NATIONAL Life stories

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NATIONAL LIFE STORIES

AN ORAL HISTORY OF BRITISH SCIENCE

Professor David Jenkinson

Interviewed by Paul Merchant

C1379/06

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Interview Summary Sheet	**Title Page**

Ref no:	C1379/06		
Collection title:	An Oral History of British Science		
Interviewee's surname:	Jenkinson	Title:	Professor
Interviewee's forename:	David Stewart	Sex:	M
Occupation:	Soil scientist	Date and place of birth:	25/2/1928; Los Angeles, California
Mother's occupation:		Father's occupation:	Merchant and farmer

Dates of recording, Compact flash cards used, tracks (from – to): 12/2/10 (track 1-2); 22/3/10 (track 3-5); 29/3/10 (track 6-7)

Location of interview:	Interviewee's home, Harpenden, Hertfordshire		
Name of interviewer:	Dr Paul Merchant		
Type of recorder:	Marantz PMD661		
Recording format :	WAV 24 bit 48kHz		
Total no. of tracks:	7	Mono or stereo:	Stereo
Total Duration:	5:25:28		

Additional material:	
Copyright/ Clearance:	OPEN
Interviewer's comments:	

[Track 1]

OK, could I start by asking you when and where you were born?

I was born in Los Angeles, in Hollywood Hospital, that was in Beverley Hills, on the 25th of February 1928. And, at the time my parents lived quite close by, in a rather nice area of Los Angeles. I remember a little of it. I remember the lemon tree in the garden, I remember the sprinklers in the lawn, in those days people didn't worry too much about waste of water. And, it was a very nice lifestyle. I remember our next-door neighbour, there was a boy of my own age. I remember we got into trouble once, we got a can of paint and stated painting the garage doors. We were able to reach up I suppose about two and a half feet, [laughs] being less than four years old. And, we got into a lot of trouble over that. I also remember actually in the garage there were black widow spiders. Now these were, in my memory, monstrous, shiny things, you know, about the size of golf balls. They're nothing like as big as that, but, Albert, our next-door neighbour, and I used to see these creatures in the garage, in the corner of the garage, and we were scared stiff. And of course they are very poisonous. Well these are inconsequential memories; you know, when you're, not quite four, you don't have very well organised memories, just things flash past, and some get stuck.
[02:00]
But, it was a very happy time there. It was, you know, a conventional, comfortable existence. My father was a very wealthy man at the time, it was just before the Great Depression in October 1929, and, he lost most of his money in fact. But, he was a pretty shrewd investor and he had enough left to keep him the rest of his days, and to raise us, his sons. But, he was a, a very shrewd man, had worked over most of, all parts of North America. He had lived in South America... no, not... in South Africa for a while, worked there as a wool buyer. And, a man with, who had gone out to America when he was seventeen, he went out to make his fortune. He had a gold guinea, or maybe it was a sovereign, I don't know, sewn in his waistcoat pocket for emergencies by his mother, and, as I say, he went off to find his fortune in America.
[03:35]
He arrived at a very bad time, would have been the 1890s, early 1890s, and, things were very hard. But he managed to, his first job was on a farm, he spent the winter on a farm, but, he didn't want to be a farm boy, he had left one farm to go, he wasn't going

to go back to farming. And, and then he got a job on, in steel mills, making pipes, steel pipes, and he was very good at mental arithmetic, he was very fast mentally, and he was very good at, you know, working out how many bundles you needed and what length of pipe you wanted in this bundle and that bundle and so on. He did all these things in his head. Nowadays you do them on a, on a calculator, but... Anyway, he, he did very well in that, and, he was very successful in many ways.

[04:30]

And, after a few years he decided he'd come back to Ireland for a holiday, which he did at regular intervals many times afterwards. But, when he came back, he thought about going back to the United States but he didn't want to do that, so he tried South Africa where he had a lot of cousins. And, he went to South Africa, finally ended up as a wool buyer in one of the towns in, inland from Durban. And, spent a few years there, mainly, mainly in the agricultural trade, and, buying wool from the Boer farmers who had come in with these huge ox wagons, you know, laden with bales of wool, and they'd come in for 'outspan' as they called it. And, he would assess, go out and take samples of the wool and, pay them, buy it and pay them for it, and then the wool would be sent off to Manchester. But, war was coming. Actually he was conscripted to work in one of the local, or to serve in one of the local militias. But, he, he had no taste for soldiering, and he saw war was coming. It was the time of the Jameson raid and so on and the, all that problem, the problems that led up to the Boer War.

[05:57]

And he left, came back to Ireland, another one of these holidays. He loved shooting, he was a great shot in his youth. And, headed off to America, and, with another cousin of his, he had, big families of course in Ireland in those days, he was one of eight, and I think, the cousins, there were ten in the family and so on. So there were plenty of cousins and brothers and what going back and forth. Anyway, he went back to America and, again it was hard times. This would be in the, the beginning of the last century I suppose, just about 1900, maybe a little earlier. And, he went looking for a job, didn't find jobs, and, his cousin who was with him, Tom, joined the American Army, and was sent to the Philippines, and, he lived there. He married a Filipino girl and lived the rest of his life in the Philippines. But, his son in fact I knew later, much later, he was in the American Army, I came to know him.

[07:08]

But, anyway, to go back to my father. He spent... went further west, and, took a job on the trains. He was... In those days they had, they didn't have a buffet car or anything of that sort, they had boys or young men who would take a tray of food or soft drinks or newspapers, sweets, what have you, round the train, and he'd go round the train. And of course in those days trains were everything in America, every... it was before the automobile, everybody went everywhere by train. And he used to, he made a living at this, made quite a good living. And then he started up a franchise with other people working for him, including his brother. And gradually he established a position in America. He made a, made a place for himself, became, quite an effective businessman. He had a warehouse in Kansas City, and he, he... where he was based, and he would go out east each year to the factories in Cleveland, Ohio, and places like that for, who were making china and clocks and all this, what he called dry goods, and then, he would go, he would get samples and take these samples in his suitcases, and he'd go to the little towns all over the west, in the south-west, Arizona, Utah, New Mexico and so on. This was what he called 'his territory'. He was basically a commercial traveller. But he had his, he had his organisation behind him, his warehouse and so on. And he'd sell these, he'd sell so many clocks, so many pots and pans and so on to these people. And then they would be delivered from his warehouse.
[09:10]
So he did this interspersed with trips back to Ireland. And, on one of these trips he met my mother, who was much younger than him, twenty-five years younger, but, they married, and moved out to California. And, she, she essentially ran his office in, in, from their house in California, in Los Angeles, and he, he... At that stage, I was born, and, he started working a little bit less intensely, part retired, and, playing the stock market very heavily, but he was pretty shrewd, he didn't, he didn't go on what he called margins, buying what we would call futures, you know, he wasn't, you know, in hedge funds or anything of that sort that they, they have nowadays. But, he was a very wealthy man, and, lived very comfortably, had a lovely house. They had a telephone, electricity and, och, gas and running water. All these things were absolutely unknown in Northern Ireland you know.
[10:29]
And, so, as I said before, the slump came, the stock market crash. And after a few years, about 1932, he decided that... He either had to go back to work full-time, or retire, and what he did was, he retired and came back to Ireland, and bought a, bought a

house near between Armagh and Portadown. Quite a big house. It had been built by a bookie, Bookie Kelly. And you're supposed to be able to hear his ghost, saying, 'Two to one the field,' [laughs] if you listen at the right time. Anyway, this house was built on, there was a small farm attached. And, it was in a terrible state, the house. And, while the house was being repaired, my father and mother and my brother and myself all lived in my grandfather's farm, Brookvale. And, must have been very crowded because, my grandfather hade two daughters, a son, himself, his other daughter, my father and two kids in the one place. [laughs] I don't know how we managed, but we did anyway. But anyway, he, he, we stayed there for six months while he, while the house was fixed up for us. But fixed up is a very grand word. As I said before, it hadn't any electricity, hadn't a telephone, water you had to pump from the well. In fact this was one of the family punishments, go and do 100 pumps. And, for a really bad crime, you might have to do 1,000 you see. And you were pumping water from the wall up into a tank in the roof. [pause] So, it was, oil lamps; cold of course, no central heating. Fireplaces in all of the bedrooms, but, they were rarely lit, and, only when you were sick would you get a fire in your bedroom. And you would, you would go to bed clutching a hot water bottle and an oil lamp in the other hand, and this, there would be great draughts howling around the hall and so on, and this lamp would be flickering and smoking and so on. All very romantic if you like that sort of thing, but, a bit miserable at the same time. [laughs]

[13:07]

Anyway, so, we lived there, and, and that was, a little farm. A tiny little farm really. Of course it wouldn't, it wouldn't have been economic, wouldn't make a living, but, it, it amused my father, he liked, he liked, he liked fruit, fruit growing, grew a lot of apples, plums, damsons, and gooseberries, we had a couple of acres of gooseberries, much to our disappointment, we had to pick these damn things come July, and July in Ireland is always showery and wet and so on, and you'd be out in it, picking gooseberries. Again with cousins you see, we had lots of cousins. And, we were working away picking these gooseberries. I think we got three pennies a bucket for the gooseberries, which were then sold to a jam factory nearby. And then, currants, big money, you got 1s.3d, one and threepence for a bucket of blackcurrants. But, we kept a lot of, we kept cows, cattle, sheep, we used to have a lot of sheep. But... And, we kids used to help with the farm, as you would expect on a farm, kids, of farm kids. It was a, it was an interesting farm. A little river in it. And, there was a quarry, a rock quarry,

Silurian shale, and, we, we were always very impressed. There may have been, there would have been life in it, fossil huntings, but, Silurian fossils aren't all that interesting, and, we never found any. But, there used to be oil in, you used to see the oil seeping out of the shell, and we were very impressed, we thought this would be a great source of wealth, but, [laughs] it never did come. But, anyway. There was lots of flowers, all the wild flowers that you get in unfertilised meadows. You don't see them nowadays of course, but... And, plenty of birds and birdlife. Foxes, much to our annoyance. Foxes were always stealing hens, we kept hens. And, very often the hens, we kept hens in the orchard, and the hens would be, you know, instead of going into the hen house at night, they'd go under the trees, and then of course a fox would come along first thing and, charm them out of the tree and gobble them up. So we had to chase the, the hens out of the trees. [pause] There used to be a couple of fellows, they were well known as being no good, in other words, they wouldn't work, and they made a living out of hunting foxes. They'd dig them out of their earths, and, they used to take them to the police station, and, this was during the war, and you would get a bounty on each fox's head. And the policeman would punch a hole in the fox's ear so that he didn't, [laughs] present it twice. Anyway, these fellows used to, they'd spend all day digging. I mean, they were supposed to be work shy; they actually in fact worked very hard to dig out a fox. And, we used to have these fellows about.

[16:35]

But, oh it's just, typical farm life of the time. We had an old man that worked round the place, and, he was an ex navvy in fact, a ferocious man. We were all a bit scared of him. I mean, he'd been in jail in his young days, in fact even quite, not long before he was with us. But, I remember a story about him. He went to this pub, and he'd get roaring drunk and the publican threw him out, and he threw him physically out, he was so drunk, and you could hear the, apparently you could hear the clunk as his head hit the pavement. Up Matt got, that was his name, and straight back into the pub fists flying [laughs] So, he was a pretty, a really terrifying man. But he was very strong and did a lot of work around the place. And we had usually a maid, and, there was always somebody to help my mother. So it was a very typical farm life, but not really economic, not really serious economic farming. For that you would have had to have had a much bigger farm, and, my father would have had to have been much younger.

Mm.

I mean he was way into his sixties at this stage. So, that was, sort of, the background.

[18:09]
Were you, apart from the spraying of the garage door, I wonder whether, at the age of three or four, before you left America, you were old enough to remember the Los Angeles house in enough detail to describe it?

Oh yes, I can. In... It wouldn't be an architect's description, but I can remember the, the living room and a piano and so on. I can remember, as I said to you before, the lawn particularly, and there were these bronze, faucets they called them, the taps, sprinklers and so on, and they were, they were in the form of frogs.

Right.

And they, they squirted water over the lawn and so on. I was very impressed by these, and, you could run out an get squirted at the same time and keep cool, because it was pretty hot a lot of the time. A nice house. I haven't seen it from that day to this, although, one of my nieces went there a few years ago and had a look at it and came back with some pictures. It's still a nice house, a Spanish style bungalow you know. But, it's, of course, Los Angeles is a very different city now, a city with racial problems, areas you don't go to. Smog. In those days of course it was clean, relatively clean. Although I remember actually my mother talking about in the, the San Bernardino Valley, which was a big orange-growing area at the time, it's now, it's, it's now, something to do with photography mostly, but, they had these pots of oil, they used to have crude oil, and they put these pots in between the orange trees if there was danger of frost, and light them. And there was the most awful black smoke that covered the whole, the whole city, if the wind was in the right direction. And you got this smog then. But that would of course be in the winter. The San Fran... the... sorry, I keep saying San Francisco. The Los Angeles smog of course, the famous one where you got these enormously high ozone build-ups, was a much later phenomenon; this was caused basically by oxides of nitrogen and car fumes, but that's much, that was much, much later. That was away into the Sixties and Seventies. But at that time it

was a lovely city. You've asked me about the house. I can't really tell you much more about it.

[20:47]
Do you remember any natural landscapes, American...?

Yes I do. Yes. I remember the Rancho La Brea, the oil pits, where the, these fossil creatures were trapped, you know, they've got these bears and what have you and some early carnivores of different sorts, some of the big cats had been trapped in the oil, and these used to sort of sink and then bubble up again and you'd see these skeletons coming up. I remember being taken to see that. It wasn't very far from where we lived. They're still there I believe.

Who took you to see those?

Pardon?

Who took you to see those?

Oh my mother and father. Probably my mother actually. And, I remember being very... It was all fenced off of course, so you couldn't fall into it yourself and become a fossil.

[laughs] Mm, yes.

[laughs] But, I remember seeing that. I remember actually seeing a railway, I don't know where the railway was, but it was near where we lived, and, seeing men walking along the railway track, and they were black. And this is the first time I'd ever seen black people.

Mm.

And, being a little surprised. I wouldn't be surprised now in Los Angeles, it's a very different city. But... And we used to go to the beach, and out to Catalina Island, I

remember in one of these glass-bottomed boats out, looking at the fish and so on, going there. The... We had lots of friends, my mother had a lot of friends, in fact as I said, the next door neighbours' boy, who actually was killed later in the war, but, we were great friends with them, people called Lewis. But, I didn't go to school of course, I was too young, and... What else do I remember? These things are very...

[22:55]
Could you tell me about the effect of the, the stock market crash on, on your father, and possibly on the wider family, at the time, if you can remember?

Yes. Yes. I don't remember that of course, but I remember my mother telling me as, as the bad news came in on the radio, you know, day after day, and he was losing, you know, thousands, hundreds of thousands of dollars. You know, he took it very philosophically, which is more than I would have done. [laughs] But, you know, it was good, he'd, he'd come from nothing, he'd come from a poor farming background, and, you know, he, he'd done well, and he lost it. Well he hadn't lost it all. He was a very strong-minded man you know, and really, philosophical about it. And... So we used to talk about rags to riches in three generations, the first generation made it, the second generation enjoyed it, and the third generation were back to rags again. [laughs] I think he saw himself, in a sense he had done that in one lifetime.

Mm. Mm.

But, it didn't worry him. He was, a very self-contained man. I don't, I don't ever really think I was able to talk to him in, in intimate detail, you know, he was al... there was always a barrier between him and me, and, he was, you know, there was no, there was no coldness or anything, it's just that, he was very self-contained.

[24:23]
What sort of things would you talk about with him?

Oh we'd talk about shooting and farming and, all these sort of things, and, local politics and all the rest of it. You know, he was, he was, he was a very strong Republican in America, and, a great believer in the American dream you know, of, of making your

way and so on, which he had done. And I was of course, when I became a bit older, was very left-wing, and we used to argue about that.

What, what age is this, when you...?

Oh that would be seventeen or eighteen.

Mm. So this is, yes, so...

Much later, much, much later.

Yes. Can you remember the sorts of things that perhaps you wanted to talk to him about but felt that you couldn't because of this distance? You, you felt happy to talk about politics, and to talk about shooting and that sort of thing.

Mm.

Were there things that you wanted to talk about but, but felt you couldn't?

No I don't think so. He, he had a career in America which... He saw a lot more of life than I did. And, he didn't talk a lot about some of the shadier things he'd seen. But he had seen things which were, not nice.

How did you know that he had seen those things?

Occasionally he'd drop a hint. But he'd never talk about them.

Mm.

He used to cross over the border to Mexico sometimes and, he saw things there he shouldn't have seen and so on, you know.

Mm. The sort of, in terms of violence or...?

Yes. Yes.

[26:00]
Yes. OK. Could you then talk about your relationship with your mother?

Yes. She was a very different person, she was very religious. Although my father was religious, outwardly certainly, I, I never, don't really know how religious he was internally. He never talked about it. But, she was very religious. Came from a strict Presbyterian background, and was, a gentle person mostly. She, very conscientious, very determined to see that her children had the best education she could get them. She ran the house with a firm hand, but, with humour, and, I mean she had always plenty of time for a joke with the girls that worked for her, the maids and so on. But she was, you know, nobody would [laughs] pull one over her eyes. But, she was a, rather bookish person in a way, she read a lot. And, she was, had a better education of course than my father. My father had left school at fourteen and then, he'd run away, he'd been apprenticed to a draper and he ran away, he was so badly treated. And then went back to school for a couple of more years. But that was all the education he had. She had a, a much better education. She, not university, but she'd gone to high school and so on. And she'd been to a course in Dublin on domestic economy and this sort of thing. So, she was a more educated woman, with, very, she was quite a talented artist in her own way. She played the piano. She was very good at the piano, she was an organist in the local Presbyterian church before she married, and, a skill that she passed on to none of her, [laughs] her sons. But, she was, a fine woman.

[28:26]
And, I wonder whether you could, you mentioned that your mum read a lot. Do you remember what she read?

In Brookville[ph] there were a lot of books. There was, oh of course the traditional *Pilgrim's Progress*, the Bible and so on as you would expect in any religious, Northern Ireland religious home. She read a lot of H G Wells. She was, into a lot of, a lot of novels of the time. She wasn't into philosophy, but she was into, particularly after her American experience, a lot of these self-help books which were very fashionable in those days, you know, on the borderline between philosophy and, and psychology, she,

she'd read a lot of those sort of things. She wouldn't have been taking them too seriously, but, she used to read those. She read, she read all the, you know, the classics, Jane Austen and so on and these sort of things.

Can you remember the titles of those self-help books, or the kinds of titles?

No.

[29:33]
No. Do you remember her reading to you?

Oh yes, yes, she, she would read to us when we were small. Oh yes, yes. Yes. And... Well this was, well, always done as part of the family, just as I've done it to our kids.

The sorts of things that she read, do you remember that?

No. I can't remember offhand.

Mm. What about your father?

There would be *Swiss Family Robinson*, you know, and these sort of things. I started reading very early, and I read *Robinson Crusoe*, which she supplied, she obviously knew the book. It was in fact the first book I read. But, I don't remember what she read to us. That's strange.

[30:24]
Do you... Could you tell me about the relationship, as you saw it, between your mother and your father?

He was very much older than her of course, he was twenty-five years older. So that meant, made a gap between them. But, never... [pause] They worked well as a couple, although they were, my father was, was a much more remote man as I said; my mother was more emotional and more, more religious. But I mean, I remember once, a lovely summer evening, seeing them walk out arm in arm down the, the lane up to the fields,

and, they unfortunately looked backwards, and what did they see coming out of our bedroom, my brothers' and my bedroom window, but black smoke. We were burning camphor balls in the bedroom. [laughs] And, you know, this rather nice little arm in arm business ended very badly. [laughs] But, you know, I think it tells you a little bit about their relationship as well as their disobedient young... offspring.

Do you remember them going out in the evenings and that sort of thing?

Oh yes, they'd go down to my grandfather's place on, once a week, and they'd go over to my Uncle James. These are farms, you know, my, my grandfather, my mother's father was David Glass, and Brookvale was his farm. And they would go there once a week, and we'd be looked after at home, there'd be, whoever was the maid at the time would look after us. And then, they went over very often to my father's farm, which was then owned by his brother James. They'd go over there. Other than that, I mean it was Armagh, and it was, the depth of the country. You know, there weren't concerts or anything of that sort. And, there were cinemas but they didn't often, I don't think they ever went to the cinema together, certainly I don't think my father ever went to a cinema, when I, as I remember it. My mother might have gone very occasionally, but I doubt it very much, sort of as a regular. And, church was the big thing you see.

Mm.

You went to church.

[32:45]
Well with the, with the image of the camphor balls burning and now that you've mentioned church, I wonder whether you could talk about the family morality if you, in its widest sense, which I suspect will include religious elements.

Yah. We were brought up very strictly, and, particularly by my mother, because of her strong Presbyterian values. And my father was, again, he didn't talk about morality, what you should do and what you shouldn't do, which my mother would, but, he had a very strong sense of what was right and what wasn't. And you knew it without being told.

What then was your sense of what his sense of right and wrong was, without being told?

Not as, not as prescriptive as my mother's, but, very, very strong on what was lawful and what wasn't lawful, what was, you know, and, what should be done and what shouldn't be done.

Your mother's more prescriptive approach then...

Yes.

Can you remember her telling you things that you should and shouldn't do?

Oh yes. Oh yes, continuously.

What sort of things?

Oh, the Ten Commandments and all the rest of it, and, and the Golden Rule and so on. But, religion was a very powerful part of our make-up, and, this would, this was, we were made well aware of that.

Could you tell me about going to church then as a child?

Yes. We would go to church on Sunday mornings of course. We had, it was eleven o'clock service, we'd go there. And, we'd usually finish by about one, a very long service of course. I remember my brother, the minister [inaud] when we were, well, fifteen or sixteen, my brother used to have a little prayer when the minister got up to preach, 'Please God, stop him.' But it never worked.

And, do you... could you describe the kind of sights and sounds of that particular kind of worship?

Oh it was Church of Ireland that we went to, although my mother was Presbyterian. Once you married in Ireland in those times, you, the woman took the, the, the branch of religion that the husband had. So, he was Church Ireland, that's Episcopalian, like the Church of England, and, she, she took over that. And she, she... And, she would have... [pause] Sorry, I missed your question.

[35:41]
I wondered if you could describe the, I suppose the, the sermons and, and the practices of it...

Yes.

...from your position as a child sitting in the church.

Yes, yes. Yeah, it, it was, very much blood and thunder, you know, and, in a way that probably wouldn't be approved today, you know, 'And Joshua slew the Acolytes until the going down of the sun,' you know, and this sort of stuff.

Mm.

But... Except it wasn't the Acolytes, but it doesn't matter. Anyway, they... And furthermore, Joshua stopped the sun, in order to slay them. But, very much that. And, the New Testament was dealt with, but, the Old Testament was the dominant thing. A lot of singing of course, and, they didn't have a choir but the congregation would sing, and some of them well and some of them very badly. What I remember more than anything is the, the sermons. You know, preacher, the Reverend John Cockrell, would... he's dead of course now, but, he would start his preamble, and then his first part. 'Now I've come to the end of my first part. The second theme today is...' And so on. And, these extremely lengthy sermons used to go on and on and on, and, my mother would be worrying about the dinner getting burnt, and, we were three miles away, and during the war of course we didn't have a car. We had bicycles, and... But, it was, always a bit of a problem. But, then, when we were, when I was fourteen or fifteen, it became more serious, and, we had Confirmation classes in the afternoon, and, as well as the church service in the morning. That was... I was quite religious at the

time myself; I've sort of, long since moved away from that. But, again, these... Religion formed a very very important part of life in Northern Ireland, and of course it was at the... It wasn't at the bottom of the divide, the political divide, the political divide in my opinion was more an ethnic issue, but of course the badge was religion on both sides, and, you were well aware of that. And, the... And the important part that religion played in life, I mean, you went to church, and that was that, there were very few people who didn't.

Mm.

And, it was, it was taken very seriously. And you kept the Sabbath. I remember, we were told... You know, nobody would work on a field on a Sunday. Although some Catholics might.

Mm.

That was considered a mark of how bad they were. [pause] And we were told, my mother, we were, I suppose fourteen or fifteen, we were making things and all the rest of it, we were not to use a hammer on a Sunday.

No.

We managed to get out of her, we could use a screwdriver because it didn't make a noise.

Really? That was your, your... Oh, because you weren't therefore heard by your mum, yes.

Yes. Yes. Yes.

[39:18]
And when you said that you were religious yourself at fourteen or fifteen, how, how did that express itself in your thoughts and things that you did?

Oh yes, yeah. I believed implicitly in the, the, the Christian story, implicitly. And...

Did it alter your behaviour, believing, do you think, did you, did you behave in certain ways because of those beliefs?

Yeah, you would have behaved in certain ways, and you would have been guilty in certain ways if you didn't behave up to the prescribed standards. I mean we weren't as haunted by religion as the Catholics were. I mean I've just been reading Seamus Heaney's, the book about Seamus Heaney, about his upbringing, and it's, it's a few years later than mine, but, in Northern Ireland, in a small country, in a farming area, and, they really were haunted by sin and, and the sin... the, sense of sin, and the punishments for sin. My mother wasn't... she was, she'd given up this sort of old harsh Presbyterian idea of hell fire and so on. I think it was, she thought Hell was inside yourself. But... Which is an optimistic view, I think. Plenty of wicked who aren't all that that sorry about what they've done.

