Association, going down for the fiftieth, fifty-fifth, sixtieth, you know, reunions. It was a surprise to be elected to the Hall of Distinguished Alumni. So, my family and I attended that, and I had to wear a tux for it. [laughter] …

Rutgers has meant so much to me in the past. It's always been my second home and a lot of the microbiology meetings have been held there, so, I'm very familiar, running back and forth. I, for a period of four or five years, was on one of the visiting committees for the Waksman Institute for Microbiology, but I've never known the group there as intimately as I have the group at the Ag School, other than those who were in the Ag School initially and moved over there. … The

ones who came in afterwards, after the Institute was established, I never really had that close of contact with them.

SI: I read that you were also the founding editor of *Applied Microbiology*.

HBW: Yes. That came about because the society used to be called … SAB, Society of American Bacteriologists, but, then, they changed the name to American Microbiological Society, but I had been very active in that, because, of course, of many papers published dealing with antibiotics, and so, I had written, co-authored, a number of papers that had gone into the society journals. … Most people that were doing applied work couldn't get their work published by the society journals. The journals were almost all managed by medical microbiologists and there was a lot of dissention developing. The society was the largest single-subject biological society in the country, so, they were proud of the fact, how big they were, but they were very worried about the fact that it looked like the society was going to break apart. Well, it did break apart, to an extent, in the sense that a society for industrial microbiology was started. … That was fairly small, but it had maybe 150 or two hundred members, and there was concern about the fact [that] this is going to become a competitive society. That had happened in England, where, originally, there was only one society and, now, there are two that are about equal in number, just because the applied people broke apart from the more fundamental, medical people. …

What finally happened, I joined the Industrial Microbiology Society. I never attended any of the meetings. I just joined because I thought I should, to know what was going on. Several of the people in my department … were active in it. They said they wanted to be completely democratic. They didn't want to have a nomination committee. So, they would circulate [to] all the members, "Who do you want to be president?" and then, they'd get the votes in. The top two, they would send out for an election. Well, the fifth year they did that, I'd never attended a meeting, yet, I got nominated for president … and won the presidency. [laughter] Well, the people at the American Microbiological Society would say, "Here, what's this? … You're going to try to aid the competitors?" "No, I'm tremendously interested in American Society for Microbiology." So, they finally had a meeting, decided the answer to this was that they would set up a new journal that would cover applied microbiology, so, they'd have the *Journal of Bacteriology* and the *Journal of Applied Microbiology* as side-by-side journals. … I agreed that that was a very good idea, as a member of the group. They, apparently, then contacted a committee to try to recommend some person to be the editor to start it off. … One of those on the committee was Wayne Umbreit, who was a professor at Rutgers for a long period of time, so, I'm sure that Wayne put my name in and must have pressed it. So, I was asked if I would be editor. So, I said yes. It took a lot of time, I must admit, but we got it started. …

During the ten years that I was editor, it really didn't make very much money. It broke even, but it really helped, … held the society together. Eventually, it actually turned out to be the most profitable journal the society has, because, as it turns out, I guess there are more applied microbiologists than fundamental microbiologists. It has become a very large journal. … It succeeded in doing what it was supposed to do, keep the Microbiology Society representative for all microbiologists. The Society for Industrial Microbiology has about a thousand members now, but it's still a relatively small society, a specialized one. … I, luckily, had a secretary who was tremendously interested in editing, so that when I sent articles out to be reviewed by various

reviewers, she made certain that nothing really untoward showed up, from a grammatical viewpoint, so that it worked out very well. … Merck's been very good about allowing the members on its staff to be officers in scientific societies or doing things, like editors, and spending a fair amount of time. … I spent a lot of time, inevitably, reading things at night and the like, but all of the real handwork was done at Merck and Merck paid for it.

NM: I also read that you are part of other professional societies.