Mm.

But, that was her view.

[41:02]
You were, you were talking then about how you felt in terms of your religion, your mother's views about the, the nature of Hell, and you mentioned a little while ago a sense of guilt, to some extent, although you felt that it was probably worse for the Catholics.

Mm.

Could you talk about then, at that age, you're talking around fourteen or fifteen I think, things that you might have felt guilty about? Do you remember?

Oh, being nasty to your brother or something of this sort of, you know. It was before sexual, age of, of sexual awareness, but... Oh you might have told a little lie or a fib or something you know and you'd feel guilty about that. Or you might have, not done

something you should have done, you know, and, these sort of things, they're child's things really. [pause] But there was a real sense of guilt, and, and that you, you weren't living up to what, what you should be living up to. And, well that was the way it was.

[42:14]
Could you talk a little more about your sort of engagement with the landscape of Northern Ireland at this time? The house, Hollyfield, and you've got the farm.

Mm.

So, that's one particular landscape that you will have moved about in.

Mm. Mm.

Could... I wonder if you could talk more about that, your experience of landscape, but then also more widely, if you travelled at weekends, or holidays.

Mhm. Mm.

So sort of, your engagement with the natural landscape at that time.

Mm. Yes. Travelling, yes. Before the war, I used to go down to Dublin with, my mother had a sister living, two, a sister and a brother living there, and we used to go down there, and that would be an opportunity of seeing a different landscape. And, again I used... my uncle was, lived very close to a carboniferous quarry, a big quarry, and I used to collect fossils there, and that was a great interest. We travelled round a bit, to Lough Neagh, which is fifteen miles away, in the car. Occasionally down to Belfast. And, we used to go on Sunday school excursions to a place called Warrenpoint, and, a little fishing village about twenty miles away, and, we'd go there on the train. And all the kids would be shepherded onto this train. And, when we got there we'd be lectured, whoever was in charge, that we weren't going, going to the slot machines [laughs], that we were all Sunday school children and not gamblers, and, then set loose. And we used to play along the seashore, and, I remember coming back with

a bucketful of crabs. Now what we were going to do with crabs inland, I don't know. But, anyway, these crabs all climbed out of the bucket in the train, [laughs] and they were going underneath the seats, covered in fluff, because the trains in those days were, hadn't been cleaned very well. And anyway, these sort of, fluffy balls, with peering eyes, staring out you, really looked funny. [laughing]

[mic dislodged]

[pause in recording]

It's off again. [inaud].

[44:33]
Once the war started of course, the car was laid up, no petrol, and we didn't, we didn't travel very far. Bicycle was the limit. And, I remember going to Armagh, and, of course I had school in Armagh, but, going down to a place called Navan Fort, which was the old, headquarters of the pre-Christian kings of that part of, of Ireland, Cu Chulainn and these great heroes once, once flourished, King Conor and so on, and, this was, it was just a mound, a grassy mound. And, there's a visit centre there now I believe; when I was there it was just a grassy mound, and, with stories attached to it. We saw that, I would have seen that on a bicycle. We went in all directions in the bicycle, on the bicycles, but, again, your range there and back, maybe twenty miles.

Mm.

So, the... I remember being, I was in the Boy Scouts when I went to the Royal School, and, we went up to South Armagh and we saw the South Armagh mountains and, up there. And saw a bit of country that I hadn't, wasn't familiar with.

[45:54]
In terms of your locality then, the farm, could you tell me about the kinds of work that you did on the farm, or the kinds of things you did when you weren't working on the farm and so on?

Oh yeah. Well when we were working on the farm, we'd go out and get the cattle, bring the cows home, or, we'd be getting the sheep in to be dipped, or, you know, sheared or so on, or, there was an awful thing, the blowfly, these bluebottles, used to lay their eggs on the hind quarters of the sheep and the maggots would hatch out and they'd eat into the sheep, and, you had to go around after the sheep to make sure this hadn't happened, and any that had been struck by blowflies as they called them had to be dealt with, and we would help with that, catch the sheep and so on. We would, as I said, fruit picking of course, we'd have been heavily involved with apples, and, gooseberries I've said before, blackcurrants, redcurrants, plums, my father grew a lot of plums. We'd be very much involved in that. We wouldn't be involved in milking the cows, we weren't allowed to do that. Feeding the hens, we could do that sometimes. The heavier operations, you know, cutting hay and so on, we wouldn't do, but we'd be asked to stook when, during the war again, when we were, you know, fourteen or fifteen, we'd have to help bind the sheaves and then put them into, we call stooks, in other words, these were groups of sheaves, to dry. We'd have to, we'd help there of course, we'd have to, I mean, it was all hands to the pumps.

Mm.

[47:41]
Mm. Non-farm things, we were very keen on, my brother and I were very keen on radios, and, electronics and so on, we were very much into this. I was into woodwork, still am a bit, and, I was very keen on gardening. You mightn't think that from looking at our front garden at the moment, [laughs] but I was at one stage. Anyway. The back garden of this house looks better, but that's because my wife's in charge of that, and I operate under her direction in the back. Anyway, the... In fact I, I used to grow a lot of vegetables and things, I had a little plot, quite a big plot in fact, and I used to grow all sorts of things, you know, runner beans and turnips and peas, lettuce, what have you, all these sort of things. We didn't grow potatoes because they would have been grown commercially. And I didn't grow cabbages because I couldn't stand them. Still can't. But, I grew a lot of things that weren't in the ordinary course of the diet in Northern Ireland at that time. My mother of course knew, had been in America and had seen all sorts of exotic things like runner beans and, peas eaten at the petits pois stage you know

and these sort of things. And white turnips; the Irish turnip was swede, the yellow one, and I grew these little white, exotic things. They were...

Who gave you the seeds?

Oh well we bought it. Actually I used to, my great-aunt had a seed shop in Portadown, and she used to give me the seeds.

[49:27]
And can you remember deciding that you were going to grow vegetables in the first place, what made you decide to do this?

At school, at the primary school, we had a very good headmaster, and he was very keen on horticulture, and he had a garden attached to the school, and he taught us a bit about gardening and a bit about botany, you know, and, dicotyledons and monocotyledons, and how to label, and diagrams, and, he, he was a nice man. He was a Fellow of the Royal Horticultural Society, and he, got a lot of the kids interested in this. And, he was growing unusual vegetables; I mean the normal thing was spuds and, and swedes, and maybe the odd parsnip, but, you know, he, [laughs] he opened, he opened people's eyes a little bit to the possibilities of growing things, mine included. So, I used to, used to do that a lot. But the main problem of course later on was, of course, my brother and I were into radios, which is the sort of, electronics of its day.

[50:39]
I'm going to come back to radios, but could you... This is Mr Ebbitt isn't it, at your...

Yes.

...primary school where you started in 1933, the Armstrong School?

Yes, that's right.

And Mr Ebbitt, you've just mentioned, had a, a garden in the grounds.

Yes.

Could you describe that in as much detail as you can remember, and what you did in it?

He had it divided up into plots and the different classes were in charge of plots. And, he would have all sorts of vegetables and, some flowers, rhubarb he used to have. I remember the boys used to steal that and eat it raw. [pause] Mainly the more exotic vegetables, artichokes and things like that he would grow, and these were unheard of in Northern Ireland at the time. And, all sorts of, rather nice carrots, these finger carrots, not the big pointy ones that you normally have. And, oh, all sorts of, French beans and things like that.

Can you remember then, at that age, this would have been, you would have been about five or six I suppose?

Oh no, we were ten-ish.

About ten, towards the end of that school?

Mm, yes, yes.

Yes. Can you remember what appealed to you then about gardening in the way that he presented it?

I just liked growing things, I liked, I liked eating them, with the exception of cabbage. And, I also grew quite a lot of flowers for the, for the house, particularly, there were flower beds round the house, and I used to grow the wallflowers and things, and sweet williams and so on, and, for my mother, and then she'd transfer them, I would transplant them round the flowerbeds. So, she wanted those very much. And she also wanted the vegetables. But, my main interest was the vegetables at that age.

[52:26]
Can you remember any other teaching at primary school?

Oh yes, I remember a lot of it. Mr Whisker, Harry Whisker, he's long dead now, but, he was a young teacher at the time, and, very keen, and, very keen to encourage the kids to talk. And he used to get kids to talk in front of the class, which is, nothing nowadays but in those days when you sat in rows and the teacher taught you, it was quite, quite something. I used to give talks, I think I mentioned them in the, the document I gave you. I talked about fossils I'd got, and I talked about, oh, flowers, orchids and things. There were a lot of orchids growing in our farm, and, I talked about those. I talked about birds' nests and birds you could find and so on. So, I got, I think... I talked probably too much.

Were you, I wonder, it sounds like that you were collecting things from your farm...

Yes. Oh yes.

...and taking them in and talking about them. And you've mentioned that, when you visited your uncle, the carboniferous, it's where you found the fossils...

Yes.

...and you talked a bit. In what way were you talking about these things?

Oh I... Oh I, I, at that stage I had read a lot of Arthur Mee's *Children's Encyclopaedia*, and, what I, what I couldn't tell from my own experience, which wasn't very wide of course, came from Arthur Mee.

Ah. Yes, yes.

And, this, this would be the basis of my lectures, talks.

Mm.

But...

Did you have the whole sort of run then at home of the encyclopaedia?

Say again?

Arthur Mee's Encyclopaedia, did you have the, the volumes at home then?

Oh, yes we did, yes, yes. It was a remarkable book. It's completely out of date now. I saw a second-hand copy not long ago and I was horrified at it.

Mm.

It was racial for one thing. [laughs] It was, completely politically non-correct. But, it was a good introduction to things like geology and, and botany and so on, and a bit of astronomy too. And, my brother and I lapped it up.

Were you encountering those sorts of things at primary school, in lessons, as well?

No. No, not, not really. No, this was at home.

So do you feel then that the encyclopaedia was when you first encountered science?

Yah. Yeah. Very much.

And would you have called it that then, would you have, did you, were you conscious about, you know, that this was science?

Oh yes, yes, yes, oh yes, yes. Maybe not science, but geology and botany and so on.

Mm.

Science was a bit, a bit grandiloquent, you know, for the... But, same as a journalist doesn't like to be called a journalist, he's a reporter or a, sub or an editor or what have you, you know.

Mm. Mm.

The... Anyway, to go back to that, that was, the origin of a lot of my knowledge at the time.

Mm.

A remarkable book.

[55:41]
Do you remember, even from this distance of time, any particularly striking pages or parts of that book?

Yes, there were some marvellous pictures of volcanoes and, magma underneath the volcanoes and all the rest of it in full colour. Oh yes, very impressive, yes.

Who would have procured that encyclopaedia for your home, do you think, who would have got it and paid...?

It was got from actually a neighbour of ours. They, they loaned it to us.

[56:12]
Mm. I see, thank you. Could you talk about something which is mentioned in the document that you gave me but won't be known by the people who listen to the recording, and that is the visits to the county museum in Armagh and the figure there.

Yes. Mhm. Yes. I started these visits when I was at primary school, and then continued when I was at the Royal School, during, you know, sometimes after school, sometimes... Well, after school. And, there were... It wasn't a modern museum in any sense. There were glass cases of all these flint arrowheads and, and it ran right up to uniforms of the Peninsular War, you know, and these sort of, rather magnificent bearskins and what have you. So, it was, an eclectic collection I suppose really. But it was... The man who was in charge of it, a fellow called Paterson, a remarkable person, he was Presbyterian background, but, he was one of the few people who could actually

move between the two communities, and, he wrote some marvellous books of stories he'd taken down from the people up in the, the mountains in South Armagh where the folklore still, still existed, living folklore. And, any rate, he was very good with kids, and, when he'd hear somebody come in to the museum, he'd go out to see who they were, from his little office, and, after a while I got to know him. And he would show you, show me things, and we'd talk about, you know, the Mesolithic Ireland, you know, the Neolithic period and so on, and, I mean this was a ten- or eleven-year-old boy, and he would be very very, he was very, very understanding, and, I learnt an awful lot from him. And, he would take things out of the cases and show them to you, you know, and you'd... And, you know, I remember being very impressed by the, the... sorry, the moulds for spearheads, you know.

Mm.

And you could see where they'd been used, and the mould had gone black where the bronze had been poured in. And, and these sort of things.

Any natural history that...?

Oh yes, there was that there too. There was everything there, in a little way.

Mm. Mm.

And, he would... Oh yes. And underneath the, one of the glass cases, was a huge thing, a mantrap. It was used by the local estates to catch poachers. I don't know if you've ever seen the old type of rat trap that comes up like this.

Mm.

It was the same as that, only, the jaws were so far apart.

Mm.

And, a monstrous piece of machinery. And, this was, would be buried, lightly covered with leaves, and then, the unfortunate poacher would step on it.

[59:24]
Mm. And this time you, you are still at home in terms of, natural history and science. Your, your... the available reading material was the encyclopaedia?

Oh yes. Yes, but then we...

Anything else?

Then, my mother and my aunts bought me books, bird books and things. There's some of them still up there. Books about birds, books about flowers and so on. They're actually behind that picture. But... I'll show you them later, but... These, these helped fill in gaps you see, and...

If I just... We could actually just...

Yeah sure.

...name the books. So these books, some of these books were given to you at the time?

Yes.

So this would have been when you were at secondary school?

No no.

No?

Primary school.

Primary school.

Those ones... Those ones there.

[collecting books] Ah, Birds Shown to the Children, and Flowers Shown to the Children.

Yes, that's right.

Let's just... And these were in the Shown to the Children series.

Yes, yes.

Did you have others in this series?

Not that I remember, no.

Oh, and this series edited by Louey Chilsholm.

Yes that's right. Nice, nice books.

So...

And then later on of course I got this, the, the...

New Naturalist.

Yes, yes. Yes, the whole series, yes. Yup.

Yes, they were post-war books aren't they?

Yes, that's right, yeah.

James Fisher and... So did you, as well as having these books on birds and wild flowers, at this... and you were visiting the museum and this sort of thing, were you going out observing birds, observing plants?

Oh yes. Oh yes.

From the, from, starting with the, the farm and...

Yeah, yeah. Yeah. Yes, I used to press plants and so on. And, oh yes, I would be keeping records of birds' nests and this sort of thing. Although, to go back a long way, further, I remember my uncle, this was when, I just came straight from America, I'm jumping backwards in time now, but...

It's fine.

My uncle was a boy of about thirteen at that stage, and he had a marvellous collection of birds' eggs, as you had in those days, highly illegal now. But, he'd got a hawk's egg and he'd got crows' eggs. He'd crawl, climbed up enormous trees and things to get these. And, he had them in a box on a mantelpiece, high up on the mantelpiece, so I who was four years old, I couldn't get them. But I got up to them, pulled them down, and broke the lot. [laughs] Oh dear. I would have been very unpopular.

Did you used to go nesting as well, was this...?

Pardon?

Did you go bird-nesting as well yourself?

Yes I did, but I didn't take... Well I won't say I didn't take eggs. I didn't do it in the sense that I collected them. I might have blown the odd egg, but, I didn't have a vast collection of birds' eggs.

Were you a member of any naturalist societies for young people...

No. No.

...or bird-watching society?

No. No.

And, was there anything then that we might now see as being a kind of popular culture of nature, in other words, radio programmes or magazines or anything?

Yes, there would have been on the radio, yes.

Did you listen to it?

Yes I would listen to these, yes. Yup, yup. And...

Can you remember any...?

I listened to those quite, quite carefully. There were also, a very good series in BBC Northern Ireland on Irish mythology, the, the old Irish myths from the Bronze Age and so on, and, well Iron Age really, and, I used to listen to those. But, you asked about organised societies and things. There was nothing of that that I knew of.

Mm.

There may have been in Belfast, there probably was, but, not out where we lived.

[1:03:23]
OK, thank you. So, we've, we've perhaps reached the stage where you're going to secondary school. So you're, you have interests in, in natural history and...

Yes, yes.

...and, early science and collecting. The other thing that you mentioned that we should just cover before we get to secondary school is that you said you were interested in radio.

Yeah, that was mainly at secondary school.

That was? OK.

Yes.

In that case we'll start with your arrival at secondary school.

Mm.

Can you remember that? This is 1940.

Yes, 1940, yes. The Royal School. I got a scholarship to the Royal School, a day boy scholarship, thank goodness, it wasn't a boarder scholarship. And, I was there for six years. [pause] Probably the most unpleasant years of my life.

Could you say why?

It was a, a very rough place. It was run on semi, semi-military lines. A very old school for, founded, what, 1608 or something like that. It had always been a harsh place, and when I was there it was no different. I... My interests, as I've explained to you, were in nature and, botany and so on. Those interests weren't in the least encouraged at the Royal School. Chemistry and physics were the only sciences taught. The classics of course had a pride of place, and, sports of course were very important, and, still are in the Royal School. But, I never fitted in to the Royal School ethos. I think you can see why, from what I've told you. The... The aim was to produce, and maybe I'm over-simplifying this, but there a little bit of truth in it, produce graduates for Sandhurst, Sandhurst material. And, the... I am over-simplifying as I say, but there's an element of truth in that, and it'll give you the, the idea of the ethos of the place. It was originally set up to provide education for the sons of the planters who moved to Ireland in the sixteenth century, and, it never really lost that ethos. There were no Catholics there of course, needless to say. It wasn't a particularly religious place. Religion was rather, rather scorned on as being soft.

Mm.

Which, you may think that's hard, you may find that hard to accept, but there was that attitude. Although nominally of course, the boys all went to school... went to church on Sunday, up at the cathedral and so on, they marched in file, in their straw hats and all the rest of it, up to the cathedral. And, so it was nominally Christian and, but not really. The ethos was a much harder one than that. The prefects used to read out a piece of the Bible every morning, it was always from the Old Testament, always, and that'll tell you something about it too.

Mm. Mm.

[1:07:23]
It was ruled over by a man called Wilfred Hutchings, a graduate of Emmanuel, Cambridge, a mathematician. He was also something of an amateur astronomer. A man I couldn't stand, and I think the feeling was entirely reciprocated. He... [pause] I remember actually, when I was, I suppose in my sixth form year, giving a talk on electronics. At the time, you know, valves and what have you. And, then, the old headmaster Hutchings said, 'Well,' he said, 'Mmm, now I understand how Jenkinson feels in calculus.'

Mm.

That sort of a guy.

Yeah.

I wasn't that bad at calculus.

Mm. So, a sort of undermining...

Oh yeah, yeah, yeah. Yeah, yeah.

What sort of, what sort of people do you think he as a headmaster would have favoured?

Oh the sporty type. The, the captain of rugby and cricket.

Mm.

And, going on, as I said, to Sandhurst.

So it sounds almost like, the school's interest in producing particular kind of masculinity.

Mhm. Yes, very much. And of course it was a boys' school, there were no girls.

Yes.

It's now, it's now a mixed school, but, the... It's probably a lot more humane place I should think. Bullying was absolutely intolerable. I, I managed to escape most of it, not all of it but most of it. It was during the war and there were these stories about German, you know, atrocities and so on, and some of them were actually practised by the boarders on other smaller boarders.

Such as?

Oh, tying kids up by their thumbs and, you know, and, and putting them on a pulley and taking them up into the air, this sort of thing, you know. Unbelievable things.

And, known about by the teachers?

[sighs] Hard to say. They regarded bullying as part of the toughening-up process. Whether they knew about the actual fine details, I don't know. I remember seeing a boy, who did, who became a scientist afterwards, a bit younger than me, a boarder unfortunately for him, being hunted by a pack of boys, maybe fifteen or twenty, hunted, the way you'd hunt a fox.

Mm.

And he was running like mad, through the corridors, being pursued by these kids.

Mm.

No, it's unbelievable.

[1:10:18]
What do you remember of the teaching? Although it could be taken a subject at a time.

The teaching was mostly pretty good. In fact paradoxically, I got a better education than any of my children. I mean, we did, there was a very good... We did a lot of history, good geography, very good maths, science was good. The Latin was good if you were that way inclined, I wasn't. Greek was good, if you were that way inclined. The... The standards were high, and they were ruthlessly maintained. You wouldn't... It was... They ruled with a stick. I think I told the story in that little article I gave you about one particular man, English fellow, he was a historian, and, I remember seeing him running in tears from his class, from the, the, the class. He just... If you didn't keep the class down like that, you were, you were broken.

Mm.

I saw this happen to several teachers.

So it was almost as if the, the aim of producing sort of, tough and physical boys, sort of, to do successfully in...

Yeah. It was... [pause] It, it was a very, a very, a very unpleasant place, I found. And completely at odds with the things I was interested in.

Could you tell me about the geography teaching in detail if you can remember?

Yes. He was a, English again. A very fair-minded man, we, he taught the, the...

[interruption]

[End of Track 1]

[Track 2]

OK, could I ask you to tell me in as much detail as you can remember the teaching of geography at the secondary school, the Royal School?

It was taught by a English teacher. It was, a lot of it was just the, the old business of continents, the rivers and the principal cities and so on. But there was also quite a bit of physical geography, mountain formation, verging on geology. A bit of social geography, transhumance and these sort of things that geographers talk about. Different ways of making a living, you know, Kalahari, tribesmen, the... you know, contrasted with the Zulu agriculturalists, these, these old traditional approaches. But he was a good teacher. And, most of his pupils did pretty well in examinations. He was very strong on glaciation of course, as geographers tend to be, and there were plenty of interesting features round about these drumlin hills formed during the last glaciation in that part of Armagh. And, and hieratics and so on, all these things that people who are interested in quaternary geology talk about. So, it was a well taught subject. He was a nice man too.

Did he take you on field work to these sites?

No.

No. So it was all in the classroom?

Yes. Yes.

Could you tell me about the science teaching?

Science teaching, again, one was a Manx man, Costain, and the other was a, a man from your world, Godley, H A G Godley. H A Godley. And, both were very good teachers, both had good records in terms of examination. Godley did physics, for the most part; Costain did chemistry. Godley had a good grasp of his subject, that I can now see. We did quite a bit of experimental work, quite, quite good, a quite good set-up in the laboratory. But, as in those days, almost all of the work was out of books.

Nowadays of course you do much more out of school and, much more practical work. Chemistry was taught by Costain. He was, a sardonic sort of man, but, a good teacher. We did the, much the same as I suppose the A-level course now, the elements, zinc, we went through all the, the group, the, Group 1 and Group 2 elements, the, all the, the periodic table. Elements. The proper... We didn't do much carbon chemistry, a little bit, but, mostly inorganic chemistry. We did a lot of practical chemistry. We did things that wouldn't be allowed nowadays in, in, even for the teacher to do. I remember seeing the laboratory green with chlorine, we were making chlorine, and the kids were throwing it at each other. It got a bit out of hand, not, not that Costain was a man to let things get out of hand, but it did get out of hand. And, we were all choking with the thing. We did all the gases you know, the oxygen, nitrous oxide, nitrogen dioxide, chlorine and so on. Properties. We did a certain amount of quantitative analysis, not very much. A lot of qualitative tests. But, it was again well taught, for that level.

Could you tell me how you, bearing in mind that people listening to the recording aren't necessarily scientists themselves, could you tell me how you made the chlorine that day, that you said was...

[laughs] Oh now. It was manganese dioxide and hydrochloric acid, as far as I remember. Now, I've got a chemistry book there. This is a long time ago, you're going to embarrass me. [laughs]

Oh no. [laughs] And, I wonder physically how you made it. Did you put it in a... The bits of equipment you used.

Oh, it was, it was, you heated a tube with these things, in a flask, and then you had a, a, a glass, spent glass tube, and then what was known as a pneumatic trough, which was a big, a large dish, a ceramic dish, and in the centre of it you had a little holder for a tube of gas, and you put the gas tube above that. The tube carrying the chlorine went underneath the glass, the gas jar, and the gas bubbled up through the water and into the, into the gas jar in which the water was displaced. I could draw it much better than explain it. It's a well-known apparatus.

And, you said that the boys were throwing it at each other. How, how were they managing to do that, what did the product look like?

Sorry again?

The, the chlorine that you produced.

Oh it was a green gas.

Yes.

Yes.

And... Oh, so throwing it in its containers?

Oh they were throwing the gas. The, the gas, the tubes or, the gas tubes of chlorine gas would be, would be opened and then thrown at another boy.

Gosh.

The gas. The gas of course would diffuse in all directions.

Yes, that's what I was thinking.

But, this...

But the actual, the container was thrown...?

Yeah, yeah. Yeah. But...

Gosh. Do you remember any other physical experimentation, and if so, could you describe it in that same detail?

Yes. I remember making hydrogen, and, you made hydrogen by pouring hydrochloric acid on zinc. And again, you collected the hydrogen in the same way, and, then you, you tested it to make sure there was no oxygen in it, and you lit it and it burnt. And if you hadn't got it right, if you still had a bit of oxygen in it, there was one hell of an explosion. And, I remember seeing the whole apparatus going straight up to the ceiling and coming down again in bits, from somebody who hadn't been as careful as he should have been. So, it was very hands-on.

[06:58]
And the room itself, could you describe the room itself?

Oh it was a huge big room, with benches, tiered benches in the middle of it, and the laboratory benches round the four walls.

And the tiered benches were so that you could look down on demonstrations?

Yes, you could look down at the teacher doing experiments, yes, on his bench across the front. Yes.

Can you remember a particular or a typical demonstration by the teacher?

Oh yes. I mean he used to do demonstrations with, for example the alkali metals, putting sodium in water, or potassium which is even more spectacular, and, burning phosphorus. These were, even for the Royal School these were considered a little bit hazardous for the boys.

Mm. Do you remember the teaching of any other subjects in a way that is clear to you from this distance of time?

History, I remember the history, I liked history very much. I told you about this unfortunate historian driven from his class, but he, he had a real love for his subject and he passed it on to a lot of us, myself included. And I've always been interested in history ever since. But, he, a strange man. He gave me the worst bang in the face I've ever had. What happened was, an extraordinary story. One of the boys had crept up...

We sat at long benches, not individual desks but long benches, and, at the Royal School, and, he was sitting on one with his, halfway down the class with, with his back to part of the class, and in front of, his front to the rest of the class. One of the boys crept up behind and stabbed him with a protractor, with a compass, quite deep in the behind. The teacher swung round, and, I happened to be just sitting behind him, swung round, and he... I, I had nothing to do with it, I can assure you. [laughs] And he gave me the most appalling blow on the, just on the face and the eye. I saw stars.

Gosh.

Extraordinary.

And...

But this was, this was par for the course in the Royal School. [laughs]

Gosh, sounds dreadful. And, teaching of literature, do you remember that?

Pardon?

Literature, do you remember the teaching of literature, English literature?

Oh. Yes. They... Yes, we had, Maurice Craig taught us English for a short while, he was a very fine poet. Wrote a disgraceful poem which was always resented by Belfast people, 'May the Lord in His mercy be kind to Belfast.' [laughs] To hell with the future and live in the past. You probably know it. Anyway, the... he was a very good teacher. We had several good English teachers, and they were... We did of course all the usual, Shakespeare plays, the more martial ones, being the Royal School, *Julius Caesar* and, we didn't do anything like *King Lear*. But, *Henry V* and so on, and, you can well imagine the sort we did.

Mm.

But, *Macbeth* of course, needless to say. And, not much else. Craig, Craig taught us poetry. We did a bit of poetry but, it was rather looked down on as sissy-ish at the Royal School.

Mm. Where did you get that impression from, that it was looked down on, who would...?

The English teachers. I remember actually, digressing, but I remember one of the Latin teachers, we had to do Ovid's *Tristia*, which is a book about his banishment to the Black Sea, the Euxine. And, he started off the course, he said, 'We've got to teach this book. The fellow is just a whinge, but we've got to do it.' So we worked our way through it. And that, [laughs] that was his attitude. The fellow had been banished by the Emperor for his, for his dalliance with the Emperor's daughter, and, he's feeling very sorry for himself. But the Latin teacher had no time for it.

Mm.

We did, you know, Julius Caesar's *Gallic Wars* and these sort of things. Proper...

Stout, manly stuff.

Yes, oh yeah, yeah.

[11:41]
Could I ask you, at this age then, at secondary school age, the, the sorts of things you did outside of school, your, your leisure interests?

My interests of course were in botany and geology and these sort of things. Which were of course not catered for in the Royal School. I was still reading a bit about that. But, the Royal School, the homework burden was very very heavy, and it didn't leave a lot of time for outside interests. When I was at primary school, I did a lot of reading, an awful lot of reading. The Royal School, I almost stopped reading for those six years, and only started again when I went to, to university. I'm talking about reading outside the course. So, that was one thing that didn't develop. Now, my brother and I, my

brother's three years older... three years younger than me, brother Donald, were very keen on radios, and we were supported in this by an uncle of mine who was at that time working for Western Electric, an American company, and, in the cinema business, and, he encouraged us. He'd been an electrical, trained electrical engineer in his youth, and he encouraged us to do this, and he gave us bits and pieces. And we used to build all sorts of radios. And, we were very unpopular, because of course, this was wartime, people were concerned with news and all the rest, and we used to take the batteries out of our domestic radio for our contraptions. And, this made us very unpopular. But, we didn't, as I say, we hadn't electricity at Hollyfield, and, it had wee batteries. But we, we built quite sophisticated things. And, we'd listen, we listened to the short wave, we could hear the German propaganda broadcasts, we could hear Radio Moscow and all the rest of it. We could hear, we could hear American radio, you know, on, who were on the short wavebands. So, this was good fun.

Where did you get the... How did you know how to go about making them?

Oh, basically, my uncle told us, and we also, he gave us books.

Ah, yes.

He gave us books about radio engineering and so on.

So you were building these from scratch, it wasn't... it's not as if you could buy kits at that time? No.

Oh no, not at all.

Yeah, yeah.

Oh no, everything. You... We, we'd get a hold of a valve, we used to save up money and buy a valve, you know, an electronic valve.

Mm.

And, we used that. And, we made quite, some quite sophisticated things in the end. Some of these short wave receivers were very good. And, we had huge... Well we, we'd put the aerials up, and...

Where did you have to erect the aerials to, to...?

Oh they'd be out in the trees outside the house.

Mm.

[14:41]
There were a lot of trees outside the, outside Hollyfield. But, anyway, we learnt a lot about electronics then. And I think it gave Donald and myself an interest in that side of things, which of course we, we continued right through our careers.

Mm.

I mean Donald was always, my brother was biophysics, was concerned with nerve impulses and he was recording these things on complex electronic instruments, and I mean I was going off later on into mass spectrometers and things, again complex electronic equipment. So, it was an excellent introduction.

Can you remember what appealed to you about the practice of making radios?

Oh just making them.

Mm.

It was, you know, we'd get a piece of board and screw the things down, and, connect them up, steel the batteries from the family radio, and away you went.

Mm.

You know, it was, all you needed was a screwdriver and a bit of wood really, and all, and bits of wire, and we'd...

So aerial in the tree.

Yes.

Wire, then, trailing inside the house?

Yes, came through the... Yes. And then, and obviously the radio, yes. Yes.

[15:47]
Thank you. I wonder whether you could tell me about the illness which I think you contracted at the age of eleven or twelve?

Yeah. I developed, call it whatever you call it, spinal tuberculosis, and, this wasn't recognised until, oh, fifteen years ago I suppose, the radiographer. But... And this combined with asthma, I had very bad asthma, and this gave marked spinal curvature, which I will have to this day. It was... It should never have happened. Nowadays of course, it, tuberculosis is, is cured, it's curable, and, again, with proper medical attention, asthma isn't the thing it was.

Mm.

It certainly marked my life. I'm not saying it has stopped me doing anything I ever wanted to do. Although it did get me out of the sports at the Royal School, [laughs] which I didn't mind one little bit.

Mm.

But... Yeah, I remember one of the science teachers actually when I was in the sixth form at the Royal School saying, there was a group of us sitting round a table working, and he was teaching us, and, he was talking about physiology for some reason or other, and he said, 'You know, if some of us here had been,' what's the word he used? 'taking

a manly attitude to posture, they wouldn't have spines like question marks now.' That was in front of my, my colleagues, you know.

Mm. Mm.

Nasty.

[17:48]
Can you remember, apart from feeling good that you could get out of games...

Mm.

...and obviously, feeling terrible when that sort of thing happened, can you remember how it affected your view of, your view of yourself in other ways, more generally?

Oh it gave me a terrible inferiority complex, which I've still got, to some extent.

Mm.

You know it's, this sort of thing. I was a very self-confident kid up to that.

Mm.

After that, not.

In what ways, particularly, do you think that you changed in...?

Oh, well I mean, at that age you're beginning to get into the sex, your attitude to girls and all this sort of thing, and inevitably you're aware of it.

Mm. Do you remember then the, the sort of things that you wouldn't do because of this, at that age, or the things...?

Rugby. [laughs]

Mm. In terms of...

And no regrets.

In terms of lacking self-confidence, are there things that you didn't do because of a lack of confidence, that you might have done otherwise?

I think that would have appeared more at university stage.

[19:00]
Mm. Thank you. And, could you please tell me, at this time, when you first started secondary school it was 1940.

Mm.

And you went there until 1946...

Yes.

...which sort of, covers the war. I wonder whether you have any memories of the sights and sounds of, of war.

Yes. Mm. Yes, I do. I remember the, the squadron of Lancasters practising a raid in Germany, although they, they had a dummy run on Armagh, and they crossed our farm, I suppose 150 feet up. The roar of those, you know, a squadron of Lancasters, squadron after squadron in fact, going towards Armagh, dropping their nominal bombs and then turning and coming back. And, they were so low you could see the men inside them, you could see the pilot. Extraordinary sight. And, again, during the war of course a lot of the Royal School boys were killed, I think, it's difficult, numbered twenty-eight or something of that sort. A lot of boys. And some of them, quite a number of them I knew, a bit older than me. And, the headmaster would come up and the school would arise, and we'd all stand, and, 'I've just been informed that,' you

know, so-and-so, 'Lieutenant so-and-so was killed today, leading his men against the enemy.'

Mm.

You know. So, this happened again and again. And, I remember of course the preparations for war, the D-Day preparations, the American troops were based in Northern Ireland, thousands and thousands of them, and they were training in our farm. And, they used to be practising, you know, going behind hedges quietly, and we kids would be following them, gathering up the cartridge cases from the blanks that they were firing, revealing their position. Getting cursed well and truly for the, for our... But we didn't want to miss any cartridge cases, so we kept close to them.

What did you do with the cartridge cases?

We collected them.

Mm. And then what?

[laughs] Nothing.

OK.

Sometimes, we used to make our own gunpowder, and, we would pack it into the cartridge case, crimp it, and then light it, and it would go off like, like a rocket in an alarming fashion. But, that was one thing. But there wasn't a lot you could do with a used cartridge case. I remember actually once, they were practising plastic, not on our farm but on a railway, a disused railway line, a little bit away, and, we found a little, a little package of oiled paper, about two inches by two inches. And, we brought this home. Oh we were... It was big stuff you see, which it was.

Mm.

I don't know what, whether it was TNT or something. But anyway, my father found that, and, he handed it back to the Americans, and were they grateful. [laughs] I think somebody was told off for...

Yeah.

...for, leaving it behind.

[22:04]
And, do you remember any other, apart from the gunpowder, which I'll ask you about in a second, do you remember any other home chemistry that you...?

Oh yes, we were into... We got phosphates and all the rest, you know, the ordinary... And of course in those days you used some awful chemicals, you used arsenate as a spray, you know, for apple trees.

Yeah. Yeah.

And we got those, and we did things with those we shouldn't have done. But, basically we were pretty careful. But, the main thing was home-made gunpowder. But it was never very good because all we had were flowers of sulphur.

Right.

And, you don't... that doesn't make good gunpowder. And the charcoal was, [laughs] was sticks that we had burnt and ground, and you can't get a, you can't get a high quality gunpowder that way.

And how did you, again, how did you know how to do this sort of thing, where had that knowledge come from?

Oh it's in chemistry textbooks.

Ah.

Yes.

When you said you did things you shouldn't have done with, with the, the sprays, what did you mean?

Oh, we would mix them and so, and, I suppose looking for precipitates and things like this you know. And we used to mix bottles of all sorts of odds and ends looking for, see what would happen, would it fizz. The... We used to get sulphuric acid, and of course that would fizz with limestone.

Mm.

And... But... We, we never really got our hands on anything really dangerous, except for that arsenate, and we were a bit scared of that

[23:38]
Mm. That's it, thank you. I wonder whether you could just say a little more about, which sounded very fascinating, the Americans moving about your farm.

Yes.

Any sort of, visual or even, the sound of what they were doing, any views of that from different perspectives, I don't know, from the house, from your position following them, at different times of day, if you could describe that?

Yes. Well, one of the things you used to do was, we had a meadow which was a swampy old thing, and, there would be, they'd run about ten yards, and the sergeant would cry, 'Down!' and they'd lie flat on their stomachs in the muck. [laughs] They'd curse and swear. Some marvellous curses. And... American ones, we hadn't heard those. And then, up again, another ten yards and so on. And, this was, this apparently was ideal territory for this particular exercise, because it was rushy and there was quite a bit of shelter in it you know. Once they were down, you wouldn't really see them because of all the long rushes and so on.

Mm. Mm.

So... But it was very unpleasant for, for the [inaud]. [laughs]

[laughs] Yes, yes. Thank you.

[end of session]

[End of Track 2]

[Track 3]

OK. Well, some... I want to make a few comments on the first session. And the first one is, perhaps I overstressed the military side of the Royal School. After all it was wartime, and that made a big, big impact on the ethos of the school. The school of course also produced doctors, lawyers, teachers, politicians, businessmen, and the occasional scientist as well as military people. But again, I want to emphasise that it was wartime. But I do remember very clearly one old brigadier from the Indian Army, a magnificent fellow, white hair, bristly moustache, red face, and he came recruiting boys for the Indian Army. And his point was of course that he wanted officer material for the Indian Army, and he used to say that, you didn't need a private income to be an officer in the Indian Army, unlike some of the crack British regiments, the Guards and so on. So, a boy could join the Indian Army, make a career for himself, hunt, shoot, fish, and have an excellent life, without a private income. And some boys did join the Indian Army. [laughs]

Really? Mm.

This of course was just two years before independence.

Mm.

And one of the boys at school, a fellow with a very distinguished career afterwards, raised the question with the brigadier, very tentatively, 'You know Sir, I wonder if it's possible that perhaps the Indians would be, you know, running the Indian Army in the not too distant future?' The brigadier exploded, and said, 'The Indians will not be fit to run an army for 100 years!' So, there you are.

Yes.

[01:45]
Another thing I wanted to comment on, I said something about the minister at Richill, the Reverend John Cockrell, about his very long sermons. Well that's perfectly true,

but he was a good man, and, and there are worse faults than preaching excessively long sermons, as we've seen recently.

Yes.

And the other thing I wanted to say was, I mentioned reading Seamus Heaney's book, but couldn't remember the, the title. So now I've got it. It's *Stepping Stones: Interviews with Seamus Heaney*, and it's written by Dennis O'Driscoll. It's a series of interviews.

Mm.

Anyway, I just thought I'd put those points right.

[02:28]
Thank you very much, that's super. Could you go on to tell me now please about the process of applying to and arriving at Trinity College?

Yes. I won a scholarship in experimental science, it was a sizarship actually, it was a primitive type of scholarship. In the old days, the sizars served at table for the fellows, but in my time, that had long passed, and, the sizarship was just a sort of scholarship that paid your, your fees and gave you free commons, in other words, one meal a day free, and all... you had to pay your lodgings of course in college, but you got one free meal and your, your fees, your university fees. So they were a worthwhile scholarship. I also got the Louis Purser prize, entrance prize, which was nice. It was a huge sum in those days, £20 a year. [laughs] Which...

For what did you get the prize?

For, at the entrance scholarship.

I see, OK.

The sizarship examination. The sizarship was a very old system in Trinity. Oliver Goldsmith was a sizar.

Mm.

So in fact was Jonathan Swift.

Mm.

But, I don't imagine that Jonathan Swift would have made a very good servant. Anyway, those days are long gone. Anyway, I went to Trinity in October 1946. Trinity at that time was at a very low ebb. It was after the war, and, Ireland had been neutral during the war. Trinity was very much, very isolated from the mainstream of Irish life. The Archbishop of Dublin for example, the Catholic Archbishop, McQuaid, forbade Catholics to go to Trinity, and, this of course isolated the university. Mind you, he also said that the National University of Ireland, the National... Sorry, let's get it right. University College, Dublin, one of the constituent colleges of the National University, was also unsuitable for Catholics, although it was a ninety-nine per cent Catholic student body, because, it wasn't clerically led, and because the staff weren't necessarily Catholics. A bitter time in Ireland, very, very backward and inward-looking.
[05:02
And of course Trinity was also, had been isolated from the mainstream of British thought by the, the War of Independence just twenty, twenty years before. So Trinity was very isolated at the time, inward-looking. It had... It of course came back to its own much later, but long after I left it. It's now one of the, well it's in the top 100 universities of the world; it certainly wasn't in those days. It's now right in the centre of Irish intellectual life and, where it should be. But in those days, it was very much isolated. The sciences were very badly taught at the time. Chemistry, my own one, was taught by Emil Werner, who was a German, as you might guess from the name, he was firmly based in the nineteenth century traditions of German chemistry and hadn't, hadn't moved into the twentieth century at all. He used to come in on, three days a week at eleven o'clock, and left at twelve and that was his work. The department was basically a teaching department for medical students, pre-medical students, first-year

medical students, people like that. No research was done. But, shortly after I arrived, Wesley Cocker was appointed Professor and Head, and they also got a very good man from Oxford, David Pepper, as physical chemistry, in physical chemistry. So things began to change, and the course it was modernised, and, Cocker demanded that all his staff do some research, and this was something that wasn't a bit welcomed by quite a few of them. It was a sinecure before, before he came. And, he gradually modernised it, he modernised the department, he got new laboratories. Some of the laboratories were really, hadn't changed for 150 years, you know, they were, [laughs] ancient. Well the gas lighting for example, not that gas lighting went back 150 years, but that gives you an indication of the way it was. And, the... So, Cocker reorganised it, and introduced modern laboratory conditions and standards, reinvigorated research, and, certainly I was attracted to organic chemistry, which was his speciality. I also liked physics, but, the physics department at that time was dead, apart from one person, Walton, who was a Nobel Prize winner I think in 1951, Ernest Walton. But Walton's lectures were terrific, I greatly enjoyed them, but the rest of the department was, was very mediocre indeed. And so any inclinations I had for physics were definitely, I, I definitely didn't, didn't follow that up.

[08:37]

So, organic chemistry it was. I, did quite well in my first years at college, I, in the first year I remember doing a, in the first, the end of the first year getting a first in physics, after a single night's, or a single day's revision. And... But, as time went on, into my second year, I began to get worse results, and I was getting too involved in other things in college, and, my results went down and down. In one exam I got a third, which was no credit to me. And, then, I began to realise that I had to pull the socks up if I was to make anything out of science, and I started working again, and, eventually I got a first, but, I went pretty low. Dublin was a fascinating place, I made lots of friends there. I was on the fringes of the theatrical crowd, you know, I knew Donal Donnelly, who died just earlier this year, made a name for himself as an actor, and I was on the fringes of the left-wing movements in Dublin. I was involved in student societies. We had a society known as the Promethean Society, you remember, Prometheus stole the fire from the gods, and was punished for his impiety. I was an active member of that very wicked atheistical, proto-communist society known as the Fabian Society. And, we were denounced in fact in the *Catholic Standard*, the right-wing Catholic newspaper of the time, as, these Fabians, you know, they're a, a menace to all that's decent, and, so

on. [laughs] So, I was involved in these things. And I had lots of friends in college, old school friends, a fair number of people from the Royal School went to Trinity. I had two uncles and two... I had an uncle and an aunt and their families in Dublin, I visited them a lot. And I developed an interest in films at the time, and, used to spend an inordinate amount of time in cinemas, you know, these sort of, new French films, *Les Enfants du Paradis* and these sort of things that were new at the time, I thought they were great. They are, they are good films. And I became a Disney addict, you know, for the, make my music and all these things. But, these, [laughs] the middle years of my college course, didn't, didn't help my grades. But, in the end I, [laughs] I came to my senses and did a bit of work. But... And then, at the end of my degree... The degrees were four-year courses in Trinity, all the science courses were four-year, lasted four years, just the same as in Scotland, but, the English, three degrees... three-year system, didn't apply there at all.

[12:15]

So, at the end of my four years I was asked if I'd like to do research, and, I, I accepted, with great pleasure in fact, because I really liked living in Dublin, lots of friends there. And I started research in the chemistry department at Trinity, which by that stage was, you know, really humming with activity. Cocker was very active and he was, he was on the Council of the Chemical Society, and... now the Royal Society of Chemistry. But, he got me started on a, on a particular problem, a three-member sugar called phenyl... called reductone, which is an enediol, and, very reactive substance, a bit like ascorbic acid. And, I was to synthesise a more stable variety of it, in which you had substituted one of the hydrogens by a phenyl group. [pause] I got this thing, but it was very, it didn't turn out to be as stable as we'd hoped, in fact very unstable, and I managed to produce a few derivatives, chemical derivatives of it, but the... I never actually isolated the, the substance itself, although I had it in solution. Probably nowadays with modern techniques I could, I could do it, but... So that came to an end, we wrote a paper on it. And then Cocker wanted me to move to another subject, the aromatisation of hydrocarbons, cyclic hydrocarbons. And, I did quite a bit of work on that, and produced a couple of papers on that. And, in the course of that work I showed that, when you got aromatisation of some of these cyclic hydrocarbons, an ethyl group was eliminated as ethyl hydrogen selenide. And, I isolated this, I think... It's a well-known substance but this was the first time it had been produced in this particular way. And, I investigated this particular substance, and, unfortunately, the apparatus I had

broke during the experiment, and I was gassed by this particular thing, ethyl hydrogen selenide, and I spent a week in an acute ward in hospital afterwards being treated for pneumonia. Nowadays I know that it wasn't pneumonia, it wasn't bacterial pneumonia. They filled me full of penicillin at the time, but that would have done nothing. It was, it gives you pulmonary oedema, this, this particular chemical. And, then I spent quite a long while recovering at home. So, an interesting experience [laughs] But, luckily I got out of it without too much damage. But...

[15:35]

So, in the end I finished my PhD at Trinity. As I say, we got three papers out of it. One of them was quite a good paper; the other two were, well, run of the mill. And, there was a question of getting a job. Now, I had contacts with Hedley's, again through Cocker, Hedley's were soap manufacturers in Newcastle on Tyne. And, they offered me a vacation placement, really it was a temporary job, I had it for as long as I wanted, or, could possibly have become permanent. So I went to Newcastle on Tyne. And, there I was working on the synthesis of new detergents. They weren't particularly new but they were, various modifications, and, I saw a side of life I hadn't seen before, industry. You know, you had to get in at nine, or, sorry, 7.30 in the morning, and you, you finished at 4.30. And, this takes a little... after student life, [laughs] it takes a little getting used to, but everybody experiences it. But, then, I didn't find the work terribly rewarding, it was... All the real research and development was done in America, Hedley's was a branch, or a subsidiary, of Proctor & Gamble, the big American detergents firm. And that's where the real research was done, and, they were really doing frills in Newcastle. For example, one of the things they were investigating was perfume soaps, because apparently British housewives weren't attracted to the same perfumes that American housewives were attracted to. So, they'd have a research programme on this. I wasn't involved, but it illustrates the sort of thing. And I came across problems I hadn't seen as a research student. I mean I remember fixing a pump, I had managed to burn out a pump with a very viscous reaction product, a sulphonation product, and, I was changing the pump and, you know, rewiring it and so on, a straightforward job. And an electrician came to me and said, 'What are you doing an electrician's job for?'

[18:30]

I, I was very unhappy in Newcastle on Tyne, I didn't like the place. It was the winter in Newcastle on Tyne. And, I missed greatly all the friends and activities I was involved

in, in Dublin. I think everybody leaving university has this feeling for a while, before you sort of settle in to real life. But, it was particularly acute because I had so many friends in so many different fields in Dublin. And, again, I like, I like research, I like science, and, I always did and have, still do. But, in Hedley's, 4.30 it switched off. I mean in Dublin we research students, we'd work in the evenings and weekends and all the rest of it. And, this didn't suit my way of, of thinking or, what I like to do. So, they offered me a job at the end of it, and I declined. And, so that was my little experience of industry.

I wonder whether before we go on to, to Reading, if I could just take you back over a few things so far?

Of course.

[19:40]
Is that OK? I was very interested in what you said about Cocker coming into the Department of Chemistry at Dublin...

Yes.

...and modernising it in various ways.

Yes.

And, you said two things really, one that he had modernised the course, and the other that he had modernised the, the place as a physical place in terms of what it...

Yes.

I wonder whether you could start off by telling me what was involved at this time in modernising chemistry, the course, how did he make the course modern?

Oh he revamped it completely. Emil Werner, who was his predecessor, spent a large part for example of his, his final year course lecturing on the structure of urea. Werner

had a primitive idea, and he'd been involved in a lot of debate about the structure of urea, various isomers, and, and... It was a completely dead debate, everybody knew he was wrong. And you know, it was, it was, outlandish. And, the course was completely fossilised, in organic chemistry certainly, in nineteenth-century German organic chemistry. Nothing new at all. Cocker introduced medical chemistry, he introduced the link with biochemistry, he brought the organic chemistry up to date.

What did that involve, bringing organic chemistry up to date?

Oh, talking about the things that had happened in the last fifty years.

Can you... What sorts of things were those that he was introducing?

Oh the, all the, the development of polymers, the development of dyestuffs, you know, the development of medical products, pharmaceuticals and these sort of things. And, the whole sweep of chemistry you see he brought in. And he introduced lectures on, well, more lectures on physical chemistry, he didn't give them himself. He introduced wide-ranging lectures on inorganic chemistry, modern inorganic chemistry, crystallography and all the rest of it. You've no idea how poor the course was before he came.

What kinds of new methods did he introduce?

Well he introduced modern... well, it wasn't modern in those days, the ultraviolet spectrograph, he got one of those. He introduced at a later stage infrared spectrographs, and these sort of things. The... It was before the days of mass spectrometry of course, I mean, that was quite a few years afterwards. But he was up to the, up to the minute with whatever was available then, and he got these machines, and, by hook or by crook, out of a very reluctant Board, the Trinity Board was very backward-looking and very unwilling to spend money, but, he was a dynamic man.
[23:00]
I remember, he wanted to build a new laboratory in one particular room, which was a big, big room, which had been given to him, but before that it was used as a storeroom for medical curiosities, you know, deformed foetuses and all this sort of thing.