HBW: Well, … American Chemical Society, I've been with, of course, and the AAAS, [American Association for the Advancement of Science], which is the wide biological society, publishes *Science*. I've been with that all along. … I joined the societies in England, the microbiological societies. … About four years ago or so, I was elected to the National Academy of Sciences, … basically, because of the antibiotic work, as well as vitamin B12, useful for animals. So, I've had a lot of contact with such societies. I tried to attend meetings fairly broadly, for a long time. I've dropped out now. I really haven't done it for the last eight or ten years. … I've gone to small meetings, specialized meetings, but the big meetings, where they have a thousand, two thousand people there, I don't really want to go to anymore. …

I did keep a laboratory down in the basement for, about, twenty years. I retired in '82 and kept it up until two years ago. … My wife and I, after I retired, discovered it was possible to buy a year's airplane ticket on Continental Airlines very inexpensively, which allowed one to … travel twenty-five times during the year, because you had to stay over a weekend. So, that meant, if you're going to stay over a weekend, well, you couldn't go every week. … I'd had a big project in Australia that I'd set up. The problem in Australia was the fact that Merck had tremendous sales in Australia, but did no research there. … Merck finally set up a veterinary laboratory in Australia, but, still, if one looked at the total dollars they were spending on research, it was very, very small. Well, somebody got the idea [that] the best thing to do was to divide the Merck Company in Australia into two companies. Then, they'd be smaller and wouldn't get all this criticism from the Australian government, but, then, they worked things out and they discovered they'd be number one and number two, and that's even worse than being number one. [laughter] So, they finally saw we had to spend some money over in Australia to do basic research. They were happy with the amount we were doing on applied research, but it was the basic research that was needed.

So, I was able to set up a project at the University of Western Australia, where they would isolate large numbers of microbes from all sorts of different soils in Australia and try to determine whether the microbes differed from one another, the extent that they differed, sort of a general biology study of the soil microbes. … Then, with all these microbes that they had isolated, they would also check to see if any of them produced antibiotics, so that Merck would at least have the benefit of having a great screening program going for new antibiotics and the government would be satisfied by the accompanying basic research program, on microbes in the soil. So, this was going along very well and we worked out quite a lot of the details of how soil organisms are evaluated. So, I decided that, after we retired, we would do is the same thing, but we'd do such things in the Hot Springs in Arkansas, and up on top of a mountain, various places of that sort. We were returning to Japan quite frequently, because I was made an honorary member of one of the universities there and we'd go back for maybe a month or two every year. So, I did the same

thing over there. … I prepared culture media, took Petri dishes out into the field, selected soil samples and, in the motel at night, I'd plate them out and bring them back and incubate them at home, to try to isolate microbes from these very unusual natural sources, to see if they would produce a higher incidence of unusual new products. … Then, I made arrangements with a company in Germany, and with a university in Japan and with Merck, that they would receive the cultures … that produced activities and to see whether they were interesting products. …

I had a lab in the basement, where I isolated cultures from unusual areas here. The others, we isolated elsewhere and brought them in and worked with them here and sent them around. … I obtained five to ten thousand unusual cultures, during the ten-year period, and I summarized, recently, the frequency of detecting unusual things, things that had not been known before, from these very wide-ranging sources, compared with screening programs, such as Merck operated in Spain and others that had been published elsewhere. … I ended up getting about ten times the frequency of unusual products from these unusual sources. I won't say it's any more efficient, in terms of working hours. You can isolate a hundred thousand organisms in a few days in the screening programs such as … Merck has in Spain and it would take me a long time to do that, going different places, but [I] at least proved the point that microbes do differ in nature. … If you go out and take five samples from the field, they're probably all going to have about just the same microorganisms, but I take one sample here and another from the Hot Springs, why, you're going to have very, very different organisms. So, we had that as a fun activity, in the basement, and have kept it going. … That's about it.

NM: I also read that you are involved with undergraduate scholarships and a fellowship for graduate students in microbiology.