Mm.

Yah, these sort of things. And, the medical people were very, you know, very traditional, and they wouldn't move. So, one morning Cocker instructed the builders to carry these specimens out and put them on the lawn, and, there they were in all their glory, in formalin and so on, and, the medical people then moved.

And what did he replace that collection of...?

Oh with a new laboratory, a brand new laboratory.

Could you describe that as a physical place, the new laboratory?

Oh it was the top floor of the old chemistry building. And, he put in new benches. Of course before that it was a museum, a medical museum. Put in benches and, a small storeroom at the side, running water. Modern by that, by the standards of the 1940s and '50s, modern laboratory, you know, with proper bench tops and, well, gas and, facilities that you normally get in a laboratory. Vacuum and so on.

Now this is the modern laboratory. Could you describe the older teaching rooms?

Yes. Yeah, I, I certainly could. There was a thing known as the Long Room, which, as you might guess from its title, was a long, narrow room, lit by, as I said a moment ago, coal gas. Benches were pitted with, great black benches pitted by generations of students burning holes in them and so on, and, the whole thing was a dark sort of grey colour where they'd been, H_2S had reacted with the paint and had given you this filthy grey colour. It was a gloomy old place. And these centre benches ran down the length of the room, and the students were on either side. [pause] You've got to remember that at Trinity, chemistry was taught right away from the 1700s. I think the first chemistry professor was 1711 if I remember rightly. And right up to the beginning of the twentieth century it was taught by medical people, and, as an adjunct to medicine. It wasn't by a real chemist at all, and this, this sort of laboratory suited them very well. [laughs]

Mm.

And... But, Cocker, in due course after I left, had it knocked down and a proper laboratory built.

What sorts of instruments did the old Long Room have in it in...

None.

...for, for determining structure or...?

No, not at all. No, nothing at all. It was just, you would have a Bunsen and you would do, what they called qualitative analysis, you know, you'd be given an unknown solution, or a substance, solid maybe, and you were told to identify it. It would be something like barium carbonate or something of this sort you see. And then, you' be given a copper salt and you'd be expected to use a, a blow, a blow pipe and a charcoal block, to reduce this to copper, metallic copper, thus proving that you were right. The fact that it was blue all along was beside the point. You know, all these utterly primitive techniques. There were no, no instruments at all in it.

So these are the sort of wet and dry, traditional chemical techniques for identifying structures.

Yes. Yes.

[26:56]
And, now the historical studies of chemistry tend to put the sort of mid-Sixties as the point where instruments really begin to be used to determine structure.

Yes. Yes.

So, Cocker really was quite, really was sort of on the ball in...

Oh yes, very much so.

...in introducing...

As these things came in, he, he managed to screw money out of the Board and buy them.

In that line, I wonder whether you could describe... I know that you used the ultraviolet spectrograph in your, in the first part of your PhD research.

Yes.

Now, for the recording, these pieces of equipment are sort of familiar to you, but won't be familiar to many of the people listening to the recording. I wonder whether you could first of all describe the ultraviolet spectrograph that you used?

Oh it was an American, DU, PerkinElmer. Quite a small machine, imported from America. You put your, see your solution in this, I think it was a little quartz cell, and, basically, the ultraviolet beam of light was moved, was passed through it, and, was spectrographed to break the beam into different wavelengths, and these wavelengths were passed through it, and you measured the absorption at each wavelength. It was all, it... you didn't do it actually yourself, the machine did it. You put the, the substance in the beam and then switched on the machine in the appropriate way. It was quite, it was quite a good, quite a useful instrument. I mean, of course it's totally superseded nowadays.

How was the, how were the spectra measured? You said that you then measured the spectra, once the light had...

[pause] Hm. Don't remember. [laughs]

I know that some...

I should, I should imagine it was before the day... It may have been a paper output, I'm not sure.

Well yes, that's the sort of second generation. Because, I know that there was an early point-by-point dial reading.

Yah.

And then later, slightly more expensive paper.

Yeah, you're right, you're right there, it was a point-by-point thing, yes. [laughs]

Oh, how did that, how did that work then, how did, how were the readings taken?

Yes, you were measuring, for each particular frequency of light, of ultraviolet light coming in, you were measuring the absorbance, how much it was reduced by the chemical at that particular wavelength.

Mm.

Yes.

I can see that different chemicals would absorb different amounts, but, I wondered on the machine, how you actually could read off these different absorptions, physically how the machine showed you.

I think there was a meter. Look, [laughs] this is, we're talking about something...

Of course.

...I did, fifty years ago. I, I don't, I don't remember the details of that, I'm sorry.

Were there any technicians who worked with you on the machine, or did you operate it alone?

Yes, with the infrared one, yes; with the ultraviolet, we used it ourselves.

I see. OK. Did you use the infrared one in your research, perhaps...?

No, because it arrived shortly after... well, just as I finished.

[30:09]
I see. And, how do you think that Cocker was able to, a) keep up... In what way was he connected to this very modern, cutting-edge of science?

Yes. Yes. Well he'd been, he, he'd come from England, he'd been, worked in Sheffield. His, one of his relatives owned a chemical company, the Cocker Chemical Company, long since absorbed by Reckitt and Colman, and, so he had, so he had a connection there. And he had a very active research career in England, in Sheffield, before he came to, to Dublin.

I see. Thank you.

And he, he worked with R D Harrison and some very famous chemists of the day.

[31:06]
Great, thank you very much. I wonder whether, just before we move on, you could tell me a little bit more about your non-academic interests in Dublin. You said that you were, you were connected to various sort of clubs and societies, including some very fascinating, the Promethean Society and the Fabian Society. Now I wondered whether, I wondered how you were able to talk about your Dublin life with your family. Presumably you went home in holidays and that sort of thing.

Mm.

When you talked about your life in Dublin, how... was it necessary to present that to your parents?

[laughs] Well I didn't tell them I was going to too many films, I can tell you. And I wouldn't have talked too much about the Fabian Society either, and still less about the Promethean Society. But, ah, you know, I think, we, you go home and you talk about your student life and your... I was living in rooms in college you know, which was very, great fun, and, you'd talk about this, and, the friends you had and so on. And sometimes I brought some of these friends home, and introduced them to my family. [pause] It was... As always, a twenty-year-old doesn't tell his parents everything.

What did you get up to in the Promethean Society?

Oh, that was a very wicked society. We were very left-wing. They're all, [laughs] they're, they're dying like flies, the old Prometheans. Just earlier this year Justin Keating, who later became the Minister of Commerce in the Irish Government, died, and a while earlier Paul O'Higgins, who was vice-provost at... provost? I think it's vice... yes, vice-provost, at... Vice-Master, at Christ's College, died, and so on. And Barbara Thompson, who was a very big noise in the Promethean Society, died a little while ago, she was very big in the Irish women's movement in later years. So... What did we get...? Oh we talked, and, what did we do? We talked and we talked and we talked. And we talked about the ills of Ireland and, and what could be done about it and, that's it.

[33:42]
Any key friends, any sort of particularly important friends or relationships at that time?

Sorry, again?

Any particularly important friends or, perhaps relationships at that time?

Yeah, yeah. I mean I had, I had of course my friends among the scientific fraternity, the students doing science, and some of those I still keep in contact with. The Promethean people, I've kept in contact off and on with some of them. Paul O'Higgins I was always close to, a very very outstanding man. He became a QC, a lawyer, later, as he became, he went to Cambridge and did well there, but... Keating I knew quite well, he was the son of Sean Keating, the Irish, very well known Irish painter, he, as I

said a moment ago, he died just earlier this year. I knew his wife quite well, Loretta Wine, who was the daughter, sole daughter of a very wealthy Jewish jeweller family, and, she's still alive. But... I knew Roy Johnston who was a fairly close, a very close friend at one stage. He was the son of one of the senior fellows at Trinity, an economist, Joe Johnston. [pause] The actors, I knew Jim Fitzgerald quite well, he became very well known in Dublin theatrical society as a producer, until he killed himself with drink.

Did you have sort of relationships at that stage that were significant, girlfriends?

Yeah, I did have girlfriends, but never, nothing very close. It was Dublin in the Forties you know, [laughs] you had to watch your step. For example, I was just reading earlier this morning a book by a man called Macken about his father who was a fairly well known Irish novelist of the time, and, Walter Macken, the father, wrote a book, and in the book the heroine has an illegitimate child by the hero. The book was banned in Dublin for that reason, you know?

Mm. Mm.

So, it was a very, a very, censorious society. I, I knew very, I think, lots of girls, but, no close relationships with them.
[36:33]
I finally, I met my wife in... I knew her brother actually, Brendan O'Brien, very well, and he was in the left-wing crowd with myself, and, we were at the Abbey Theatre, I was at the Abbey Theatre, and it was at the time the old Abbey had been burnt down, and the new Abbey was a temporary theatre, so, the... I was up in the gods, and, so was Brendan and his sister, so he introduced me, and that's where we met. [pause] And, well, [laughs] you know, we went from there. But, no, the... That was one of the other things that was very attractive about Dublin of course, you had a tremendous theatrical movement, you know, and you used to be able to get into The Gate, the back seats of course, for a shilling, 5p, you know, and, we went, I went to an awful lot of plays and things there. More time out from chemistry of course.

[37:37]

Mm. Mm. Thank you. Now, perhaps we ought to just touch on something you said about the industrial research, which seems quite interesting, and that was the, the feeling that this company had that British and American housewives liked different perfumes.

Mm.

I wonder whether you can remember what they thought the difference was, and then, how you could tackle that chemically.

[laughs] No, I don't remember what the difference was. But I remember, they had teams of housewives smelling different bottles of perfume, mixes, the different perfume mixes, and, these women would come in and would be paid £1 or something for a morning's work, and they'd sniff and sniff and sniff. And, the one that I suppose got the most marks were the ones they put in the soap. I don't remember more than that about it. [laughs] I've no idea what perfumes they selected. But I do know that American preferences were quite different from the preferences of Newcastle on Tyne women.

[38:35]
Thank you. Now in January 1955 you joined the Department of Agricultural Chemistry...

Yes.

...in the University of Reading. And you started to teach, at that stage soil science.

Yes.

I wonder whether you could tell me how you went about learning soil science in order to teach it, including the key texts involved.

Including...?

The key sort of texts, books, involved.

Oh yes, yeah. Yeah. Well, I tell you very simply, by reading the textbooks furiously. I was teaching honours, final year's honours students in soil, in agricultural chemistry who were doing soil science as a major, I was teaching them, not quite from my first week, but very soon afterwards. And it was a real scramble, but my goodness it was a good way of learning a subject, because you got to talk to honours students in it. [laughs] So I, I was reading furiously. I mean I suppose, the classical book was Russell, *Soil Conditions and Plant Growth*; Robinson on soils. There were a lot of books. Grim on soil chemistry... soil chemistry, yes, particularly the crystallography. But, I can't, I can't imagine a better way of learning a subject than have to [laughs] lecture. So, with luck I was a week ahead of the students. I mean it took me a long time to produce a lecture; for an hour's lecture I would perhaps put eight hours' work into it, I mean, that sort of thing; an experienced lecturer wouldn't need that. But, this is what it took, and maybe even more than eight hours.

[40:15]
Mm. And could you describe, as a physical place, the department of agricultural chemistry at that time, including the different rooms and the instruments that it had?

Yeah. It was, there were two, two sites to agricultural chemistry in Reading. One was, there was an animal side, and the other was soils. I was in the soils section, and Tinsley was, Joe Tinsley, later professor at Aberdeen, was head of the soil section. So I was under him. This was a smaller section. The major section was concerned with animal husbandry and animal chemistry really. It was, Tyler was the head of department and he was interested in eggshells, and, chickens and things of this sort, but particularly his research was on eggshells. But, there was a very active group on digestion, animal digestion, and they used to have pigs in, [laughs] in some of the, in some of the, back room, back quarters of the department, and, they would kill these pigs every so often. So, if you wanted un-hung and badly butchered pork chops, you could often get them.

And your department, the particular rooms of your soil section?

Yeah, they were just a little group of rooms, Tinsley had one, I had the next one to it, and there was a couple of laboratories attached.

What implements did the laboratories have?

There were the usual things, fume cupboards and all the normal laboratory facilities. Nothing very special. Any, any chemical laboratory of the time. We didn't have access to modern techniques that were coming in there, again infrared, but, then, I was friends with a man at the National Institute for Research in Dairying, which was three miles away up the road, and he was a spectroscopist, and he and I did quite a bit of work on infrared spectra of humic substances.

Did he have the machine then?

Oh yes, he, he had all the latest machines. Yes. So, in a sense, although the laboratory wasn't very sophisticated in Reading, we did have access to the machines that we needed. We had an electrophoresis set-up, primitive by modern standards, but, Tinsley was very interested in humic, in humic substances, these are humic acids, and, these sort of things, and, he was I think probably overly optimistic about the things that modern chemistry could do to sort out the structure of the humic acids. Still, they're still not really well understood fifty years later. They are complex things. And, he bought this rather fancy gadget for electrical research, and, I, I put various humic preparations on the top of this machine and resolved them into different fractions. But, the fractions themselves were extremely complicated, I mean they weren't the sort of things that an organic chemist could crystallise or anything of this sort; he used the ordinary techniques of organic chemistry. They were complex... It was, you, you sorted a very complex mixture into a series of almost equally complicated fractions. [44:14]
Tinsley had his theory about the structure of these things, which I think were basically right, but they were not like, a thing like cellulose, which is produced by an enzyme in cells assembling sugars in a certain way, and, under genetic control. These things are random aggregations of reactive chemicals produced when hotolysis sets in, when the cellular mechanism is, is disrupted, under, under genetic control, and you get a reaction

between amino acids, peptides and proteins and things like quinones, all of which are present in cell, intact cell, but don't get at one another.

Fascinating. So, the reason why these humic substances are so complicated is because they're chemicals that are normally sort of, controlled and supervised by the cell...

Yes.

...but because of the cell has lost control, they're mixing randomly, which creates these huge humic molecules that you were being asked to separate the fractions of.

Yes.

But because the initial substance was so complicated, the fractions themselves were...

Yes, exactly.

You hadn't really resolved, you hadn't resolved anything very small.

No no. No.

[45:35]
Now could you... I didn't know about this instrument. Could you tell me about that instrument that you were putting things on in order to separate the fractions? What was that?

Oh, it was, a primitive machine. You had an electrode on either side of a sheet of paper, chromatography paper, and you applied the humic acids to the top of the paper, so they flowed down under the influence of a strong electric field across the paper, and, this would then, they would be sorted out according to the charge, the negatively charged ones if there were any would go to one, the positively to the other, and so on. It's a technique used in molecular biology all the time now. But, this was a very primitive and very dangerous instrument, because we were using something like 1,000 volts in a largely unprotected system.

Mm.

But fortunately, there were no accidents.

[End of Track 3]

[Track 4]

When I stood up there now. You asked about girls in Ireland and so on, and student friendships and all the rest of it. Trinity was very special in that respect. If you wanted a lady friend to visit you in your rooms, you had to apply for written permission from the, one of the deans, and, you had to supply the lady's name, address and the names of her guardians, her parents. And if this was approved, you were allowed to entertain her for two hours on Sunday afternoon from two to four, with the door of your, of your rooms ajar.

And were you sort of, checked up on in that, in that period?

[laughs] No. But that was the rule. And then even more esoteric things. The front gate you see, one had to sign in in the evenings to come into the college, at the porter's lodge on the front gate. And of course the library was a little bit away. So, ladies had to sign in at the front gate and then sign in at the library, within six minutes. And if they didn't, this was investigated. [laughs] Now why the Board set a limit of six minutes, but anyway, so they had six... [laughing] It's a funny world. Anyway.

Thank you.

That's beside the point.

[01:35]
Could you describe then the... You've described the, the electric chromatograph that separated out the fractions of humic substances. What did you then do with the fractions in order to attempt to identify them?

Well, we did some analysis, the nitrogen content, phosphorous, carbon, hydrogen, you know. It didn't show a great deal except, as you would expect, that, the humic materials were acidic, they were mostly carboxylic acids. But, more than that, it didn't, it didn't give much. The only really positive things that emerged from that work, and it wasn't from the electrophoresis machine, was, came from the infrared spectroscopy. And there we did manage to show, you know, that these humic substances contained

amide bonds, like protein amides. And we also managed to show that, these humic acids didn't contain any recognisable signatures for lignin, and, before that there'd been a theory put forward by Waksman, a very famous microbiologist, Nobel Prize winner, that the humic substances were produced by reaction between proteins and lignins, they were lingo-proteins. Now, we disproved that. The reason is of course that lignins are decomposed by plenty of organisms in the soil population, and, the things that are left, the humic things, are much more degraded than, than lignin fragments, you know, that... Lignins in fact are quite attractive to a large part of the soil, a special part of the soil population, so they're not, they don't last round, they don't hang around for long. Just the same as cellulose doesn't hang around for long.

And, for the recording, lignin is the, the cell wall material in plants?

Lignin is, is present in cell walls, yes. It's the stiffening material in higher plants.

03:55]
Mm. Thank you. Could you describe, if you can, how, using the infrared spectrograph, you were able to show those two things, one, that the amide bonds were present, and two, that lignin wasn't?

Yes. You picked... The amide bands are pretty well known to infrared spectroscopists, and well-established in the protein spectra. So when we just spotted those, I mean they were in exactly the right place, when we put humic acids in we saw these bands coming up in the output, and exactly where they should have.

Now...

So far as lignin is concerned, we, we produced pure, well I won't say pure, but, specimens of lignin from straw and from spruce, and, we noted the infrared spectro of that, and looked for the corresponding bands in the humic products and they weren't there.

[05:00]

I see, thank you. I think then we, we just need to know how, once you've put the... Well could we start then with describing the infrared spectrograph as a physical instrument, what it looked like, the parts of it, and then I'll go on to ask a supplementary question about how you read off spectra from it. But what did it look like?

Oh I couldn't really do that. It was a large machine. Again, it was basically a prism, and, infrared... ultraviolet... Let's get it right. Infrared light was shone into the prism, broken into its frequencies, and then the prism would have been rotated to sort... the sample would have received infrared light of different frequencies as the prism rotated. And then the absorption of that light would be measured. The output was on paper, you'd got the spectra coming out on paper.

And what did the out... what did the output on the paper look like?

Oh just a series of ups and downs on, on the paper.

And you actually found the, the spectra of the lignin by getting lignin and then finding the spectra...

Yes.

...and then looking for... But for the amide bonds, did you have to refer to any written material in order to, to look for, 'Oh this is the spectra of that, this is the spectra of that'? Were there sort of, keys and...?

Oh yes, yup. Yeah, I mean, John Goulden, who was my collaborator on this and was working the machine, I mean he, he had all these reference compounds and things.

Mm. And how did you work together?

I used to take samples up to him, and, we would, he would run them, and then I'd go up and talk to him. We were, you know, we produced a paper together.

How long did it take once you'd put the materials in, started to shine the light through the prism on them, how long did it take for the output to emerge?

Oh, a few minutes, twenty minutes, this sort of thing.

Mm. And any...

Wasn't very long.

Any supplementary technicians working with the machine?

Not that I remember. Goulden was, was very much a spectroscopist, and he, he was in charge of everything. I think he'd have done all the work for it.

Thank you. OK.

It wasn't a very successful piece of work, I must say. I mean, amide bands, we were the first to spot them OK, but so what? And the, the absence of lignin in the humic materials, again, when you look at it, it wasn't very surprising.

Mm.

I mean the soil is full of hungry organisms, and, you're not going to put something like lignin in and leave it on scales for long.

Mm. And were there any particular difficulties in reading the output and being certain of what you could...

No. No.

It was clear?

It was clear, yes.

Mm.

Yes.

Thank you. Now the next stage in your career I think I'm right in saying is Rothamsted, right?

Yeah. I'm going to say something more about Reading before I go on to that.

Fine.

[08:12]
About Joe Tinsley. Joe was a meticulous man. He had worked, or did advisory service during the war, the Agriculture Advisory Service, and... worked for the Advisory Service, and, he was a first class analyst. And, this was one of the most useful things I learnt from him, is the value of analytical chemistry. Now this was a side that had been neglected a bit in Trinity. Organic chemists, you either got the formula right or you didn't. Whereas, in so much agricultural science, and many, many sciences, analysis is absolutely central to the thing. You, you are not dealing with pure substances. And, analysis can take you a long way. And he emphasised the importance of analytical work, and this was a lesson I took from him.

Could you explain for the recording what analytical work is, as distinct from other...

Yes, for example, just analysing a soil for percentage of nitrogen carbon, phosphorous, forms of phosphorous, sulphur and so on, these sort of things.

Mm.

The same goes for plants, plant nitrogen, carbon, phosphorous, oxygen and all the rest of it.

So if that's analytical organic chemistry, identifying parts of more complicated substances...

Mm.

What is the rest of, what was the rest of organic chemistry that was not analytical and the part that was focused on at Dublin?

Part that was focused on...?

At Dublin, at Trinity. You said that an...

Oh, structure all the time you see.

Right.

Pure compounds, structure of pure compounds.

Mm. Mm, sort of, the arrangement of particles and [inaud]...

Yeah, the arrangement of the atoms in the compounds, yes.

Mm, I see, OK.

Yes.

Whereas this is actually trying to find the components of...

You know, complex mixtures and, like soil and plants and all the rest of it.

Yes. What attracted you to that kind of chemistry as opposed to...?

I, I wouldn't say I was attracted to it; it was just that Tinsley did it and I learnt from him.

Yes, I see, thank you.

He was a very good analyst. And you know, when things didn't work out, when you get replicates that weren't close, he would do them over again.

Mm.

You know, he, he wouldn't put up with any slack techniques.

So apart from repeating to be sure, what else made him a good analyst as opposed to simply an analyst of...?

Meticulous care in preparing the samples. He was careful sampling. Great attention to the analytical techniques you use. He developed techniques himself for doing soil carbon. And, a great deal of replication, you know, he, he would... One analysis would never satisfy him.

Mm.

And quite right too.

[11:17]
Mm. Now you were there I think for two years.

Yeah, two and a half years actually.

Could you describe your living arrangements at that time? Were you...

The first few months I was in digs with, with a lady, Mrs Spencer, and a few other, a few other people in the university. And then, I got a flat, and I had this flat with two other people. And, that was, that was, it was very nice. We had a lot of friends.

Now by that time you had met your wife, hadn't you?

Oh, I had, but she was in, she, at that time she was in Denmark.

Ah. How did you correspond with your wife, from the point of meeting to... when you were... because you were at Newcastle and now Reading.

Yes.

How did that keep...

Oh, letters.

OK. And when was...

And occasional meetings.

And, just for the chronology. When was the first point where you lived together, or, lived in the same city at least?

When I came to Rothamsted.

Mhm, which I think we're on to now.

Yes.

[12:26]
I wonder whether you could explain why you moved from Reading to Rothamsted.

Rothamsted of course was a very famous, and is a very famous centre of agricultural research into arable crops and plants and plant diseases and plant pests. It just, I'd been there a couple of times, taken students over to look at the Classical Experiments, these long-running experiments started, well, the first of them in 1843, and still running, and, it was a sort of pilgrimage, once a year you took all the students over to see the experiments. So that's the first time I came across it. And then I got to know one or two of the people working at Rothamsted. Jack Bremner, a very able scientist. And, he had a position going, and, he asked me, would I like to apply for it? Which I did. My

contract at Reading was running out of course, it was a three-year contract, temporary assistant junior lecturer or something, I don't... one of these sort of jobs. And, I was a bit worried. Although afterwards Tinsley said, 'You shouldn't have worried,' he said, 'you should have, you should have stayed.' I sometimes wish... Oh, I don't say wish. I sometimes wonder, should I have stayed? I don't know. Anyway, Bremner asked me to go over to Rothamsted, and I did. And, he thereupon went for a year to America with his wife and family. So my first year at Rothamsted I was on my own. And I got involved in all sorts of things. And then he came back for another year, and we did a little bit of work together, but he was unsettled at that stage, and, he, he had been offered a professorship at Ames in Iowa, and, he was going, going to take that up. So the collaboration never really got going. We wrote a couple of papers together, but... And, in retrospect, I think it was probably just as well for, for me certainly. Jack, I liked Jack, I think he's dead now but he was a fine man, and a very, very very good scientist, he was elected to the American, the National Academy of Sciences, the US National Academy of Sciences, which is a distinction not a lot of American scientists get, and, did a lot of very good work in the States. But, he was a very dominant character. And he wanted me to work on things that he was interested in. But since he, he left within two years of my arriving at Rothamsted, it gave me the opportunity of going off on my own tack.

[15:33]
So what were the things then that he was interested in that you worked on for the...?

Oh he was interested primarily at that time in inorganic chemistry of nitrogen in soils.

Could you explain what that...?

He was interested in nitrogen fixation in soils. He was interested in denitrification, this is the, the release, the decomposition of nitrates by organisms, which produce nitrogen gas. And, and, N_2O as well, under certain circumstances. He was interested, very interested in, again analytical methods, total nitrogen in soils. He did a huge piece of work on, on comparing different ways of measuring total nitrogen in soils. And, this was the sort of thing he, he would do. He... And when he went to America, he continued this, and he wrote the, the three big chapters in the book, the American

Society of Agronomy book, on analysis of soils, or, three big chapters on nitrogen. So, this was his main interest. I was more interested in organic matter, in the dynamics of organic matter, and these things, and when he was away that year, the first year, I built a growth chamber to grow uniformly labelled plant material, this is [inaud] with radiocarbon, radioactive carbon. And, I grew this stuff, and, the process and the storing, and then eventually incubated the soil to follow its decomposition. [pause] And Jack wasn't a bit pleased when he came back, I can tell you, that I had started on this line.

Can you remember what he had said to you when he returned?

Nothing. Absolutely nothing. I said, 'Would you like to see this growth chamber I have constructed?' I took him in to see it. He didn't say a word. [laughs]

[17:45]
Ah. And, could you describe the... I'm going to go back to the, the work that you did on nitrogen with Jack before he went away for the year, but, could you describe this growth chamber that you built in the...

Oh it was just, a large Perspex construction I suppose about a metre long, a metre high, and, about sixty centimetres deep, with fluorescent tubes over, above it, produced the light. It sat inside a fume cupboard, because of course, carbon-14 is a radioactive material and we'd got to be careful of it. Incidentally, I'd never be allowed to do that nowadays, the whole experiment, it wouldn't be even contemplated with modern regulations. But, I supplied the radioactive carbon dioxide to the plants, and they took it up. And then, after a certain number of weeks in the growth chamber I harvested them, ground them up, and mixed them with soil, and did all the things I wanted to do with it.

Great, we'll come back there. And, were you, when he did start talking to you again, did he have... When Jack did start talking to you again, after that moment where he looked at the chamber and didn't say anything...

Mm. Yes.

Did he say anything about your movement away from his work then?

No. No. We, we did a bit of work on analytical chemistry of carbon, we wrote a couple of papers on that, which were quite interesting papers, and, there's, one or two of them... they occasionally still get quoted. But, they were quite good papers, two of those. But we never worked together on nitrogen.
[19:33]
Now he wanted me to work the... he had ordered a mass spectrometer, a Cooke Yarborough mass spectrometer, which had been invented by two scientists working at Harwell, and, this was a state of the art gadget. And, it arrived when Jack was away and I was in my first year at Rothamsted, and, it, it was a very, oh, botched sort of a gadget. It had, a lot of it was ex-service, military stuff, you know, the oscilloscope was a military oscilloscope, and, you know, it was all sort of, very clever but very, but not really a, a useful machine. And, it wasn't nearly sensitive enough for what we wanted to do. We wanted to use nitrogen-15 as a marker for nitrogen entering soil and plants, and this, this machine was, wasn't up to the job. In fact it was nearly twenty years later before mass spectrometers became good enough at this job.

[20:55]
Could you explain how it, how it worked and why it wasn't up to the job, how it failed?

Well, like all mass spectrometers, it ionised the, you produced the nitrogen gas which you wanted to analyse for ^{15}N. It was analysed... Sorry, it was ionised, and then its combined magnetic and electrical field applied to it. Essentially it's, the ions are attracted to the electrode under a very large electric EMF, and, it shot past, during its flight it shot past a magnet, and this deflects the beam, and then you, you measure the deflection on a, a number of... using basically a DC amplifier. [pause] It was a primitive instrument. I mean, it was only fifteen years after the first mass spectrometers were built by Aston, and, it just wasn't up to the job. Whereas the later ones were, were produced commercially, and were, you know, proper commercial instruments made for the job, and not botched together out of various bits and pieces. So... Anyway, that was, that was that one.

And, you presumably then weren't able to see whereabouts in, in the organic material the N had got to?

Oh you could in a rough sort of way. But, it was... You see, the trouble is that I wanted to do... I don't know if Jack did, but I wanted to use field experiments. Now you, if you put, say, let's say in a commercial dressing of nitrogen, maybe 150 kilograms per hectare, and, perhaps thirty of that ends up in the soil, in soil organic matter, but there's already 3,000, 100 times as much you see, ordinary nitrogen. Now it's very difficult to spot that ^{15}N against that sort of dilution.

Mm.

So, it just wasn't up to that sort of job, which is what I wanted to do. And then later of course we, we did all that.

[23:24]
Thank you. Now you, you yourself were more interested in organic matter...

Yes.

...organic turnover. Do you know why at that stage you were more interested in that side of soil?

I suppose it was basically because of the introduction I had to agricultural chemistry by Tinsley, Tinsley's influence. I was still interested in it. And in fact I wanted to try, I wanted to do some of these things at Reading, but, I got the opportunity to go to Rothamsted.

OK. Could you then take me from... You've grown the ryegrass in the container...

Mm.

...with the labelled carbon dioxide. Could you tell me step by step what you did next in your work with that?

Well, what we did, we, we ground it up very finely of course, and then... most of it, and then we incorporated it into soil, different soils, different pH's, different textures, you know, clays and sandy soil and so on, and we followed its decomposition for ten years, sampling regularly. And, I did this at Rothamsted, and then later I did it, much later I did it in Nigeria, the same type of material and following its decomposition. And, what happened was that, you very quickly, in the first three months, lose about two-thirds of it, and then the remaining third, or perhaps even less than a third, decomposes very slowly, so that even ten years after you've still got, you've still got maybe half of it, or maybe even more. So, it falls very quickly to say, twenty-five per cent, seventy-five per cent is lost very quickly, then that twenty-five per cent falls maybe to half its value, say 12.5 in the next ten years. A very slow process you see. And this is when it's in the humic materials. And, of course if you do this in Nigeria, the same thing exactly happens, except everything is four times faster.

Why was that linked with Nigeria, what was the history of...?

I was encouraged by Dennis Greenland in Reading, who was a professor at Reading, to do some work at the Institute, the, IITA, Institute of Tropical Agriculture, International Institute of Tropical Agriculture, in Ibadan. And I went out there a couple of times and did some work there, and set up these experiments. I did a lot of other things as well as, as that in, in Ibadan. But...

What was the purpose of that institute there, what were...?

Oh, to introduce new methods to agriculture in the Tropics, in the humid Tropics.

Did it have a sort of colonial history as...?

Sorry?

Did it have a colonial history, this...?

No.

No.

No, it was set up by the, basically with American money. No, there was an institute set up in colonial times, Moor Park[ph] research station, which I visited. But, the Americans put a lot of money into a number of these. There was one in, IRRI, in the Philippines; there was another one in Hyderabad; and there was CIMMYT in, in, where... Mexico I think. Yes. And there was one in Colombia.

Mm. Who was working with you on the labelled ryegrass work over the...?

Nobody. I'd have an assistant, but basically myself.

What was the role of the assistant in the work?

Pardon?

What was the role of the assistant?

Oh just to help me. He was a young fellow. He'd wanted to get to medical college, which he did in the end, and, he got a year to repeat his A-levels, so, during that year he, he worked at Rothamsted.

And what sorts of things did he do in a support role?

Oh he'd do a lot of the analytical work, you know, under instruction of course. He was a youngster, eighteen.

[27:33]
Could you describe the analytical work? This is presumably taking the, at various points, I think you said over ten years?

Mm. Yes.

So you've got the soil samples with the labelled carbon in.

Yes.

And you said that you followed its decomposition, and you said that you sampled regularly.

Mm.

Could you say what you did when you returned to these soils, how you got the stuff, where you put it, what you did with it?

Yes. Usually we just took the whole bottle of soil which is out in the field, and it was, it was just a cylinder with a glass fibre bottom to it so that you'd get drainage through it. We'd take the whole lot out, sieve it, and take a sample, and then analyse that for total carbon and radiocarbon and what have you. And put the rest back for another year.

How did you analyse it, the little sample you got?

For total carbon, by the usual methods; for radiocarbon, by a series of methods that I developed actually.

With instruments or chemicals?

Oh with instruments, yeah, yeah. Scintillation counters basically. I spent a lot of time developing methods for, working with quite high activities, quite sensitive methods. We published a paper in *Nature* on it. But, the... most of the work was done with scintillation counting, which is a standard technique for measuring radioactivity.

Could you describe that, the instrument involved and the method of...?

You would put the... You'd get the carbon dioxide, you would absorb it in alkali, and then, you would add phosphor to it, and, and then you'd put it in a vial and put it in a

belt which went through the machine. And each time a belt came to the point of analysis, the flashes of light would be detected, and these were caused by disintegration, and the more radioactivity you had in the sample, the more flashes you see.

So you counted the flashes?

Yup.

And wrote them down. Is that the kind of work that your assistant could do once you'd sort of explained how?

No, well it was quite a, it was quite a fancy machine, and it was done by another person, for me, I'd ask him to analyse umpteen samples.

And what did that person give back to you, in terms of the...?

He'd give me the cards.

OK, I see. Thank you. So, which would be a number of flashes of light?

Yes, yup, yup.

OK. And then, in the... Whereabouts at Rothamsted were your containers with the glass fibre bottom, with the main sample, whereabouts were they, you know, on the site?

Oh they were out in one of the fields. Yup.

All standing in a sort of...?

They were all fenced off of course, yes.

And how many...

So that the cattle didn't walk over them.

[laughs] Yes. How many did you have?

Oh, I suppose a dozen or so. Different... I started new experiments a couple of times.

Mm. OK, thank you. Were there any sort of, key problems in that work, key difficulties?

Yes, one... several of the, [laughs] the containers were wrecked by ants, carrying, built nests, carried soil in. [laughs] You know, sort of... That wiped out a couple of the replicates.

So, once ants had done that, they'd taken soil, was that container useless? Yes.

Useless, yes.

Because it was, it was therefore not scientific, it wasn't controlled.

Yeah. Yeah, yeah.

It wasn't controlled.

You had no idea how much they'd brought in you see.

Mm. OK. And how did you know that they'd done it? You could see their nests and things?

You see them.

Yes. And I suppose there's nothing you can do about that, because you need the top open, do you, for the...?

Well, I, I didn't usually leave the top open; I put a glass fibre, or glass, glass cloth over the top and bottom you see.

Mm.

So that they're open top and bottom.

But they were able to weasel in.

Oh yes, ants can do it, yes.

OK, thank you. Now.....

[End of Track 4]

[Track 5]

I wonder whether you could continue by explaining the detection or the recognition or the role of the thermonuclear test...

Oh yes. Mhm.

...effects on the radiocarbon dating work.

Yup. Yes, the thermonuclear tests produced huge amounts of carbon-14 in the atmosphere, reaction of neutrons with nitrogen. And, these tests of course peaked in the early Sixties, the Americans let a few off, and then the Russians let a couple off, one of the Russian ones was absolutely huge. So this pulse of ^{14}C entered the atmosphere, and then the plants, and eventually the soil. Now, I'd been radiocarbon dating soil organic matter, and, I was very much, I was using old stored samples that had been taken long before the... [telephone ringing] There we go. Excuse me.

[pause in recording]

You'd been radiocarbon dating soil from stored.

Yeah. And, much to my surprise, the age came out to be, oh, thousands of years, topsoil 1,000 years, subsoil down a metre or so, 10,000 years. I hadn't expected this, in fact in one of the early papers I said that, soil turnover is too fast for radiocarbon to be any use. [laughs] A spectacular mistake. Anyway, the... Of course these thermonuclear tests took place, and the pulse of ^{14}C entered the plants and the soil, and this gives you a way of following the entry of plant material into soil, and, you could use the difference between the carbon content, the radiocarbon content of the soil before the tests, and after the test, as a way of calculating how much carbon goes into the soil each year from plants. And I did this, and of course, this ultimately led to the RothC, the carbon turnover model, but, we'll leave that for the moment.

Could you explain how precisely the, the fact of the pulse of carbon dioxide, of carbon, of radioactive carbon, caused by the testing, allowed you to measure how much carbon enters the soil from plant matter each year?

Well, you measure before and after, and you, you actually follow it for a number of years, as this pulse dies away. And, if you're under a steady state system, which we can assume in the Rothamsted Classics, some of the Rothamsted Classic Experiments, which had been under cultivation, the same system, for well over 100 years, so you're pretty near steady state conditions, so, the input of carbon isn't going to change very much or at all. And then, by looking at how much of the new radiocarbon comes in over time, you can then calculate back how much the input of carbon to the soil from plants was.

Mm. OK, I see. And, do you remember the names of the particular tests?

Oh, no I don't. There was the, the big American one in Bikini. There was a huge Russian one in Novaya Zemlya, way up in the north of Russia. And, the French let off a hydrogen bomb, so did the British actually. The Chinese did one later. But, atmospheric testing was banned, and that was the end of those big tests.

Mm.

So, since then, the radiocarbon content of the atmosphere has been dropping back to its previous levels, and... In fact, I think in the paper this morning, that people were able to detect wine that was supposed to be laid down in 1960 from, laid down in 1960, but in fact was grown in 19, say, 90, you could tell.

Mm.

So... They've also applied this to whisky. So people who have been lying about the age of their whisky can be caught out. [laughter]

[04:28]

I see, thank you. OK, and so, this work was extended later for the net primary production?

Yes, yes. Yeah. That really comes out of the, the RothC, the turnover models, so we'd better leave that for the moment, we'll come on to that.

OK. Could you then describe the particular, the practice of radiocarbon dating the soils? You said that you, you followed, you followed them over a period of time.

Yes.

But what, what did actually dating them involve?

Oh. Yeah, well, [laughs] we didn't have anything to do with it, we just parcelled up the soil and sent it off to a radiocarbon dating laboratory.

Ah.

And they oxidised the carbon to carbon dioxide, which they then reduced to carbon, and they, they, they then put this in... There's a number of ways of doing it. In the old days it used to be done by scintillation counting; now it's done by mass spectro... accelerated mass spectrometry. So it wasn't done at Rothamsted. These are very specialist facilities. There's one that we used mostly in, in Scotland, East Kilbride, it's the NERC facility, and, we sent samples there.

And so the samples, could you describe, as I don't know, and many people listening to the recording won't, how the, these archived soils are stored at Rothamsted, the one...?

They have... They were stored up till last year in a building up near the manor, in bottles, sealed, and labelled of course. They've now got a new soil store near the, in the main building, where the main buildings are. And, this is completely automated, all the things are bar coded and so on. But basically, crop soils, crop samples and soil samples, are stored sealed in bottles, apart from a few during the Second World War, where they had to use all sorts of tins and things, they didn't have the bottles.

Mm. And, you went to these bottles, and...

Yes. Took some, some samples from them.

And could you describe how you had to package these up for sending off to the Scottish...?

Well, we had to be very careful, because, I was using radiocarbon at tracer levels you know, much, much higher levels in the main lab. So we couldn't handle the samples in the main lab. Because, although I, I, I was very careful to avoid contamination, the levels of carbon we were using in these experiments I describe we were incubating, ^{14}C labelled plant material and so on, they were magnitudes, many magnitudes of order greater than you're using in radiocarbon dating. So, we had a special laboratory made up in the manor, in one of the outhouses of the manor, to handle these samples, and we, we changed shoes and all the rest of it, you know, and put on special coats and things, so that we didn't cross-contaminate these samples before we took them, opened the bottles and took out the samples and, you know, took however much, however much we needed from the bottle.

And when you took the sample out of the bottle, wearing the, the gloves and the shoes...

Yes. Yes.

What did you then do?

Oh we just put them in, in a container, and sent them, posted them off.

Mm. And then what came back to you?

The radiocarbon age.

So, the... How, how did you label the soil so that the bit of paper you got back matched?

Oh we would have, we... We stuck labels on.

Mm.

Nowadays you'd use barcodes. We, we just stuck labels on.

[08:29]
And when you are saying 'we', who, who were you working with on this?

It's the royal we, me.

Ah. Did you have any assistants on this radiocarbon dating?

Not much. I'd have an assistant all the time, but, usually I do this work by myself.

Mm.

In the early days of course we, we sent some samples to America, we, we sent them all over the place. Sent some at the very beginning to the NPL for radiocarbon dating, but, it's quite expensive. We used to send them to America, and that was very expensive indeed, you know, something, two or three hundred pounds a sample.

Could you describe any problems that you had if you did with, I don't know, samples going missing, or, difficulties in matching up what came back to you in terms of results with the samples that you sent?

No. By and large the results were, there was nothing alarming in it, in other words we, we didn't find we'd dealt with a contaminated sample. [pause] There was no great problem.

[09:36]

Mm. I'm still wondering a little bit, I, I think I was a bit shy to ask. How quickly did the, the radioactive carbon that was a result of nuclear testing, how quickly did that enter plants, and then become recognisable in soil?

Well, it would enter plants... I mean let's say you got a test in the winter, the carbon from that would probably enter the following season's plants.

It would already have entered global circulation of atmosphere?

Yes, yes, very quickly. It would be mixed in the Northern, let's say, take the big Russian one, it would be mixed in the Northern Hemisphere in a matter of weeks, and then the plants would take it up the following growing season.

And did you imagine that this was going to be the case with... You knew about the nuclear testing. Did you think to yourself, that's going to affect soil, or did you find the, the raised levels in the soil and think, that...?

Oh no, we, we knew about the tests, and, and people were interested in this, and I, I said, we can apply this to soils.

And you expected to see these raised levels?

Mm, yup, yup.

[10:42]
Thank you. Could you describe your next, the next stage in your work at Rothamsted?

I got very interested in fractionating the organic matter that I had labelled with this plant material, and so, you spent a lot of time trying to find out where the labels had gone. When we took plant material incubated in soil, let's say for a year, where was the label now? And, I looked at all the traditional humic acid fractions and fraction, and, it smeared across everywhere, there was no great distinction between any of the fractions we isolated. And then, I was working at the time with an Australian visiting worker who, he and I were doing some work on fixation of nitrogen, that was from bio-

organisms living in soil, and he said that, 'I know about this work being done by a man called Birch.' And I sort of read that up, and I realised that there was, there was something in it. And, so I repeated some of Birch's experiments where we treated the soil with chloroform, and, there was... After you treat a soil with any antiseptic, chloroform being one of them, there's a tremendous flush of decomposition and then it subsides after a while. And I did this, and I found that the stuff coming off after you'd fumigated with chloroform was very heavily labelled, very very heavily labelled. Whereas if we look at the soil as a whole, the label is everywhere, smeared across. So, this led me into the idea that, well, the question then was, where was this stuff located, that you released when you treated it with chloroform? And, there were a lot of theories about this so-called partial sterilisation, and this had been known since the beginning of the last century, and, even earlier, but, none of the theories were very satisfactory. Except one put forward by a man called Störmer, a German, way back at the beginning of the century, who had said it was just due to the killing of organisms, the organisms were killed by the fumigant and they decomposed. And that, that in fact, in the end I came to the conclusion that was true. And we did a lot of tests, an awful lot of work to show that it was so. And, that's exactly what happens. You kill the, the, the, that material decomposed in soil; some of it goes into the microorganisms, some of those are, go into dormant forms of one sort or another, they'll hang around for quite a long while. And you come along with your chloroform, you hit them with the chloroform, and off comes this very heavily labelled carbon dioxide. And, the interesting thing here was that this gave you a way of measuring the size of the soil population. So we introduced a fumigation technique as a way of getting an estimate, getting a handle on how much microbial biomass there was in soil. And, this, I published a paper, and this away back in 1966, and this had negligible response. And then, David Powlson came some years later and, we did a lot more work on it, and we introduced a method for measuring microbial biomass based on a fumigation and then the size of the flush that follows this fumigation. And, this was then taken up quite widely. And then still later with an American visiting worker, a fellow called Eric Vance, a man called Eric Vance, we modified it still further. So we didn't look at the amount of carbon dioxide released when you incubated the fumigated soil, but rather, we looked at the amount of material solubleised by chloroform. In other words, this was the, the guts of the biomass, the sort of, you broke the, the cell walls and you disrupted the lipids in the bacteria and protozoa and fungi and all the rest, and this

allowed lysis of the bacterial contents, microbial contents, and these were then extractable. So, we developed a new method for measuring microbial biomass so it was much easier to do, you didn't have to incubate. A lot of other advantages I won't go into. So this was, this was in fact my most cited, well it's, Eric Vance is the lead author in the paper, but this is the most cited paper I've been involved in, this measuring of the microbial biomass. They're pretty widely used today.
[15:47]
It threw into relief a number of things. First of all that, most of the organisms in soil, you can't cultivate them on agar plates or anything of that sort; most of them are there in a resting stage. They're, really they're sitting around waiting for the good times, waiting for the next input of plant material. And they've developed this ability to maintain themselves over long periods, in anticipation of the, the good times that are to come. And of course, this is what you would expect of a soil population. I mean, the, the input of plant material is sporadic, and, if you've got an organism which has got a short lifetime, there's none left by the time the next plant material comes in. So that, you've got this very large population, it's, it's a huge population. I mean, in terms of sheep, I mean, twenty sheep per hectare is very heavy stocking in this country, but, it would be 200 kilograms per hectare... twenty... You know, you'd have vast amounts of, of microbial biomass in soil.

Could you first of all describe...

200 times the weight of the sheep.

Mm.

Mm.

Mm. And, and therefore a significant sort of stock of carbon.

Yes. Yes, oh yes. It's something of the order of one, two per cent of the soil carbon is in microbial biomass.

Mm. [pause] And yet... And the rest of the carbon is in these humic substances that you attempted...

Well, it's, it's complex… Part of it will be plant material being decomposed, in active decomposition.

Yes.

Part of it will be in these humic substances. And part of it is tied up in extremely resistant forms, probably in, closely linked with clay minerals. This is the part that gives you the large radiocarbon ages.

[18:02]
And how, how did you attempt to measure the amount of carbon in the humic fractions that... You said you found the carbon to be smeared across the fractions. Could you describe the, the practice...

Oh yes. It's a standard technique. You just, you extract the alkali, and then you add acid to the, the alkaline extract. A precipitate comes down which is called humic acid and the stuff that doesn't precipitate is called fulvic acid.

Right.

And you, you then separate these by filtration basically, and then, that's your... Then, so you've got three fractions, you've got your stuff in the humic fraction, you've got the stuff in the fulvic fraction, and there's stuff that you couldn't dissolve.

Were you at this time using instruments to examine hu...?

No no, you just, just radiocarbon date each of those fractions and do it.

[18:50]
I see. Thank you. Could you... You've mentioned two sort of key co-workers in this work.

Yup.

David Powlson and Eric Vance. I wonder whether you could give the recording a sense of the, the sort of social relations involved in scientific practice if you like, in other words, how you and for example David Powlson work together.

Mm.

So the, a flavour of two scientists working together, how did you break up work between you, or, who did what, how did you interrelate, what work, and that sort of thing.

Yes. Yes. Well it changed over the years. I mean initially he was a PhD student working for me, and then he got his PhD, got a good PhD. And then, he was on the permanent staff, and we worked together on all sorts of projects. He had other things that I was not involved with, he did things in acid sulphate, soils in Malaysia, on his own. And... But mostly we worked together. We'd plan experiments together and we'd do them together. And then in the end he became head of the department after I retired, and he was in fact my nominal boss. [laughs]

Mm. Mm.

So, [laughs] if I'd still been working... So anyway, the relationship was always... We, we argued a lot. We never fought. We'd argue a lot and still do.

What would you argue about at this time?

Oh, technical points. I mean, he, he sent me a draft of a little, I suppose a reply to an erroneous... reply to a, a bad paper, and, on Saturday night I sort of rewrote it, you know, and we'll argue about that, was my rewriting right or was his... You know, it's all good humoured.

Mm. At this time then, you were working with him on a way of measuring the flush of CO_2 when...

Yes. Yes.

I wonder whether you would remember any conversations you had, any agreements or disagreements or discussions you had about the method of measuring the flush of CO_2.

I don't think so. Because, I basically made up my mind about that before he came.

OK.

And, I think he, I think, he was convinced.

What was that practice of measuring the flush, how did you...?

Oh that was in the 1966 paper. Measuring the fumiga... the size of the flush that follows fumigation. And then, what we did, we put in organisms into the soil, and saw how much of their carbon was released as CO_2, when we exposed it to chloroform.

Mm.

And we worked out a factor then for converting the CO_2 that follows fumigation to the carbon originally in the biomass. The factor was round about, about .45, in other words you get rather less than half of the carbon. It was originally in the biomass, in the flush.

Mm. OK. So, slightly more than half remains in the bodies of the...

Yup. Yup. Yup, yup.

OK. Thank you. And how was the flush measured, was there a... How was that gas, the amount of gas...?

In the early days it was just measured, you'd have a control which hadn't been fumigated and you measured the carbon dioxide coming off in ten days. You'd absorb it in alkaline and determine it by titration, and then you'd have a flush where you'd exposed the chloroform, removed the chloroform, incubated the soil, and then incubated it for ten days... inoculated the soil, and then incubated it for another ten days. And the difference between the fumigated and the un-fumigated was the flush.

And when you worked together, where did you work together?

Ah we had a laboratory together. He shared one, he was on one side of it and I was on the other side

Was all your work together done in the laboratory?

Oh no, we did lots of work in the field.

And, all within scientific spaces then, or, did you work at other times? I mean did you socialise but...?

Not a lot. I mean I know his wife and he knows mine, but we didn't, no, not a lot. I mean, basically it was a work relationship.

Mm. Mm. Thank you.

I mean, there's no, never any antagonism between us, whatsoever.

No. And, the working relationship with Eric Vance on the modified...?

Yeah, well he was just here on a Fulbright scholarship for two years, so, he was the, he was first author on that important paper on the modified method for measuring biomass, improved method. He was, he came to work for two years. He had already got a PhD.

Mm. And do you remember the kinds of discussions that you would have about that work?

Oh, we'd have been talking about it the whole time.

Mm.

You know the usual scientific business, you're arguing and tossing and, back and forth.

Do you remember parts of that improved method that were mainly your led ideas and parts that were mainly his, so that you could assign, I don't know, different...