HBW: When streptomycin was discovered, as I guess you know, all the history, it started to earn royalties and the royalties came into Rutgers. … At that time, Rutgers had never had that happen in a major way and they had no formal relationship [as to] how to handle royalties when they come in. … Initially, it was decided, at Rutgers, that it would be the best thing that the royalties should go back to the laboratory where the initial discovery was made, which would decide where the funds would be used, either in that laboratory or the general laboratories. … Waksman was appointed the individual who would see that these funds would go to the various areas. Well, royalties started to accumulate even more and they added additional functions onto Waksman's responsibility, and they did make some arrangements, that certain funds, he would be able to direct where they would be used. …

Then, of course, the Schatz case developed, where Schatz felt that he should receive a certain portion of the royalties and, also, he was very unhappy, because he had not received the recognition that he thought he should have as part of the Nobel Prize Award. … In resolution of the suit, it was decided, at Waksman's strong recommendation, that the major portion of the royalties should go to the University and it was decided, by that time, of course, they would establish the Institute for Microbiology as the place it would go, that a smaller percentage of it would go to Waksman, which he could distribute elsewhere, wherever he thought it would be right, and a portion of it would go to him for his personal use. … He insisted that, if Schatz were to be compensated, that not only Schatz, but all the students that had anything to do with antibiotics, students now, former ones and laboratory workers, should share in the royalties. So,

even though I had nothing directly to do with streptomycin, since it was discovered after I left, but because of the technique that I had worked out to isolate streptothricin was applied to streptomycin, I was to be included among those, as well as our dishwasher in the laboratory. …

There were a large number of people that came into this, but, in any case, I did receive a small percent of royalties, a small fraction of the royalties from the streptomycin [patent], over about a ten-year period, until the patents ran out. Jeanette and I really had no major need for this, so, we decided, "Well, we'll just invest it in the stock market," and, luckily, we put it in Merck and Company stock, [laughter] rather than the general stock market, "and what we will use for ourselves is anything it earns, dividends, but we'll let the principal remain and decide later what to do with the principal." Well, Merck's stock went up about a hundredfold. So, it ended up that the small amount at the starting point was growing up to millions of dollars, [laughter] so that we decided that it's still the appropriate thing to do, the principal should go to various places. I felt that, in a sense, the Microbiology Department in the Ag School had been somewhat shortchanged, by the reason of the fact that it didn't receive anything and the Institute for Microbiology received everything. … I also felt that maybe the best thing to resolve this would be that, since I had a departmental fellowship during the period I was there, that it would be well to set up a departmental fellowship, … an endowed assistantship that would … be limited to a graduate student in the Microbiology Department at Cook College, working in the field of soil microbiology or … environmental microbiology. Environmental microbiology is the more popular name, rather than soil microbiology, now.

So, we did so and set aside a million dollars for that. … A million dollars gives about forty-five thousand dollars a year [in interest] that a department can use and that's adequate to cover one or one-and-a-half graduate students, and that, now, is a permanent thing. … We set up about an equivalent amount in an irrevocable, charitable trust, a portion of which will go to Rutgers, not the complete amount, but a portion will go, again, to the Ag School, later on, and this takes care of the principal that has developed out of the royalties that we received from streptomycin. … I think, from our viewpoint, it was fulfilling an obligation that we felt existed and trying to do it in such a way that it would balance out what we thought maybe should have been done in the past, in terms of the way the distribution was made.

SI: What did you think of the Schatz case and the issues it entailed?

HBW: Well, … this has been brought back to mind recently, because there's a man at the University of Pennsylvania who is trying to get published a paper that claims that Waksman purposely worked in every way he could to downgrade Schatz after the suit was brought and to glorify himself. … He sent me a copy of the paper about a month ago, for comments, and I sent very strong comments about it, but I personally feel that Schatz could have resolved the problem in ways other than bringing a suit. In other words, I really felt very strongly that he'd made a mistake by bringing this suit. He not only caused all sorts of complications and concerns, but he basically destroyed his own career, because, once having done that, practically no one would take him as a member of their department. …

It seemed to me so completely unnecessary, because, of all of the people that I've dealt with, Waksman has been open to discussions, open to work things out, and, surely, it would have been

possible, with appropriate, advisors, I guess, is the right word to say, rather than the legal advisors he had, to have worked the thing out to almost essentially the same conclusion that presently exists. Now, I don't know how much Schatz attributes his problem to lack of financial recognition and to the Nobel Prize situation. I feel very strongly that Schatz had absolutely no part in the Nobel Prize situation. Nobel Prizes are given almost entirely for individuals who have developed a field, made major developments in the field, and something very practical or exciting has come out of that, can be fundamental or it could be practical, that has made it noteworthy. … As a result, those two things together, having developed the field and a major development, is what … goes into the recommendations when one receives a Nobel Prize, and the man who made the announcement at the Nobel Committee, when Waksman got his prize, made it very, very clear, he said, "This prize is for the great developments you have introduced in the field of soil microbiology, *resulting in* the discovery of streptomycin." Schatz spent about three months in the laboratory before streptomycin was discovered. He had nothing whatsoever to do with this proof of TB activity.

On the other hand, I have to agree, he made one of the most important inventions in the world by having discovered that culture, and I think, very clearly, … New Jersey has its hall of honored inventors, [the New Jersey Inventors Hall of Fame], and he should be a member of that hall of honored members for what happened, but I don't think he had any rights or any claim whatsoever on the Nobel Prize. So, to what extent his filing the suit was due to his dissatisfaction with the Nobel Prize or the lack of financial recognition, I don't know. Personally, I don't think he deserved the Nobel Prize. Personally, I think he could easily have worked out, … through negotiations in an appropriate way, something that didn't lead to the suit. Once it led to the suit, it led to the resolution, in a way that it should have been. … Rutgers clearly was wrong in the way that they had gone through this thing in the first place. They were inexperienced, they hadn't had that type of thing and, if you look back on the record, I don't think it was a very logical system that they used for working these financial arrangements out. They eventually came to what's logical, but the University of Wisconsin had gone through this, completely, on, as you know, vitamin D in milk, … so that the knowledge was there, how to handle problems of this sort, and Rutgers did not follow that knowledge. … Probably, it wasn't even aware of it, the lawyers that existed at the time. So, you know, I hold Rutgers at fault for what it did, but I hold Schatz more at fault for not having resolved the problem in a more reasonable way, and I think it could have been, from my knowledge of Waksman. You know, any problem I'd ever had, he was perfectly willing to discuss things. … Certainly, he's going to not fall over, to immediately accept it. You have to convince him, but he can be convinced, or he could be convinced, there's no question about that, so that it's just a really, purely unfortunate thing that led to a near destruction of Schatz as far as a scientist is concerned and led, in the end, to what is probably the appropriate way to handle such things in the future.

You know, I have no antagonism for Al Schatz. I've been together with him in meetings. … In fact, to tell you the truth, I've been very pleased at what the University has done. It started with the graduate students and students at Cook College, where they thought he deserved recognition and they gave it to him, and there's a plaque on the wall, … emphasizing the fact that he was the co-inventor of the drug, and then, more recently, the University has made other arrangements, so that, two or three times, he's been, essentially, honored by the University, and I'm glad to see it. I mean, I disapprove of what he did, but I'm glad to see it, because I think he deserves what

recognition he has had in recent times. … It's one of the things I told the man who wrote this paper about Waksman. At Merck, we probably discovered close to twenty products, either discovered them or made improvements in them, that made marketable end products, and I would guess that as many as a hundred people were involved in the stages that led to the initial detection of a compound, proof of its activity, and close to a thousand people involved in each of them by the time it got out and reached the market, and never once in all that time have we had something of this sort develop. I mean, we have firm rules as to what is necessary to be an inventor and there are certain individuals that have to be there, based on what they did. I mean, the person who isolates the culture, the person who does this, the person who does that, and so forth, has to be on the [patent]. Others can be added, if … we feel that they've done satisfactory things. It doesn't mean that we haven't had disagreements as to who should be there.