It's hard to say. He was, he is, a highly intelligent, good scientist, although he's not, not very active in science now, he's in the forestry business, but, och, I'm not going to say that I did it all or that he did it all, it was, you know, the two of us were at it.

Yes.

And in fact Phil Brookes, another of my major collaborators, it's, Vance, Brookes and Jenkinson is the paper.

[24:10]
Mm. Mm. Thank you. And then, could you say where you went next with your research and...?

The... I was also interested in the accumulation of organic matter in woodland soils in... Because there's an experiment at Rothamsted, the, called the Wilderness experiment, where two areas of land were just fenced off and let to, to tumble down to natural vegetation, and now they're, they're woodland. I mean this, this part of the world would have been woodland in pre-Roman times, and, even before that, and, these areas have just gone back to woodland. Now, the people at Rothamsted, long before my time, had measured the accumulation of carbon in these soils reverting to woodland, and of course, carbon builds up under woodland, or a grassland, and, we measured that. I mean, there were measurements made about 1902, and there were more measurements

made on, I measured them in 1965, and then, with colleagues, and we measured them again in 2000 and... in, no, in 1999. So we were following the accumulation.
[25:30]
This is an important issue because of course it's one of the ways of storing carbon from the atmosphere, taking carbon up, and, these papers were, have been quoted in, in terms of that need, and, I... So, I did a bit of work of that, and the accumulation of carbon, nitrogen, sulphur, phosphorous and so on.

How do you measure, how did you measure, for example in 1965, the amount of carbon that had accumulated in the soil underneath the wilderness?

Yes. We went... We went into the, for the wilderness, and we sank a big rectangular, square in fact, pot with an open bottom, or a sharp bottom, into the soil, drove it down, took out the soil; then drove it down another layer, took out the soil and so on. It was a very laborious business. And we did this, you know, perhaps four or five, four replicates in each of the wildernesses. So, we, we shifted a lot of soil. It takes about a day to, to do a single hole.

How many times down did you go with that?

Usually, three or four.

OK. And then, you're saying, were you... there was...

Oh, this was heavy work. I had a big strong assistant in 1965, a fellow called [inaud] Anderson [ph]. He later became a police forensic scientist. But, he was a big fellow. And, I, I, I did a bit of work too, I was, [laughs] I was stronger then than I am now and... But we used to do this. And then later of course the 1999 sampling was done largely by corers, big, big power-driven things you know. But, long since, sampling has always been to take a big sample, not a little one, and to measure the, the mass of it very carefully, so that you can calculate everything back to, you know, a soil layer basis.

OK, I see, thank you. And so, once you'd, you'd driven this square pot into the soil, say, for the first layer, you've got the layer, what did you do with that mass of sort of soil, where did it go next?

Oh you'd sieve it, pull out the roots, if there are any roots, pull out stones, weigh them of course.

In the field? Do all of this in the fields, in...?

Oh yes.

Yes.

Do that. And then bring in the, the soil that passed a half-inch sieve into the lab. And then it would be further treated you know, and finely ground for analysis.

How is it treated before it's ground?

Oh it would be, other sieves, stones, smaller stones removed and so on.

Mhm. And how was it carried from the field to the laboratory?

Oh in plastic bags.

Right, OK. And so this would take a day to do the four samples...?

Oh gosh, it would take you four days to do the four pits.

OK. So, within each wilderness, one pit is a day.

Yes, that's right, yes.

Digging it, taking it back to the lab, sieving it again...

Yes. Yes, oh yes.

Mm. And how was it, how was it laid out in the lab to make sure that you knew that the sample from this part of the wilderness was...?

Oh it would be all carefully labelled.

How was it labelled? Just...

Oh, plot numbers, pot numbers and so on. Depths first of all, and then site. Ah well, first of all it would be the, which wilderness, Broadbalk Wilderness or Geescroft Wilderness. Then it would be, which depth, and then it would be, which hole.

Right.

And we had a map on which the holes were marked.

Mm. I see, thank you. And then the samples themselves, was there a label stuck on them, or...?

Oh yes. Yes.

Scratched on the...

Yah. Oh it was very, it's absolutely vital you know, to get the, to get your labelling right.

[29:10]
OK. And, you found that, with the growth, with the reversion to forest, that, what was the discovery in terms of carbon in the soils?

We, we measured the rate at which the soil gained carbon. We also measured the amount of carbon in the trees, by measuring the size of the trees and what have you. And, this way we were able to work out how much carbon had been gained over... and

how quickly it had been gained, and nitrogen of course as well. And, it's interesting because, the Wilderness gained vastly, much more carbon than the increase caused by human additions of carbon dioxide to the atmosphere. So I mean, [laughs] if you put all your agricultural land down to woodland, you, you would sop up an awful lot of the CO_2 that's building up in the atmosphere.

I mean that's a, a sort of climate change implication of the work.

Oh yeah it does. But...

What was, what was the interest in, in that work in 1965, when you were measuring?

It was mainly in nitrogen, the rate at which nitrogen was accumulated and how it was getting in.

And, and so carbon was one of the things you were measuring, but...

Yes.

It wasn't at that time especially important?

Not as important as it subsequently turned out to be, yeah.

And why then was nitrogen the key?

Well we were interested in the mechanism. I was very interested in how nitrogen got into soils at that stage. And, and there were no... In one of the wildernesses, there were no legumes at all, in fact there are no legumes in either of them now, and, nor were there any nitrogen fixing trees. So the question is, how did this nitrogen arrive? Probably from the atmosphere, there was a certain amount of nitrate and ammonia in the, in the rainfall and all the rest. Unfortunately Broadbalk Wilderness is very close to the farm buildings, and they've got great heaps of manure, so there may have been an input of ammonia from that.

Mhm.

But, the other wilderness, which way on its own, accumulated nitrogen much more slowly.

[31:32]
I wonder whether you can explain why at that time you or perhaps Rothamsted were interested in, in how nitrogen got into soil that was, that had reverted to woodland, perhaps in relation to how scientific work at Rothamsted at this time was funded?

Mm. Yeah, there was a lot of work at the time on nitrogen fixation by legumes. The microbiology department was very largely concerned with this, on nitrogen fixation by clovers and what have you. And the head of it, Phillip Nutman, was very keen on this sort of work. Of course, this is immensely important in, in soya beans for example, fix all their, virtually all their nitrogen by symbiosis, like the clovers do in vast amounts of upland grazing, or, depend on clovers and what have you for their, their nitrogen inputs. And, there was a lot of interest in that at the time, probably more than now. And then I had been interested, this, I mentioned him earlier, Jim Barrow, the Australian scientist who was working with me, we'd followed up some earlier work done by a Jack Bremner, and even earlier by some Danish workers, a fellow called... I've forgotten, doesn't matter. [pause] I've forgotten. Any rate, that in certain situations, certain rather specific situations, you can get an awful lot of biological fixation by soil population. These were, when you got plant materials mixed with soil and you had got an aerobic/anaerobic interface, in other words, at the bottom of a swamp, and in these situations you can get an awful lot of nitrogen fixed biologically by clostridia as a matter of fact. And... Jensen was the name of this, the Danish scientist who originally investigated this. But, I was interested in this you see.

[33:51]
What was the relative importance at that research station of sort of, just pure interest in soil and how nutrients are gained and accumulated...

Mm.

...and a kind of, sort of, practical agricultural interest in sort of, optimising agriculture if you like?

It wasn't as close as may be it should have been. I think we were left to go off on our own tangent perhaps more than, certainly more than we would be now. But as I say, at the time, this, we're talking about the Sixties, there was a tremendous interest in biological fixation of nitrogen.

Mm.

And, of course subsequently the use of fertiliser and nitrogen has increased enormously, and this dominates the situation in most agric... most modern agricultural systems.

So the reason there was this interest in the fixing of nitrogen naturally is because, artificial fertilisers, the application of that hadn't started to...

Yeah, they were used, but not as widely or anything like as in large amounts as they are now. And, the Agricultural Research Council of the time had set up a unit of nitrogen, study nitrogen fixation, down in the University of Sussex.

So that rather than fertilisers was then seen as the way to...?

Mm. Yeah. Yeah, people were interested in that. But, the... What happened really was that agriculture, independently of the science, moved much more to an industrial type system, with large inputs of fertiliser. And of course, later on, we got into this as you, you probably realise, we got into the question of the fate of fertiliser nitrogen in soil.

Mm.

But, at that time, I suppose it wasn't really very well focused, but I was interested in nitrogen fixation, and I was wondering how these soils in the woodland gained so much nitrogen when there were no legumes there.

Mm. Now there were a few people at this time, in the Sixties, who were thinking about carbon dioxide and, and warming of, of atmosphere, although of course it was nothing like the interest now. Were you aware of any, of any discussion to...?

No.

No.

No. I knew of course of the greenhouse effect, I mean this goes back to the previous century, but, the importance of it, no. No, no the, this is a thing that's much later than that.

Mm. Thank you.

I mean if I'd been more aware, maybe I'd have made more of it, but... [pause] At the time you see for instance people were much more concerned with acid rain than sulphur dioxide, produced by power stations and what have you, ships and all the rest of it.

[36:56]
Mm. OK. So from the Wilderness experiments, where did you go next with your...?

I was doing these all simultaneously of course.

Mm.

The most, the major... Well there are two main lines that followed from that. One is the development of RothC, the carbon turnover model, and the other is the nitrogen, study of fertiliser nitrogen fate. So I'll talk about the fertiliser nitrogen next.

Yes.

We've plenty of time yet. [pause] When I came back from Australia after a year there, a very enjoyable year incidentally, at Adelaide, David Powlson, Johnny Johnson and

myself were very interested in using the new opportunities that there were for following labelled nitrogen in soil; in other words, mass spectrometers had improved enormously and were commercially available, and reliable. And, we put forward a programme to our head of department, Bernard Tinker at the time, and, there was a lot of... Bernard wasn't keen on it. Basically he wanted the mass spectrometry to be at, to be done at Letcombe Laboratories. He was one of the, on the board of Letcombe Laboratories, and, they had a, a man there doing mass spectrometry of ^{15}N, measuring ^{15}N by mass spectrometer. And, he wanted us to send the samples there. We didn't want that; we wanted it on, on site so that we had complete control of the thing and... A lot of debate and argument. And then finally, I mean to be honest with you, I went behind his back and went to the, the ARC as it was at the time, and managed to persuade them to, at last, to have a mass spectrometer. And, then, the... [pause] We got the machine, and we started these, some experiments in nitrogen-15. Another thing of course that made them possible was, the cost of nitrogen-15 had gone down enormously, and we were able to buy it relatively cheaply.

[39:23]

So we started a series of experiments. The aim was to see how efficiently nitrogen fertiliser was taken up by plants, when it was taken up, how much is left in the soil, what form it's in soil, and what happens to the stuff that's left. And, we did a huge series of experiments on that, starting on the Classical experiments, the wheat experiments in Broadbalk, continuous wheat since 1843. We laid down plots on that. Receiving different amounts of nitrogen. And, the main finding, and probably the most important, was, that when we harvested in August or so, this is winter wheat, we found about, oh, quarter of our nitrogen, maybe, maybe a little less, was still in the soil that we had applied as fertiliser. Most of it was in the pant. But, some was left behind in the soil. But on that, practically none was in inorganic form. It was almost all organic.

[40:30]

Now, before that, people had said, 'Oh yes, if you use inorganic fertiliser, some of it will be leached out.' But if you do it properly and you put it on at the right time, and not too early, then, very little is left in the soil. Virtually all of it was left in organic form. And this, this was a really important finding. And contrary, if you put it on in the autumn, when the plants were growing very slowly, you got most of it leached out. It did go into the watercourses. So, what it meant was that, as you moved up the scale

of nitrogen use, in an application of nitrogen to a crop, the leaching losses didn't really get very much bigger, until you put more than the crop could take up.

Mm.

In other words, you used excessive nitrogen. So, this put, made it most important to not use more nitrogen than was necessary. But up to that, you weren't going to be losing vast amounts by leaching as earlier ideas suggested. So, this was a very important finding, and this was, this was then, we checked this on a lot of crops, so we did maize, we did potatoes, we did beans, we did barley, spring barley, and, oilseed rape. And with all those, with the exception of potatoes, the same holds, if you use nitrogen fertiliser at the right time and not use too much, you don't get a large residue of unused fertiliser sitting in the soil at harvest ready to be leached out into the watercourses.

[42:19]
And so, in the case of winter wheat, let's take one crop.

Yup.

Could you explain how precisely you used the 602 Micromass isotope ratio mass spectrometer...

Yes.

...which you got in 1979...

Yes.

How you used that piece of equipment to find what you've just told me about, what happens to nitrogen.

Yes. Well, we took the soil sample or the plant sample whatever we had, and we digested it by the Kjeldahl procedure, this converts all of the nitrogen to ammonium, a standard analytical technique, and then we would release the ammonia, and, we would

react the ammonia with reagent to convert the ammonia to nitrogen gas, and this nitrogen gas would then enter the mass spectrometer. We built a special apparatus to do this, and we published a paper about it, on how to convert the ammonia... the nitrogen in plant material to a gaseous nitrogen sample. And we developed a new method for the particular mass spectrometer. Which isn't used nowadays for very good reasons because they use a different way of doing it. This... The method we had was very good, but very longwinded.

And so when you... How do you put the gas into the mass spectrometer?

We had a, a little vial and we would inject the reagent which converts the ammonia to hydrogen gas, inject that in, and then the nitrogen gas would enter into the mass spectrometer, the inlet tube.

And then, once it was in the inlet tube, what did the machine do?

The machine would then ionise it, and then it would go through the ordinary procedure of being attracted by a high voltage, and swung round a magnet.

And what was the output of that machine?

The output would have been, the ^{15}N, the ratio of ^{15}N to ^{14}N.

And, you said that you wanted to have this instrument in your, at Rothamsted rather than sending it off, so that you had control over it.

Yes.

[44:48]
Did you use it yourself, or, was a technician using it?

No, we... I did use it in the early stages myself to get the thing, get the techniques running, and particularly developed this inlet system for gasifying the nitrogen. But it was run then by a man called Gordon Pruden, who was an analytical chemist, very

good; he died shortly afterwards unfortunately very young of one of these awful leukaemias. But, he did most of the analytical work. And he was a, I mean, one of these very, [laughs] I, I shouldn't say this, very English type, very, you know, very solid, you know, absolutely dependable, you know. And he, he did absolutely as, as you wanted.

Mm. Thank you. And then, to do the same with soil, the same process of turning whatever...

Yeah, oh yes, the Kjeldahl, used the Kjeldahl to convert whatever you had, whether it was plant material or grain or straw or soil to ammonium. And then the ammonium was converted to nitrogen gas.

And then the ratio... you get a ratio of, of labelled nitrogen to unlabelled, do you?

Yes, that's what you... that's what the machine gave you in the end, yah.

And then you would use that to decide...

To calculate how much of your... You knew how much, what the $^{15}N/^{14}N$ ratio was in your fertiliser.

Yes.

And then you knew what the ^{15}N ratio, $^{15}N/^{14}N$ ratio was in, let's say, the grain, and from that you could work out how much had gone into the grain. You also knew the total nitrogen.

[46:36]
Thank you. Now, your finding about what had happened to the nitrogen was clearly important as a contribution to the debates about nitrate leaching and eutrophication, that sort of thing.

Mm. Mm, mm.

Which raises a question, which I hadn't really tackled with you, of funding, and that is, how did you go about attracting funding for your research, how was research at the station funded, how did you have to present research proposals in order to make it likely that you would get funding, from when you started there to this, we're now getting I suppose into the...

Eighties.

Yeah, into the Eighties. So, could you talk about the funding regime of your scientific research from when you started to now?

Yes. Yes, the early days at Rothamsted, all you did was, you persuaded your head of department, and he if needs be went to the director, and, that this was something worth doing, and that was all there was to it.

Mm.

And, if you wanted additional funds, let's say for radiocarbon dating of something, you went to the head of department and he went to the director and it would be argued out. And, that was, again, it wouldn't go outside Rothamsted normally.

And what were the directors most likely to say yes to, what sort of thing at that time?

Ah, depends which director it was. They, they were generally, you know, they were very much in favour of, of allowing researchers their head, and, if somebody with initiative, you know, they would encourage them. In those days of course, I mean there were people at Rothamsted, I mean, there was one chap, I won't mention his name, but, in twenty years he produced three papers. You know, there was this, that was the other side of it. But, if you were, you know, enthusiastic and so on, you, you could get support. In the Eighties this began to change, and then you had to get much more formal permission, and you had to apply for grants. And, the later stage of the ^{15}N work that I've been talking about was funded by EC grants, we got a big EC grant, and, that, that funded us.

And the EC grant, why do you think you got that money at that time for that work?

Ah well, we were able to persuade them that nitrate leaching was an important issue, and we'd got angle on it.

Mm.

So, we got that, and it was a very nice grant too. And, unlike modern grants, you know, you didn't have to sort of, have milestones and quarterly reports and all the rest of it; provided, you know, the work was done at the end, published, and the proper report written, that was all they wanted.

Historical sort of accounts of funding of science tend to suggest that the Eighties was a period when especially government-funded research suffered cuts and difficulties.

Yes it did. It was...

So what was your experience?

[49:37]
In the Thatcher period, the Government was determined to get rid of as much applied research as possible, and would refer it to private industry or to get rid of it. And, the funding for Rothamsted was cut enormously, and, and the staff numbers dropped by half in, in the Eighties. Whole departments... The head of department, the head, the director at the time was Leslie Fowden, and he took the attitude that he wasn't going to cut away at everything. He would take whole departments out, but he didn't want to cut away at everything, because that would, would incapacitate the whole system. And, so he took out microbiology, he took out soil physics, he took out, several departments, from top to bottom.

Mm.

And these people were made redundant. And, in fact they even tried to sell Rothamsted, but... as they did the Plant Breeding Institute in Cambridge, but... with disastrous results incidentally. But, Rothamsted was owned by a trust and not by the Government, so although it was largely government-funded, in the end they didn't own it.

Mm.

So that came to nothing fortunately.

You said with disastrous results?

For the Plant Breeding Institute.

Ah.

Yup.

[51:06]
I see. And, what was the effect of popular and press interest in...

Sorry, again?

What was the effect of popular and press interest in nitrate pollution...

Oh yeah.

...on your funding experience?

Yeah. Well of course, at the time there was, there was a great deal of worry about nitrate, the nitrate time bomb and so on. The idea was that nitrate was percolating down the profile into the aquifers underneath, and then nitrate levels would build up in drinking water, which of course they have done to some extent. Nitrate at that stage was very strongly associated with blue baby syndrome, and, that's a very weak link, in

fact you get it but, you normally get it when there's bacterial contamination in the water as well as nitrate, as you'd get from water seeping from sewage and this sort of thing, or from farmyard manure heaps. The... At that stage again they didn't realise that the body produces nitrate itself, and the production of nitrate internally is of the same order as the people were getting in their drinking water.

Mm.

So, although nitrate, nobody wants nitrate floating around drinking water, it's not the harmful thing that they were talking about in the, in the late Seventies and early Eighties.

Why do you think your particular department was not cut out by the attempt to cope with the funding cuts?

Well, the, the department was very... Well, the Department of Soils and Plant Nutrition, it had a lot of good contracts with Home-Grown Cereals Authority and so on, which helped, which saved it, and so far as the group that I headed, the nitrate issue saved our skins.

How do you know that...

I mean they were very, very important at the time. I mean... And, we, we were unscathed.

How do you know that it was that that saved you?

[laughs] The fact that the other fellows were axed. I mean, the Pathology Department was axed completely and amalgamated with Soils and Plant Nutrition, and a lot of quite good scientists were made redundant, or given early retirement.

You mentioned nitrate time bomb, which sounds like a newspaper headline.

Exactly what it is, yes.

Do you remember which newspaper or, or...?

Oh, they all, were all talking about it.

Mm.

[end of session]

[End of Track 5]

[Track 6]

One of my earliest memories in Ireland after we came back from America was, going with my grandfather to have oats ground, crushed, you know, at the mill.

Mm.

And, this would be, it was actually driven by electricity at that stage, but it had been a watermill before that.

Mm.

I remember being very impressed by the watermill wheels and all the rest of it.

Mm. Yeah.

These sort of gulleys going past carrying fast-moving water you know.

Mm.

I would have been about four at the time.

Yes.

Anyway, that's beside the point.

An impressive piece of machinery.

Oh, oh my God! they could have been very big for a four-year-old to see, very, very...

Yes.

...big and impressive.

[00:48]

Could I ask you to tell me how it is that you began working in the computer modelling of carbon in soil?

I did some calculations, quite simple calculations, by hand, of turnover times using elementary calculus and this sort of thing for soil carbon. And it became obvious at that time that this was a very laborious and slow business. And at the same time computers were becoming much more manageable; before that they'd been mainframe computers, big machines, and, you had to have special access to them, but about that time, in the late Seventies, or the mid Seventies, computers were getting smaller, and, again, one of my colleagues and friends, James Rayner, was establishing himself as a very effective modeller using these smaller computers. He had used the big ones before of course, but... And so, we decided to come together on this, he would do the computing end of it and I would do the, producing the data and, and building the model. Which we did. And, this model was based on a number of experimental measurements, first of all the decay of radiocarbon labelled plant material in soils which I'd done in Nigeria and I'd done it in England. It was then based on the Rothamsted long-term experiments, these had been running at the time for over 100, well over 100 years, and they'd given us a lot of data on rates of accumulation of organic matter and rates of decay and so on. Then, we also had radiocarbon measurements of soil organic matter that I'd been doing over the previous decade. And finally we had these new biomass methods that had been worked out earlier. So we put all these four things together, and, into a, a very simple model, and James wrote the, wrote the model, and, got the bugs out and so on. And, we deliberately made it simple, we wanted to have something that you, you could run anywhere without having to get a lot of esoteric data. In other words, we, we used mean monthly temperatures which you can get for most parts of the world; we used evapotranspiration on a monthly basis, rainfall on a monthly basis. Early versions of the model used a cation exchange capacity for our indication of how clear your soil was, but that proved too difficult to find, so we just went over to clay content, that's a simple measurement which you can get on, on most soils, or even if you can't get it, you can make a rough guess at it. So, we were trying to model in a way that didn't bring in things that wouldn't be at hand for most sites. I mean Rothamsted of course, you had all the information on the soils that you needed and so on, but this wasn't applicable widely. So this was the, the thought behind it, the

simplest model we could build using data that we could lay our hands on from virtually anywhere in the world. And this model was published in 1977 I think it was. It was reprinted a couple of years ago, the paper, as a classic in *Soil Science*, which was nice. [04:56]

And, it was, it's been used very widely, improved and varied and so on over the years, and, I think, we have it on the Internet and people can apply to use it, and I think we got the thousandth application to use it a few months ago. So it's been used widely over the years. We updated it in the late Eighties, that was with Lynn Parry and Kevin Coleman and Phil Hart, who was a New Zealand PhD student at the time, an outstanding PhD student. Anyway, we got together and updated it quite a bit. We simplified it even further, and, I think with advantage. That was published, in a rather obscure way, which was unfortunate, in the late Eighties, at a conference proceedings, which was a mistake. And, then again, Kevin Coleman and I updated it, and at the end of the last century, just in 1999, made further changes, and at the moment we're still working on a new version. So, it is showing its age, there's no doubt about it now. It's thirty-five years old. And, there are plenty of good models in literature now, and some not so good ones. About ten years ago a colleague of mine, Pete Smith, compared a whole batch of these models, and, RothC, which is our model, came out reasonably well out of the, the comparison, although by no means head and shoulder above the others. So... This is... It's been, been a useful model, although, because we simplified so much, inevitably as people can get hold of better information to run them, it will become outdated, and this is happening. So, it was useful in its day. It's still useful, it's still used, but it is, is in urgent need of, of revamping, and, we're trying to do that. Whether it'll be successful or not, remains to be seen. There are a lot of cuts in, at Rothamsted at the moment. I heard, I had a phone call on Friday saying one of my colleagues who I've worked with for many years has just been made redundant at fifty-eight, I think he'd about fifty-eight. Not even sure if it's true, I just got this phone call, it's probably true. So, whether or not we have the manpower, or womanpower, to update it, remains to be seen. This particular colleague wasn't involved in the modelling I should say, he was more on the biomass side of things, microbial biomass. So, that's RothC. James Rayner unfortunately died, 19... He retired in, in 1987 I think it was, and died a year later. I was in Australia at the time he died. But he had a massive heart attack and, he was very overweight and... But a marvellous, marvellous colleague, very witty, Oxford graduate, he'd worked with Dorothy Hodgkin in

crystallography in his youth. And, a first rate scientist, mathematician, computer modeller and all the rest of it. And we had, we had planned to set up a consultancy after I came back from Australia. This was not the first time I went to Australia, I think it was the third time. But, he died, and, Harpenden Models, which is what we were going to call it, was never set up. [laughs]

Mhm.

Anyway. I don't know what sort of phone calls we'd have got as Harpenden Models, one can imagine they would have been a little mixed, but anyway, that was our little joke. So, that's RothC.

Thank you. I wonder whether.....

[pause in recording]

[09:53]
I wonder whether you could tell me what was involved in the very early hand calculations, what you were actually doing in order to begin to produce this pre-computer model.

Yes. I was using the bomb carbon data to calculate the input of carbon to a soil under steady state, actually in fact the un-manured plot on, on the Broadbalk wheat experiment. And I used the change in radiocarbon after the bombs went off as a way of calculating how much carbon was going in each year. But it was a very laborious business, and, something that you, you did once.