The same thing is true with papers. I think the vitamin B12 paper had about fifteen or eighteen authors in *Science*, when it was first published, but … Merck maybe goes over backwards a little bit, in terms of that. There still were people left out, could have been dissatisfied, but, on the other hand, we've gone through that whole thing and never had anything develop like this Schatz case, and it just was wrong that it happened.

SI: Is there anything else you would like to add?

HBW: Not really. I think we've covered everything that I know of. … At the beginning, I know when … someone contacted me, I said, "Look, if you want somebody, … your war experiences during the Second World War, I'm the last person in the world you should ask," because I had absolutely none, but the return that came back indicated that, "Well, we're broadening it now, to try to find things that had influence on the final resolution of the war," and, there, I can see that things that I was involved in … did play a part.

SI: Absolutely. Would you like to say anything about your family?

HBW: … No, nothing really, beyond the following. Our elder son, Brian, got his PhD … at the University of Connecticut. … Both sons attended Trinity College in Hartford as undergraduates. I must admit, at the time they were looking around, I didn't encourage them to go to Rutgers, simply because I felt that I had gained so much from a small college that I thought a small college would fit them better, and they visited many of them up in New York State and New England. … Well, Brian ended up at Trinity, I'm sure, ninety percent, because of the individual that showed him around. The student that took him in his own room and showed him what he did, here, there, and so forth, and, I'm sure he was strongly influenced by that student. …

Then, our second son, Hugh, was influenced by the experience of the first son. So, they both got their BS there, the one in mathematics, the other one in chemistry, and then, our older son, Brian, went on to get a master's at Brown in physics. He decided that wasn't an area that he was interested in and decided he was more interested in statistics. So, he switched to that and ended up with a PhD … from the University of Connecticut and he has spent, really, his life, up to the present time, in the Air Force, doing various things related to statistics. He's now retired. You've got to get out in twenty years, if you're not a pilot, and he isn't, so they set up a store that sells puzzles, all kinds. They've got five thousand puzzles, but he's essentially used his

experience to computerize that store, so that the computer tells him when to order and do things and everything else. … His wife is a statistician, too, so, they seem to be having a wonderful time there.

The other son, Hugh, received his PhD in chemistry from the University of North Carolina and went into Merck Research Laboratories from there and, since then, he switched again, over to computer science. So, he's mostly involved in computer functions and, just this last week, he was also appointed head of all of the library systems of the company. … I think they feel that computerization is the future, of the library programs and the like. So, that's why they decided they needed someone who had a computer background to head that function. … So, he's happily engaged there.

Jeanette, my wife, got her BS degree in home economics, at NJC-Douglass, and she taught at Princeton for three years, and then, we moved here. … When we came here, she worked for awhile, until the children came along, as a part-time in the extension service in Elizabeth, to give courses in cooking and sewing and things of this sort, mainly to adults around the county, but, once the kids came along, she's been a homebody since then. So, I guess that's the extent of it.

In the meantime, the years roll ahead. I'm eighty-seven now, she's … eighty-four, and, how much longer we have, I don't know, [laughter] but we're treating it as though it's forever. I guess that's the best way to put it. … I must admit, I'm sort of sitting around now, wondering what to do with myself, … also, because of the fact that I have not gotten back into the laboratory work since the museum work was finished, and I doubt that I will now, so, I don't know. I've been writing papers and doing the various things of that sort. … I haven't settled down yet. … I'm having my retirement crisis at eighty-seven, rather than at sixty-five, [laughter] trying to decide what to do next. …

SI: Thank you very much for sitting with us. This concludes our interview.

HBW: Okay, fine.

----------END OF INTERVIEW----------

Reviewed by Chris Brophy 11/05/06
Reviewed by Youngsoo Han 11/05/06
Reviewed by Shaun Illingworth 9/4/08
Reviewed by Sandra Stewart Holyoak 9/10/08
Reviewed by H. Boyd Woodruff 9/22/08 & 5/22/09