Could you explain that, that laborious process, the steps. So what was the... You've got your, is it hand calculator?

Yeah, just a hand calculator, yes.

OK. And so, what's the sort of first thing you did?

Well you, you just updated it annually on the basis of the previous years' measurements and the radiocarbon coming in from the bomb tests that year, and then you updated it for the year after, and so on.

So it's sort of keeping a running total of the...

Yeah, yeah, yeah exactly.

...labelled carbon.

Yes. And seeing how that tied up with what was actually happening in the field.

OK.

And adjusting the various parameters to make them come together.

What other variables were there in the field that you had to relate to this increase in carbon in the soil?

Basically the measurements, the two measurements, total carbon and radiocarbon.

OK.

[pause] It was a tedious business, but, it took a few days you know, not impossible, but, the sort of thing you'd do in two seconds with these things nowadays.

[12:00]
Mm. Do you remember the kind of calculation involved, in the sense you've got total carbon, and you've got radiolabeled carbon...

Yes. Yeah. Well, a situation under steady state, which simplifies it no end, so total carbon wasn't changing. So if you had an input that increased this, obviously it was wrong, or if you had an input that decreased it over a lot of years it was wrong, so you'd got to get the input that kept it right. At the same time you'd got to get the

radiocarbon age of the soil, contaminated as it was by thermonuclear radiocarbon, correct.

[12:42]
I see. OK. Thank you. Could you tell me more about Rayner's work on modelling before you linked up with him?

Oh he was very much involved in clay mineralogy and crystallography of clays.

Where was he based?

Based at Rothamsted.

Right.

He was in the Pedology Department. He was originally appointed to work on X-ray crystallography of clays, but he was an appalling experimenter. I mean if you wanted to have a piece of apparatus broke, [laughs] broken, you asked James to, to work on it. He was all, all thumbs. But, this was well known, so nobody let him near an apparatus, any piece of apparatus of any value. [laughs]

But, he was let near computers.

Oh...

Do you remember the type of computers that...?

Oh I don't. He would have been on the mainframes of course in the old, the early days. They had an Orion, and... They were into computers very early at Rothamsted, in the early Fifties, before I came. But, I don't remember the ins and outs of it, no. But they, they had, they continually updated these mainframes, and, until the mainframes were supplanted by these, these things, these PCs.

Mm. Do you have any sense of why Rothamsted was sort of, so up to date with computers?

Oh the Statistics Department, they had a very good statistics department, and, James worked very closely with them. They were all mathematicians of one sort or another. And really James was a mathematician, although his training was in physical chemistry and crystallography, but he was basically a mathematician. And, they had a very good statistics department at the time, and, still have a good statistics department, although it isn't just as world famous as it was.

[14:40]
Mm. Thank you. And, you moved from the hand calculations to working with computers, for the reason that it would be quicker and it would cut out the laborious work.

Mm. Yes.

More widely, why did you think that producing a computer model of carbon turnover was a useful thing to do, or an interesting thing to do at the time?

Well, I didn't move to computers. I, I relied on people like James Rayner and a young woman called Lynn Parry to do my computing for me. And it's only when I retired and, [laughs] and hadn't access to very skilled and very able people, that I, I started to do it myself. But, it's, the whole thing is that, RothC was a perfect example, I mean you could do these calculations by hand, it could take you days and days to do one soil, and with RothC you could, you know, rattle through them like nobody's business. It was just not feasible to do all the things I wanted to do on the calculator.

[15:54]
Could you tell me about Lynn Parry, who was also on this post?

Yes. She was James Rayner's assistant, and, she was a very good mathematician. Not trained. She went to university, went, I think it was Reading she went to, and, she left after about twelve weeks, which sometimes happens. People decide they, they don't fit

in and leave at that stage, you know, after a term or so. And, which was a great pity, because she was very able. She, she was very bright indeed. And I remember... And James of course was a devil for, he'd do things very fast, and, a devil for covering his tracks. You know, in a proper program you say what you've done and you, you set out an explanation of each step. James never bothered with that. And she used to puzzle over James's programs, and after about half an our she said, 'Oh now I see what he's done.' [laughs] And this was... And she was much more methodical than he was.

So what was her role in the second version?

Oh, she was one of the authors.

Mm.

And she played a big part in developing it. And she was quite rightly one of the authors. The second version of course was after James... [pause] Yes, after James died, yes. Yes.

And Phil Hart's?

Phil Hart was a New Zealand student as I said. Came in the early Eighties to work with me, and, did a very good PhD, and... He wasn't... he, he was an all-rounder. In fact he hasn't stayed in research, he's now in scientific management in New Zealand, quite a high position there. But, again, he and Lynn Parry got on very well as colleagues, and, he, you know, he could see, he had a very realistic view of things, and, he could see what he wanted to do, and she had the computing skills needed to do it. So, it was a good team.

[18:20]
Could I ask you about the, in practical terms, the, the link between your data and their modelling, whether it's James... Now, four kinds of data you said went in to the model.

Yes.

The experiments on decomposition of labelled carbon, classical experiments, radiocarbon dating of pre-1955 archive soils...

And biomass.

...and the soil biomass.

Mm.

Now, we, I can... People listening to the recording can perhaps imagine that you've got data for those four types of research on paper. Would that...?

Oh yes.

Yup.

Oh yes.

So, I wonder whether you could explain the actual practical process of interrelating with these modellers and getting them to put that data into a model, which may seem a rather mysterious process from the outside, but it would be nice if we could see how it worked in practice.

Mm. Yes, you see, you, you construct the model according to a preconceived plan for decomposition of plant material in the soil, and, using, as I said before, the simplest possible assumptions that are necessary. And, with that data, or at least with the model, the model will then predict certain things, and the model will have a lot of parameters in it which you will adjust so that the model fits your data in a situation where you've got good measurements. So that this, it's basically, you construct the model, and then, with various compartments and feeding each other, and, you see what output you get for a given input, and you say, that's far too high, or that isn't right, and you keep adjusting it, each parameter. All these complex models are full of parameters that you vary. And you try to keep it as simple as possible. And... [pause] But at the same time, you do have to allow the experimental measurements to govern the size of the, of

the various compartments and the rates at which, the decomposition of the compartments. The rate constants in fact. You see, in any, any model of this sort, you've got two things, you've got the feed into a particular compartment, and you've got the length of time the stuff spends in it. So you've got two parameters there straight away, the turnover time and the actual input each year. And those govern of course the rate at which it builds up or declines. So these are the sort of things. It's empirically adjusted in the end. And one hopes that having got it right for one particular climatic condition and one particular soil type, that then you can try it on other soil types and see how wrong you go. And if it gets a reasonable result, then that's great. If it doesn't, then you're going to have to do some more adjustment.

So is it, am I right in saying that you used the model, and you checked to see if it could account for things that you already knew had happened?

Yes. Yes.

Because you had, you had measured them in the field, so...

Yes.

...you knew for example at a particular time a certain amount of barley decomposed into the soil...

Yes.

...and that had been studied actually in reality.

Yes, yes. Yes.

And then you put that into the model to see if it would come out with the same...

Yes. Yeah well, you don't put it into the model; the model comes out with a figure, and you say, that's nonsense.

Mm.

And you then have to adjust the parameters of the model to give a reasonable output.

How did you manage to adjust the parameters so that it could account for various different soils at various times, so, how did you adjust the model so that it sort of matched all four of those kinds of research?

Well we got, we got data for different long-term experiments, different parts and different places, principally the one at Woburn, which is an out-farm of Rothamsted, which is a light sandy soil, so we used it on that. But the truth of the matter is that, the sort of data you want isn't very common, long-term field experiments are, there are a few of them but not many in the world.

Mm.

They run... I mean, long-term in this context is 100 years, not a decade you know. A lot of people talk about long-term experiments lasting ten years; well, that's not good enough for slow-moving things like soil carbon.

Mm. So there weren't many sets of results in existence which you could test the model against?

No. No, that's right.

[23:30]
Thank you. OK. And, you mentioned that you, you improved, and made a second version, and then a third version in 1999.

Yes.

And you are now working on what I suppose would be a fourth version.

Yup. Yup.

Could you explain what kinds of improvements were made over those versions?

Well, the version issued in 1999 was very much a more user-friendly one. It was basically made so that somebody could take this model off the peg and apply it to their own situation, and that was the real improvement there. It was, it is a user-friendly version. The '88 or '89 revision was a, a much more fundamental one, we changed some of the, the concepts of the different compartments, behind the different compartments. Essentially we, we, we threw out one compartment because we couldn't get the data to justify it.

Which was that?

Well we had two compartments for humified organic matter, one was called chemically stabilised organic matter, and the other was physically stabilised, and, you couldn't really get the data to partition organic matter into these two compartments. And... At that time; you can now. But... So we cut it out. And, then we had one humic compartment and a very ancient compartment called inert organic matter, when, that's where we threw all the age, the really, the very inert carbon that was giving these huge radiocarbon ages, and we put it into this inert fraction. And, in this way we lost the parameter you see, we saved the parameter, and, were able to match the data pretty well. It's a controversial thing, and a lot of people haven't accepted it. The American Century model hasn't accepted that. This was built basically on the earlier issue of RothC, but, they didn't accept these modifications, and they kept the old form.
[25:54]
The present changes are concerned with the weather. In some situations the calculations of the water content of the soil are not right, and you do this by measuring rainfall and also evapotranspiration. So you, you're adding in the rainfall at the beginning of the month to what was there, what's on the soil already, and you're taking away evaporation during the month, and some of these evapotransporation calculations aren't as good as they should be. So, we're going wrong there. That's one thing we're working on. The other thing is that, some people say that a monthly time step is too coarse. I don't think so. Once you start to go into weekly time, or daily, I mean, the

amount of data you've got to process is astronomical, so, I am against this. But we'll see how it goes.

[26:51]
You said just then that some people say that. Could you talk about more generally feedback on the model from users?

[pause] Not really. Kevin Coleman is much more in touch with that than I am. He is in charge of day-to-day running of the model, running it for people, and also issuing permits to use it. And I said a minute ago, there've been something like 1,000 of these issued. So he would be more in contact with feedback than I am.

Fine. Would you be able to tell me about the... You may not be able to, but would you be able to tell me about the operating system that each of them ran on? You mentioned for example that the, I think it was the, the third version, really the improvement was in the sort of interface, how it looked and its, its user-friendliness.

Yes. Well, it, it's on this computer, but, it's, it calls for, first of all the weather data, in terms of monthly mean temperature, in terms of monthly rainfall, and it calculates evapotranspiration. Oh yes, and once-monthly open pan evaporation from a, an open pan. And from that it calculates water content. It wants to know what the soil, what clay content it has. It wants to know about what sort of plant material is going in, whether it's woody material or grass or wheat or, wheat residues or what have you. And, that's about it.

So it does actually rely on the user doing some field, some simple field experiments, or measurements of their...

Well... Well, I mean, these measurements are made in any, these are all standard meteorological measurements you see, so they're available to anybody that knows where he is. [laughs]

Yes, yes.

And, so far as the quality of the organic matter coming in is concerned, it's just a number of categories, is it woodland, grassland, arable land and so on. And again, another thing you need, you have, what time you plant the crop if it's for arable work, and what time it's harvested, and when the next crop is planted. Things like this.

Mm.

Now obviously that doesn't apply with grassland or forest.

Mm.

So, if you're working on an arable system you say, I mean, once the thing is under the crop, and what these months are. But again, anybody would know that.

[29:29]
Can you remember any difficulties that you had in terms of communicating your scientific results to someone who was attempting to convert that into a sort of computer language? So in, in the sort of conversation between something which is agricultural science and something which is computer science, that sort of...

Mm. Well, I think this is really what we tried to do in the 1999 version of the model, to make this easier.

Mm.

So that people who weren't au fait with computer models, the internal workings of them, could use the thing quite easily. The earlier versions of RothC, you needed to know quite a bit about computing to use them.

Mm, I see. What I was really thinking is, in your conversations for example with James Rayner...

Yes.

He is a mathematician with a background in crystallography.

Mm.

And, you're a soil scientist. And you've got to communicate an understanding of, a very detailed understanding of soils to James, and he's got to talk to you about the limits of a computer and a computer program and that sort of thing.

Mm.

So I wonder whether you could give a sense of the flavour of that kind of conversation that took place?

Oh we, we argued all the time about it you know. I couldn't, I couldn't really answer that because, the thing took place over months.

Yes.

And, [laughs] we argued in the best sense, you know, we...

Yes, I'm not...

There was no...

I'm not sort of digging for disagreements...

...no quarrels or anything.

...yeah, for quarrels.

No quarrels.

But really, I was wondering how, your strategy for presenting it to him and then his way of presenting computers to you in order to get it all to work.

No, we'd just come back and forth. I would say, you know, 'Can you put that particular box in, or does that throw the whole thing out?' And, he would maybe try it and, we'd see how the results came out. It's a continuous process of debate and argument and discussion.

Mm. And...

And he was, he was very good at spotting errors, James, mathematical errors you know, and I would possibly be putting my own thought forward and he'd say, 'Oh yes, that's OK, that's OK,' 'I don't like that one.' Then you knew there was something really wrong with it.

Mm. And, did you see... When the computer model didn't work, in other words when a parameter wasn't set right, or... how did the model, the computer, tell you that that wasn't working? Or did...

You'd see the output. It used to come out in those days in great big long rolls you know, computer paper. It wasn't like today. And, you'd go through those, and you'd see the output, and you'd say, 'Now that, that's not what reality wants.'

So you, you almost had to be the one to look at that to...

Yes. Yes.

Because, you'd need to have this understanding of the soil to say, 'Well, no that, that's ridiculous.'

Yes. But James, James was no fool on soils either. I mean he, he was, he knew what was what. I mean... It, it's difficult to, difficult to disentangle the, the contribution that he made and I made, very difficult.

Mm.

Because it was a close collaboration, and it was, all the time we were looking at things as we gradually homed in on a reasonable version.

Mm. So it was a constant sort of, gradual negotiation, not you putting a, a pile of paper on his desk, him doing the modelling and...

No no no, not at all. No no. No no.

[33:12]
Thank you. Could you talk about the comparison of RothC with the other carbon models, organised by Dr Smith?

Pete Smith.

Yup.

Yah.

Starting with, what were the other carbon models, contemporary carbon models?

Oh gosh. [laughs] Oh don't ask me that. It's a big...

In general terms.

It's a, it's a huge big paper, written in Geo... two papers in fact, in *Geochim Cosmochim Acta*, and, he reviewed all these models. And he also developed original statistical techniques for seeing how successful they were, which was a very big advance. And, he applied these techniques to assessing the quality of each model. [pause] It's all... [laughs] I'm not going to go into detail.

Yes.

It's, it's in this, these papers. Not a paper I wrote.

No.

Although my name is on it. In fact, those papers with Smith are the only papers I've ever had my name on and which I haven't been deeply involved in the work.

Mm. Mm.

I mean, so far as Smith was concerned, he's a friend of mine of course, but, we gave him the model, told him how to run it, and then he wrote those papers.

Yes.

And, showed us the results. But, I wasn't deeply involved in, in that.

No. But, but you said that, it's come out reasonably well, so in general terms what did that mean?

In terms of statistical tests, some of the models would come out better than RothC, some worse.

In terms of being able to predict...

Yeah, yeah, yeah, yeah.

...accumulation.

In, in... It was... He got a lot of long-term experiments, some much better than others, some were very poor quality ones, some good quality ones. And he ran all of the models on these experimental measurements. There were some from Czechoslovakia, there was a long-term experiment from Germany, near Halle, there were some Danish experiments, some American ones, you know, and, as well as the Rothamsted ones. So, it was a, Herculean bit of work. But then, that was Smith, he, he wasn't afraid of hard work. Still isn't. He was one of the major authors of the, these climate change books you know, IPCC.

Ah.

He was one of the authors of the agriculture section, I think it's part three. But...

Did he work in your section at...?

No, not with me. We worked... I, we worked together but he was on his own.

I see.

No, he never, he never worked for me.

Before I ask...

He wasn't the sort of guy who worked for anybody. [laughter]

Oh. OK. A loose cannon.

Yeah. Yeah.

[36:01]
Before I ask you about the, the sort of, climate change interest in these models, could I just, as I haven't asked you yet, ask you to tell me about the influence of links with Australia, well, and New Zealand as well.

Mm.

You've mentioned a couple of times visits which, a sort of, visiting scientist type posts in various cases.

Mm. Yes.

Now it may be that these were incidental or additional to your scientific career; it may be that things that you saw or did in, abroad, in Australia or New Zealand, profoundly affected what, what science you, you came back to do and that sort of thing. So I wonder whether you could talk about the extent to which links with Australia and New Zealand were influential in the content and form of your scientific work.

Yes. The year I spent in Australia, I did, I worked with Malcolm Oades, who was a sort of chemist, and subsequently head of the Waite Institute where I was working. I was working on an ATP, adenosine triphosphate, measuring and soils and so on, and, we went out, we, we saw a lot of Australia, as a family we travelled an awful lot. I remember one occasion I was going to the, Canberra, to the soils group there in CSIRO, and Moira dropped me, and she had the two, the smaller kids in the back of the car. I went to the lab and gave a talk or something of that sort, met various people. And she was, ended up by abandoning the car, she was... Canberra, have you ever been there?

No.

No. A huge roundabout, it's a very modern type of city. And she found herself going round a roundabout the wrong way, [laughs] so she abandoned the car at that stage, and walked. And walking in Canberra is impossible anyway. It was... This sort of thing was happening all the time. I would be giving talks and things and meeting people, and, she would be doing other things with the two kids in the back of the car.
[38:20]
But, sorry I've avoided your question. No. I saw an awful lot of agriculture, of Australian agriculture, and I was very interested in that. I met an awful lot of Australian soil scientists, some of whom I knew before, some I didn't. I established a working relationship with one man in particular, Jeff Ladd who just died last summer. And, we wrote a review together. Trips to New Zealand, again, meeting people I knew, their names, some of whom I actually knew personally, seeing something of New Zealand agriculture. And, giving talks and things of that sort. It was basically establishing the contacts in, in Australia and New Zealand, apart from the work in the Waite, where I was actually doing some real research.

Mm. Were there any techniques or traditions or methods that were peculiarly Australian or, or based in New Zealand, that you were, you picked up there?

Not so much scientifically, although the, the use, the proper techniques for using ATP were already in work in, were already in use in the Waite, in the department I was in, the department headed by Nicholas at the time, John Nicholas, a very able scientist. And, I got a lot of advice from him on developing ATP techniques which were very useful. When we came back, when I came back to Rothamsted, I introduced these to people here and they were very good techniques, far better than anybody else had in the world at that time. And, the... Nicholas knew what he was doing.

Were these chemical techniques, or instrumental?

Oh yes, yeah, they were scintillation counting methods, yes. Yes. And they have been used widely since. So, this was one technique had become... But I picked up an awful lot of things on agriculture and, interesting, and, dryland agriculture and so on, which were subsequently of importance, you know, in model development. [pause]

[40:50]
Could you expand on that, the, the things that you saw in terms of dryland agriculture a little bit?

Yeah, I saw these long-term experiments at the Waite, and again, Jeff Ladd took me out to various experiments. And he'd been doing experiments rather like the ones we had done, with labelled plant material and, well he'd used labelled carbon and nitrogen-15, nice techniques. So... And he'd used them under dryland farming conditions, and, a whole lot of conditions, he'd laid out experiments all over the place. So, this was, this was useful.

How was that useful in terms of model development?

Oh, will your models fit these, these conditions, when you, when you put the weather conditions in?

So it almost gave the model a, an international habitat arranged....

Yeah. Yeah, yeah, yeah. Yeah. Yeah, and one of the, one of the sites that Pete Smith used in his comparison of the different models was the Waite long-term field experiments which were modelled on the Rothamsted ones but, because Australia's so different they've moved in, in a slightly different direction. But this was one of the datasets he used in comparing the, the models.

And previously you'd used that in creating the model, so...

Not really.

Mm.

No. We... I, I, I'd seen Jeff Ladd's data and we'd, we'd fitted his model, or his data to our model, but the tests of the, the actual field experiments at the Waite, was done by Smith.

[42:36]
I was, I was glad in a way that you did dodge the question and talked about sort of, family life on these, on these trips. Not necessarily sticking to overseas trips, I wonder whether you could say something about the, perhaps peculiar difficulties of combining a scientific career with family life.

It's I think something virtually everybody has, scientific or not scientific. I mean, [laughs] my youngest son came back from India on Saturday, and he left for Sweden this morning, you know, part of his job as an engineer. So, it's, it's by no means unique to scientists, this business of combining work and, and family. If you have a nine to five job, it makes it easier of course. The... [pause] The opportu... I think... [pause] The trip to Australia, the year in Australia I think was very, very useful for some members of the family. Some people were, well, how shall I put this? Our twins were seventeen at the time, and very wild, and we were lucky to come back to England with them alive. I mean, they, they started to drive in Australia, and they were rally driving

up in the Adelaide Hills, and one of them was caught in the bumper of the car and dragged along on the ground.

Gosh.

You know, and these sort of things. We had no idea this was happening until, you know, afterwards. Again, they were in the Venture Scouts, and, they went off to a cave underground. And, [laughs] you know, and this sort of thing was happening, and, they, they were fine in the end, but, you know, it was, what I said is true.

How did Moira spend her time while you were... apart from abandoning cars?

Well she was, she was teaching piano to various children in Adelaide. She made quite a lot of friends. And we had a very good friend from our, from our Rothamsted days. The Wilkinsons, we knew them when they, when Graham Wilkinson was a statistician working at Rothamsted for a number of years, and, and Gwen, his wife, and Moira became very good friends. And then of course, when we went out to Australia, they, their friendship was taken up. Actually not immediately because Gwen was in America at the time, but when she came back to Adelaide. Moira's a very extrovert person and she, you know, she makes friends in a way that perhaps I wouldn't. So... Our youngest son was there, and he went to a very good school, and, benefited enormously. He's dyslexic, and, this was recognised for the first time there. In England you would just say, he'd be slow.

Mm.

And, this was, this was diagnosed correctly by the school in Australia and, he benefited greatly. I mean he's a very successful engineer now, a director and all the rest of it in his company. So... Or his section of the company. He still can't spell. But then these things help you.

[46:19]
Yes, quite. And what was your, what was your family's view of your work, in terms of their understanding of it or their opinion of it?

I think they tolerated it, [laughs] to some extent anyway.

Why, why...?

You know... I mean, I mean I remember one occasion I was in Armidale in New South Wales, and, up in the, the, quite far north, Sydney, and I went off to the lab and so on and gave a talk or what have you. And then, poor old Moira and the two youngest kids were again stuck in a caravan. We were, we, we, we had no home, we used to, we used to rent a caravan, a fixed caravan site, rather than... you know, it was cheap.

Mm.

And they were sitting in the caravan in the pouring rain, and, you know, [laughs] it wasn't easy for them. So... On the other hand, you know, the day afterwards we were out collecting amethysts you know. There's a river where these things were found you know.

Mm.

Ups and downs.

Mm.

But by and large, it was tough for Moira.

Why would you, why do you think that that's the case?

Oh, she was away from her natural environment, she was, she had... I mean I had immediate friends and work and all the rest of it; she had to make it, with the one exception of this Gwen Wilkinson, she had to establish a place for herself, which she did.

[48:00]

But, back in, back in Britain as a scientist, did that present any difficulties for family, or...?

Oh, I mean I was always, I was always preoccupied with things and so on, and, I'd be working in the evenings and so on. It didn't make for, for good domestic arrangements sometimes. I've no doubt you do the same thing, you know. It's, it's... If you have a nine to five job and switch off at five or 5.30 or what have you, OK, that's different. But if you're a scientist or doing something like you do, it's difficult to fit in to the ordinary run of domestic life, and, this produces tensions of course. And... But, Moira knows when I'm thinking over some problem or other. 'What is it now?' you know. And... [laughs] You know, when she doesn't have, she doesn't have... she knows without any words. And of course as a scientist, you're continually mulling over things, and your current problem, and this makes for problems. I think you probably know the same thing.

Mm, yes.

Yes. Most people know that problem. It's nothing, nothing like as intense as the problem, for example, my youngest brother who was a sailor would be away for three months or more from his wife and children. Or indeed my youngest son who's, who's an engineer as I told you, and, he's all over the place. He's lucky if he gets home at weekends.

Mm.

[End of Track 6]

[Track 7]

Could I ask you about the, the origins of your interest in global carbon cycling?

At the time, I realised, well this was in, by the time I retired, that, if the earth warmed, and, there was a lot of talk then about warming at that time, it was just beginning to be an important subject, the rate of decomposition of organic matter, soil organic matter, would increase. This would decrease the pool of soil organic carbon, and of course that pool is very large, it's about twice as big as the, the carbon held in the atmosphere. So, if you get even quite a modest warming of the soil, you could release quite a lot of carbon dioxide by accelerating decomposition. And, I wanted to look at this, and, when I retired, I had a chat with Alan Wild, who was Professor of Soil Science at Reading University, and, we decided to apply to the Leverhulme Trust for funding for this, for a programme on this, and in fact we were given the funding. And, we appointed a young scientist, Dawn Adams... sorry, Denise Adams. Dawn Adams is an actress. [laughs]. Denise Adams, to, to do the computing work involved, a massive amount of computing work, which she did. And... [pause] Gosh, gosh there's a hawk out there. Yeah. Sorry. Yeah, sorry. [laughs] Anyway. We got started on this programme, and, I used to travel over to Reading once a week, and, got involved in it, and Denise did all these calculations, and Alan and myself were feeding in the experimental data, you know, it was to be matched, and the weather data and all these sort of things, soils and... It came, it came out rather nicely, and we got paper in *Nature* as a result, a paper which has been pretty widely quoted since then.
[02:34]
Basically, we confirmed the idea, and it wasn't my idea, I wasn't the first person to have it, but we confirmed the idea, that indeed if you got global warming, you would increase the rate of decomposition of soil organic matter quite considerably, and this would give you a positive feedback, increasing warming still further. And we calculated how big this effect would be. And that was the basis of the *Nature* paper.
[03:06]
Now, subsequently, we did a collaborative study with the, with Peter Cox of the Hadley Centre, part of the Met Office, and we extended this to their studies, and this again showed that the, that warming would have, would give you a positive feedback. And, it didn't give as big a positive feedback as they had postulated, mainly because our

model, our RothC, was more accurate than the very simple model they used, they used a simple exponential model for the turnover of carbon, and that isn't good enough. So... But anyway, the long and the short of it is that, there is quite a quite appreciable contribution from soil organic matter if warming takes place. And it's, it's, it gives a positive feedback, enhances the effect. So it's something to be watched for. This was really all there was to it.
[04:17]
Denise Adams got married during the, the work, and, had twins, and gave up science, and so... I haven't heard from her since unfortunately. She was an able young woman, but, she had these twins, and then her husband left her, so, I don't know what happened in the end. It was rather tragic.

Mm.

Very premature twins, and I remember visiting her in hospital and seeing these two tiny little things. I've often wondered how she got on without a husband and, all the rest of it. So, there you are, that was, that's, that's really all there is to that paper. Although it was quite, quite widely quoted, it's been quite widely quoted. Yup.

[05:17]
Could I ask you about the, again taking you back to the sort of, procedural detail of how you did things. Could you talk in more detail about providing Denise Adams with experimental data and weather data, and your awareness of how she used those in the computing?

Well, we basically used a thing, a big book called Müller, a collection of weather data from sites all over the world, and, this gave you evapotranspiration and mean annual temperature and monthly temperature, and rainfall on a monthly basis, all the information that was needed came from that.

In terms of the weather...

In terms of the weather, yes.

And the soil?

The soil would be, we would have discussed it in detail in terms of the world soil maps and things of that sort.

And can you tell me what the model that she produced looked like as a, as a thing on screen, as a thing that you could use with keyboard?

Well, in the end it was just a graph, showing the, the release of carbon dioxide over the next, I don't know, number... I just... I've probably got it, got it behind you somewhere, the paper. If we can just.....

[pause in recording]

[06:49]
Would you be able to describe perhaps one visit to Reading where this work was done, in terms of, even details that may seem unimportant, in terms of where the work was done, where you discussed things with...?

It was done in the Department of Soil Science. I would arrive, talk over what, talk over with Denise what had been done during the previous week, and then we'd get Alan Wild in and we'd have another discussion. And, we'd sort of lay down things that we'd like her to do.

And...

And, she, she would be involved in the discussion, but... [pause] I find this difficult to say, but, she was good on computers, and was particularly good on graphics, but, she would wait till you suggested something. She wasn't, for example, like Lynn Parry, who I think I talked to you about before, who had, who would contribute to the thing actively. Denise was... Sorry. Denise was, more passive. She, she'd do what you asked her to do. Which was a pity, because, it's always better fun when there's sort of two-way flow and argument and debate in science.

Mm.

It's also, she was doing a PhD at the time, but she never finished it.

When you say good on graphics, what did that, what do you mean?

Good at producing computer graphs and things of that sort.

Mm.

You know, and producing the, the data in an understandable way.

Do you remember any discussions you had about the graph that appears in the Nature paper with the, the curved lines going up?

Yup, yup. Oh yes, we did. I don't remember in detail, but we would have discussed that and exactly how we wanted to present it. And then she would have gone away and, and modelled it and put the, put the lines in.

[09:10]
Could you talk... You mentioned that that paper has been heavily cited.

Mm.

Could you say something of the, of the response to it, in terms of the interest then in climate change?

Yes, it was the first time that anybody had really tried to do it on a global scale. So this gave people an interest in it. It's been superseded, there are much better, I won't say better models, I don't think there are better models for this sort of approach than RothC, but, it's, it's been subsumed into the larger climate circulation models.

Now you've mentioned then the, the subsuming of this particular model into the wider circulation models.

Yes.

Could you... And you mentioned also that you met at one point Peter Cox at the Hadley Centre.

Yes.

Could you in more detail say how that relationship with the Hadley Centre developed in the first place?

Yes. Cox was interested in, in using a better soil model than the one they had, and, there was a man called Pete Falloon who was in a sense a link between the Rothamsted and the Hadley Centre. He now works for the Hadley Centre. And, he I think introduced Cox to the idea that we had this RothC, and then of course we, we ran these computer simulations using their very simple model and our more sophisticated soil model, and published a paper on that. It's all very theoretical. I mean, if you can talk to people like Cox, they talk about doing an experiment; they don't, they're not doing one at all, they're just doing a computer run. And, [laughs] so... But, the long and the short of it was that, our more accurate model was less alarmist in terms of its effect on soil carbon than their very simple one, which is a useful finding I think.

How did Peter Cox himself feel about that effect on the model?

No idea. I mean he, he's involved in so many things. I mean, atmospheric circulation, oceanic circulation you know, ice, polar ice, all these things. It's only a small issue to him.

And did you actually go to the Hadley Centre physucally?

Never.

So, it was a matter of conversation?

He came up to Rothamsted...

OK. And...

...on a couple of occasions.

Can you remember what you did in terms of showing your model?

Oh we just talked about what it can do and what it can't do. And Pete Falloon was the one who actually incorporated it in the Hadley model.

[12:18]
Mm. Mm. And, what was your view then of the models that the Hadley Centre were themselves using to account for or predict climate change?

Well, these big atmosphere-oceanic circulation models are very specialised, there are a number of them extant in the world at present. I'm not in a position really to comment on those. They're used in all of the long-term predictions. My own feeling is that, people sometimes put a bit too much trust in them, but that's, that's, that's a gut feeling, it's not, it's not based on any real scientific knowledge of the intimate parts of these models.

Mm.

Particularly when people push things forward to 2100 and so on; I would, I would tend to keep it to 2050 you know.

Mm.

And... I think, I think they're being pushed too far myself. But, this again is gut feeling.

Mm.

Largely gained as a result of writing this, this particular article on climate change. But again, I mean, I am an amateur in this field. I'm not an expert. I know a little bit about one corner of it, but, these are huge models, very complex, based on complex physics, and, even then, complex physics and all, they're, they're very coarse, they're usually on most of them are on a fifty kilometre square size and some of them are not even as fine as that. [pause] The... [pause] I don't think I can say more than that.

Mm. And what was the... could you tell me about the soil model that the Hadley Centre were using before yours was...?

Oh a single compartment, instead of the multi-compartment model that we were using.

[pause in recording - interruption]

And the single cell in the soil, the model used by the Hadley Centre previously, contained... What as the, was that model running, what information was that?

Sorry, again?

Could you talk more about the limits of the model used by...?

It was just that, it was vast over-simplification, that, it ignored the more stable, really stable fractions of the soil organic matter, and, it also ignored the quick, the more dynamic fractions. It put them all into, knocked the whole thing into one compartment. And this gave you results which I think were erroneous.

[15:19]
Yes, I see. Thank you. Now you mentioned your interests since retirement in climate change and a document that you are writing at the moment, or are revising at the moment.

Mhm, yup.

Could you talk about why you first began to work on that?

Oh that's very simple. My youngest son was in charge of his company's Formula 1 racing outfit, and they transferred him to their environmental [laughs] department, and, he wanted a quick introduction to climate change and environmental issues. So, he asked me to, to write this for him, which I did. And I got involved in it, and I quite enjoyed it, you know, reading up new things and all, and I've been at it for a couple of years now off and on. So, it's more or less finished now. And, I think it served its purpose. He, he said he found it useful. And, I suppose in a sense, [laughs] that's really all one could expect from it. But, I have sent it to one or two other people to read, and they suggested that it be published, but, no publisher I have contacted has been interested in it. For example, I went to CABI, the Commonwealth Bureau publishers, and, they said, yes, yes they'd like it, but, they wanted it twice as long, and they wanted it suitable for students, and they didn't want colour. So, it was out. I wanted something that was as brief as possible, and, to have to double it didn't strike me as a good move. It's... I don't know. I'm getting it, I'm going to put it on the Internet, see what happens, and, anybody who wants it can use it.

On Rothamsted's website?

Yah, yah.

And, the title of it, which says, 'Climate Change: a short introduction for anyone who has to do something about it'.

Yes.

Or at least that's the title...

Yes. It's not for, it's not for the general public, nor is it for the specialist who knows a great deal, let's say, about climate change modelling or, design of windmills or, you know, wind turbines or any of these things. It's for somebody who needs an introduction to the whole field, as a background to their own work.

[17:58]

And you mentioned that in retirement, now you're working on a latest revision to the RothC?

Yes.

What is, what are the revisions that you are working on?

Mainly to the weather side of it. And, I'm also looking into something that's come up recently, some colleagues of mine say it's giving far too high results in certain experiments, and I want to examine that in detail. I haven't started on that yet.

Mm.

I think I know what's wrong, but I'm not sure. But these sort of issues.

Any further work on modelling in relation to global carbon?

No.

No.

No. No. Not really, not... No, definite no. [pause] I retired in 1988, when I was sixty, much to my annoyance. I didn't want to retire, but it was, that was the rule. And, I have since, since I have been pretty active. That volume over there, that was... [pause] Where it's got to, where... Oh there it is. It's made up of papers I've written since I retired, so, I haven't been [laughs] entirely devoted to gardening.

And where, where have you done your work since retirement, your scientific work?

I have an office at Rothamsted, which I used to use a lot immediately after I retired, but nowadays I use, I do it here.

Mm.

I go into, I go into Rothamsted usually once or twice a week, and talk to people I'm working with.

[19:38]
Mm. Thank you. Now people are interested in origins, and I suppose one of the ways in which the recording might be listened to by someone is someone who was attempting to perhaps make links between early life and later career.

Mhm.

In your unpublished scientific autobiography, you comment a little on the effect of your childhood...

Mhm.

...in the sense that it led to an aversion to, although a love of the countryside, an aversion to the kind of back-breaking work of sort of unsupported agricultural work...

Mm. Yup.

...and a belief in the benefit to be gained from the application of science really to agriculture. In what, in that way and in other ways, what do you think is a real link, in terms of influence, between childhood and your scientific career?

Well of course, it gave me the interest in agriculture, and this has continued all through my life. Again, I saw what this, I saw the back-breaking work our local, our neighbours spent their time doing, you know, ploughing with horses and so on, and, heavy, heavy work, stooking, you know, grain, and, milking by hand, you know, morning and evening, and all, all this work. And, I was aware, even as quite a young, young boy, that, you know, there were, these things could be improved. I mean I was very well aware that my uncle, one of my uncles for example, a very progressive farmer, was introducing, you know, quite a lot of fertilisers, inorganic fertilisers. And again I saw the end of the horse era. I saw farmers, first of all, they took old cars and they converted them to mowing machines, and, these were very, [laughs] very

impressive gadgets going round the field. And then of course the first tractors came, and I remember one of my uncles was one of the first people in that part of the country to sell their horses and buy a tractor. And, I, I was very impressed by this, and I still, I still feel that, that this is something that is important, science and engineering should be used in agriculture, both to raise productivity and also to, to eliminate, at least some of the, the awful heavy hard work that was normal in those days.

[22:28]
What do you think might be the future contribution of chemistry in this area?

Well of course, the enormous contribution of chemistry in the development of herbicides, pesticides, better fertilisers. [pause] It's hard to... it's hard, always hard to see what way things will develop. [pause] I think, at the moment, there's a movement away from the more toxic herbicides, pesticides particularly. This is not, it's something that's been going on for the last thirty or forty years, and to, to ones that are more environmentally friendly, and less dangerous to the operatives. And this is something that I see continuing. I think that there'll be development of more specific herbicides that can knock out particular pests, that's one way. The other way of course is that, where Monsanto tried, rather unsuccessfully, to build resistance to herbicides into their crops, and then they could use the herbicide in the crop left standing, for a lot of reasons this wasn't very successful. It was rather a pity that, that that happened, that in a sense Monsanto went off half-cock. They were selling something that was advantageous to the farmer, but it was of very little benefit to the consumer. Whereas, I think nowadays, people interested in choosing genetically modified organisms are very aware that there has to be a real benefit to the consumer.

Mm.

I mean, if you enable the farmer to do without perhaps two herbicide dressings in a season, this only amounts to a few pence on the final product, in fact most, probably a fraction of a penny, and, the consumer isn't going to see this sort of benefit. Whereas if you introduce something like the, the new, the yellow rice with sort of, vitamin, high vitamin content, vitamins, then this is of value directly to the consumer. But again, people are rightly suspicious I think of, particularly of commercial, the pushed

products, and I think scientists need to be very careful before they're pushed by the commercial people down a particular line, until the side-effects have been pretty well investigated, including the social side.

[25:36]

The GM crop business, when we had trouble at Rothamsted, people came along and pulled up some crops at one stage, and, it was stupid, but, it revealed that people are worried about this, and, and I think you should take account of these worries. Not that you necessarily agree with them, but that you, you say that, you have to explain to people that, these things have been tested, are harmless, and, or virtually harmless, you'll never be sure absolutely harmless, and, that's the basis we're going ahead with them. If you don't do this, you very quickly find that you'll get a movement that'll stop you dead in your tracks, as the GM model, the GM movement stopped the introduction of, of modified, GM modified crops in many countries of Europe.

What would you say more generally about the image of, particularly chemistry?

Yeah, I avoided that issue, probably, [laughs] you spotted. Yeah. Well as I say, chemistry is deeply involved in the protection of crops, fertilisation of crops. And then, more particularly, the, the handling of crops afterwards, you know, the preservatives that are used, the ways of conditioning crops and the various additives used to meat, added to meat and so on. But, I, I don't... I can't see, I can't really see new initiatives for chemistry. But that doesn't mean that they're not there. It's just that, as a chemist, I see the enormous advantages of the application of chemistry to agriculture, but I don't really see the future ones. I can see continuations of the present things. But then, this is, this is, is life. Who 100 years, 200 years ago, would have thought of the electric light bulb, you know?

Mm.

And, the... [pause] I haven't given you a very satisfactory answer on that. I'm well aware of that.

[28:06]

I suppose it's the, the link now made between chemistry, chemicals and the idea of things being toxic.

Yeah, I know. Yeah. Yeah. It's, it's also another version of the old thing of natural and artificial, which I think's an utterly artificial distinction. I mean, many of the most toxic things are natural. Strychnine is [laughs] an entirely natural product, you know, and, and very unpleasant. I remember, to digress, my uncle was poisoning foxes with strychnine as they did in those days, and he laid bait for the fox, and we were out in the field one day, and this was, the fox, the bait had been laid months before. And, his dog suddenly keeled over, and, the dog had found a bit of the bait and had eaten it, and killed it, there and then, before our eyes.

Mm.

So, natural, [laughs] entirely natural.

Yes.

And, I, I, I think it's a, it's a, a foolish division with no real basis in science. I mean, originally the idea, organic chemicals were chemicals that were found in life, but most of the pesticides were organic chemicals you know. [pause] It is, it's a debate that annoys me, just as the organic movement in agriculture annoys me. I think that... Although, if you use organic manures, these are good, if you have them. You can get excellent results with farmyard manure with many crops. But the problem is, you don't have enough. And, farmyard manure, basically, you're gathering fertility from a big area and you're putting it in a manure heap, and then you're spreading it on a relatively small area. So, by definition you'll never have enough to, to fertilise large areas of arable land, unless you go for the old traditional mixed farming, and that isn't on any more, for economic reasons and for yield reasons. So, there's really no choice. I mean I was walking over yesterday the farm owned by the Prince of Wales, well it's the Duchy of Cornwall of course, but, and he'd got, he was growing an organic crop of wheat there, and it was miserable. Full of weeds. Obviously yellow, suffering from extreme nitrogen deficiency, and they'll get a tiny little yield. But on the other hand, they'll sell it as organic flour at a colossal price. So, it's tolerable as long as people are

prepared to buy these enormous, enormously expensive special things. But as a way of feeding huge populations, it's, it's not on.

Mm.

And... [pause] I, I feel that an awful lot of the organic farming movement is basically anti-scientific, is, looking back to a past that wasn't as nice as they sometimes think. [pause] Yup.

[31:58]
Thank you. Now, earlier in the recording you've, you've talked about not liking, as a child, certain forms of masculine culture, particularly in...

Which culture?

Certain kinds of masculine culture?

Oh yes, yes.

Yeah?

Mhm.

Particularly the idea at one point that poetry was seen as feminine for example...

Mm. Yes.

...and, certain kinds of sports seen as properly masculine.

Yes, yes.

So you're, you're sort of conscious of the fact that there are different kinds of masculinity and different kinds of femininity that might be valued.

Mm.

I wonder whether you could talk about the, the masculinity or not of science in our period.

Mm.

Now, for example, at one point in your autobiography you talked about the, the primitive instincts that lie behind science.

Mm. Mm.

And the metaphor that you chose was that of the hunt.

Yes. Yes.

Including things like pursuit of the quarry, camaraderie of the hunting group.

Mm.

With that in mind, perhaps, I wonder whether you could talk about the extent to which science in the period that you worked was a masculine activity.

Well, of course it was. Although there have always been women working at Rothamsted in the sciences, some of them quite senior, by and large, most of the people there were men, and, I think this is true of most universities. On the other hand, a few very formidable women made a mark in Rothamsted. Winifred Brenchley for example, a botanist, is a weed expert and she was a very considerable authority, but also a very formidable person, and she had to be of course to hold her own with the, the mainly, almost exclusively male background in her time. Blanche Benzian came later, again, a very able woman, able to hold her own with the best of men. And, there are lots of women scientists there now. [pause] I, I think you can push that analogy, I was using the hunting group, you can push it too hard. I don't see any reason why women can't be as good as or better than men in science, except that because of domestic, because of

biology, because they bear children and have the main task of rearing them, their careers are almost inevitably less... what's the right word? single-mindedly devoted to science. Occasionally, I mean, there are, I mean there are famous women, Dorothy Hodgkin is one, who combined family with excellent science and produced outstanding science. But usually because either the husband stays at home and looks after the kids, or they're wealthy enough to have a, you know, permanent childminder. If that isn't the case, and scientific salaries aren't usually big enough to, for a woman to, to have a, a child, full-time childminder, then, inevitably they will fall behind, if they have children. And, science is a very fast-moving subject, particularly in some branches of the DNAs, their work is moving at a colossal speed. I mean, the things I work on, soils, tend to move a little more slowly, but, a lot of science moves very fast, and to be out for a period of five or ten or fifteen years means that you're at a big disadvantage.

Mm.

Now, the Royal Society is very well aware of this, and has got special 'return to science'. That's not the word they use, but, but, systems in place to help women back into the mainstream of science after a career break. [pause] But, I've never had any problems working with women or men. I mean I've met difficult women to work with and I've met difficult men to work with. [laughs] I've never made distinction between the two.

[36:58]
No. But I wonder whether, do you think that the relative absence of women in the time that you were working, then, because of the, if you like, the, the... because the women aren't there, it's mainly men doing the work, does this produce a certain kind of masculinity in, in science?

Yeah. Yes I think it did. I mean for example, the, the tradition of long hours, I mean, for example, I mean Sarah, who we talked about earlier, last week, she had the responsibilities for two children, and, she would have to, you know, she would have to home, and, where I could maybe stay on till half six. My wife might be really cross with me, but, I could. Whereas she, for example, would have to get home whenever they came home from school or whatever the arrangement was. [pause] There's that

side to it. [pause] And science is a funny thing. It's something you don't switch off when you, in my opinion, when you go home, you keep thinking about it and, and, you don't switch off at weekends. And I think, women are, not able to do this.

Mm.

Particularly if you've got kids.

And I, I don't know the answer to this question, so I haven't got something in mind, and it's the last question I'll ask on this issue, but, do you think there's a maleness in the way that scientific work is discussed by scientists in your period because they were men?

Not particularly. I mean I, I discussed thing with, with Lynn Parry, just as if she was a man or... I mean there was no difference, no difference whatsoever. I did say again about Denise Adams, a more passive person, but I mean that's just character. And, I've never... I mean, I've worked with lots, with lots of women over the years and never had any problem relating to them in terms of work.

[39:12]
Mm. Thank you. Could I ask you about your archives, where you intend to put unpublished material, where you intend to sort of leave it or house it or archive it?

A few of my notebooks are in the Rothamsted archives, a few of the important ones, particularly in, the ones dealing with the long-term experiments, my notebooks and things have been held there. The rest of them are, the stuff has either been published or wasn't worth publishing.

Did you keep a diary or a...?

No.

No.

No. No, there's always the notebooks. And, once the thing is written up and in the paper, I've no further interest in the notebooks.

Mm.

With the exception of these, of the work on these, for example the Wilderness experiments, where, the sampling I did in the 1960s and the sampling I was involved in in the 1990s will presumably be repeated in fifteen, twenty, thirty, forty, fifty years' time, and my results are just in, in the archives there, and will be repeated just, and will be used just the way I used Sir Daniel Hall's 1904 measurements.

And so, the notebooks that you used for papers that are written up and are not part of long-term studies, what have you tended to do with them?

Oh, they all sit in my office in files.

In, at Rothamstead?

At Rothamsted, yes, yeah.

But will they hold those do you think?

No.

No.

No, I mean, every time a scientist retires at Rothamsted... [laughs] You know, it would be different if I was Einstein or somebody of that sort, or even Fisher, one of the great scientists who worked at Rothamsted, but, for me, just... Either I've written it up or I've decided that it isn't worth writing up, and which, in either case, there's no point in keeping the archive.

[41:10]

Thank you. I wonder whether you could talk about the importance of soil as a material. I wonder what it is about soil that has kept your interest over your career, what is it, what is the role of that particular material in your scientific work in terms of maintaining your interest?

Mm. Mm. Yes. Well of course, it's the fundamental basis of agriculture, with certain exceptions, hydroponics and things of this sort, which produce a very, very minute part of the world's food supply. But, again, once a scientist gets involved in a certain direction, unless for some reason his career takes a major turn, he changes job or something of that sort of, you tend to stick with what you've started on, once you've got yourself established. And that's, that's the case. I mean I, throughout my career I've moved to different aspects. I was interested in dynamics of organic matter, and then biomass, then nitrogen, then modelling and all these sort of things, different aspect of... But all, all built round that. But basically because, that was, the job I had. I was in the Chemistry Department, then I was in the Pedology Department, then in Soils and Plant Nutrition, and now in the Soil Science Department, you know, so...

So you're saying it was the material that you started with?

Yes.

And so it's...

Yes.

Yup.

Yeah, once you get deeply involved in a subject, you become a bit of an expert in it. And unless there's some very good reason, you tend not to move from it.

Mm.

And, I think this is a way with most scientists. Somebody working on the physics of the Sun will tend to stick to the Sun, or he might look at the other stars, but, he won't tend to sort of, let's say, move to the, to, terrestrial physics.

I suppose then, there must be something in the complexity of soil that allowed you to stay with it...

Oh yeah, yeah.

...and analyse it in different ways.

Yes, yes.

If it was a simpler material...

Yes. And you see, and as agriculture changes, you need to watch things very carefully. For example my colleague, David Powlson, has just been in China, and, there they've been using enormous amounts of nitrogen fertiliser, far more than they need to, and, a decade, a couple of decades ago they used, they didn't use enough. Now, this is a new problem, they're getting soil acidification, they're getting far too much nitrate washing off. It's absolutely unnecessary, you know, they're applying far more than they need for the crop. And, this is a new problem for soil science, to analyse the soils and show them what's going wrong.

[44:15]
Mm. Thank you. And, the last question. Could you talk about your feelings about the process of being interviewed for National Life Stories. This might be feelings you've had about it as we've gone along. So, as a process of thinking about and talking about your life, how have you felt about it?

Mm. Mixed feelings. On the one hand I, I have written, as you know, a brief account of my scientific career for the Royal Society. I feel that... What should I say? I mean, I'm working in a small corner of science. I'm, I've been reasonably successful in it, but it is a small corner. And, I don't think I'm any exception, any way exceptional. And, I

have a feeling [laughs], you know, I know, you've put a lot of effort into this, and I appreciate it, but, you know, it may be right for the great people, great figures of science, but I, I wonder if minor figures like myself are really worth it. [laughs]

And about the process of being asked to think about childhood and, family?

Yes.

How have you found that?

I've thought about it a lot, and of course talked to my brother about it, who is also a scientist, my middle brother. [pause] I think, particularly if you come from a background like we did where we had the change from America to Ulster to Dublin and so on, you do think a lot about that. And, I, I found that, particularly talking about the Royal School, it brought up memories that I had well and truly buried, in fact I may not even be all that happy about them being recorded. [pause] Is it useful to a historian? There are millions and millions of scientists you know. Is it really useful? Is it useful for a long-term record? Maybe, I don't know. That's for you to judge, not me.

[End of Track 7]

[End of Interview]