

An interview with Paul Fatt

Conducted by Jonathan Ashmore
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Paul Fatt photographed by Jonathan Ashmore in September 2013.

1924–1940

JA: So Paul, what I think perhaps the most useful thing is if you could just tell us first of all where your interest in science started, some of your background. Would that be helpful?

PF: Well, interest in science: I've always had an interest in science. You could say that when I lived in Chicago back at the age of 14, I think, practically every Saturday I would go with my friend, Martin Kanovsky, and visit the museums, particularly the Field Museum, which is on the coast. There's an aquarium, there's the Shedd Aquarium, there was later the Adler Planetarium, but particularly the Field Museum which had stuffed animals, fossils, everything like that. It was a museum of natural history and it was there I sort of became interested in biology, palaeontology in particular. That's as far as it went.

JA: Is your family very scientific? Your other brothers?

PF: No, no, no, no. My family had nothing to do with that. My brothers: My younger brother, Milton, he's five years younger and he's a mathematician. He in fact studied and later taught for many years at UCLA and he also got a degree at the Eidgenössische Technische Hochschule in Zurich. And my older brother, Irving, he was interested in diffusion in all sorts of ways and in fact he got a degree at Caltech Pasadena just outside Los Angeles. And he usually studied the diffusion of oil through rocks, which you can see is of some commercial interest with the oil companies. And then he later took an interest in diffusion of oxygen through material which can't really exist, they made, and he got that interest from me via my friend, David Maurice, whom I shall speak about later.

JA: You had a scientific education to some extent in your Chicago, but you didn't go straight away to university?

PF: No, no, no, no. Well, it's a rather complicated story which was I went to the ordinary grammar school, I think it was called Grant's School, named after some American poet who

nobody's ever heard of here. And I finished there at the age of 14. Yes, I should know. I then went to a high school and high school was named Robert Emmet, which you will have heard of because the British hanged him in 1800 or so, supporter of Napoleon and a revolutionary in Ireland. But I was only there for six months since in Chicago, and I think perhaps everywhere in American cities, you could enter and leave a school either in the summer vacation or the winter vacation. As I was born in the winter, I was born on 13th January 1924 in Chicago, and so I entered school always in the winter vacation early in January. And when I finished I finished in the winter vacation 1938; I would have been 14 then. And so I then went to this high school which was the Robert Emmet School.

But then in the summer the family, three boys, my mother and father, emigrated to Los Angeles and there I went to what they had there was a junior high school, it was called that, which I hated because you could not go to the proper high school until the summer of 1938. So I had half a year at this junior high school, which I hated. The name was Mount Vernon High School; I'm not sure.

JA: But did you complete high school?

PF: Then after six months I left there and went to Fairfax High School, which is on the north side of Los Angeles, and it was fine. I spent the three years there since in Los Angeles there's junior high school for three years, then senior high school for three years – in Los Angeles, not in Chicago. Every city has its own system. And from there I went to Los Angeles City College. It was already 1940. There was a war going on in Europe and expecting America to get involved in it. Instead of taking biology, which I was really interested in, I took civil engineering, which in the first year consisted almost entirely of mathematics, solving differential equations. It went on and on and on; differential equations for homework every night and having to turn in your solution and fact report on how you did it. Anyway, differential equations drilled in. Now I presume nobody every bothers with them; you do it by computer. You get the solution by approximation. Not then.

1941–43

PF: So one weekend my parents and I, Irving driving the car, my father never did, went to the beach and there we had, and after that we listened to the car radio and happened to be [December 7th, 1941] and the Japanese attacked Pearl Harbor [...]

JA: And so what was your response to that?

PF: Well, it was a war; America was in war. I was going to go off. I was, how old was I then? 1941? [...] I was just 17. Anyway I was going off to the wars so the first thing I did was, rather than wait to be drafted I would join the Army as a reserve, and I was allowed to continue with my studies. That was the condition under which I joined and then they would find some use for my information that I got from studying at Los Angeles City College for a year. And in fact it only was a year because it was three months' time I was informed it was time to get into the active service and I was going to be put into the air force doing meteorology and they had a course set up at Pomona College at Claremont, California, where we were going to study to be meteorologists for the United States Air Force. I went there and in two weeks' time they decided, "No, you're finished with that." They had

enough meteorologists, they wanted infantrymen. So off I went, was sent to Fresno, California and it was the middle of winter; it was extremely cold there in basic training.

JA: And with the intention of training to be what, eventually?

PF: Well, it was basic training. From there you could go into anything. But one assumed they wanted infantrymen so one didn't, wasn't very optimistic about doing anything else. And so that was basic training in the winter; it went on for six months. In the winter it was too cold; in the summer it was extremely hot. This was the San Joaquin Valley in California where they grow lettuces. They don't grow them in the summer. It was extremely hot that summer. And in that summer, so where are we now?

JA: '42, '41?

PF: '42. I was very, very, very fortunate at being sent to do ASTP which is Army Specialised Training Programme at the University of Kentucky, Lexington in the heart of the bluegrass where the tobacco and the bourbon whiskey is produced. And I did, continued civil engineering there, and did various courses in construction, sewerage, whatever else I did.

JA: Did you see yourself as going to become an engineer at some point?

PF: Oh yes, then I presumed going into the engineering school ... and such things. However it didn't turn out that way. When I finished the course there for a year, of course then we're in the summer of '43 already, I was sent to Camp Gordon in Atlanta, not Atlanta, some city in Georgia, in Augusta, Georgia and the Savannah River. And there I was in in sound ranging. It was the field artillery, what do you call it? FAOB.

JA: Ballistics of some sort?

PF: Field Artillery Observation Battalion. The 291st Field Artillery Observation Battalion. And with my mathematical knowledge I was put into sound ranging, which is looking for enemy guns by the sound bursts of the guns firing. And the system is you put microphones buried in the ground, at least four, maybe up to six, strung along a line, preferably a straight line, for sound seconds apart, and roughly sound travels one thousand feet per second so about four thousand feet apart. You don't have to be exact since they would be plotted on a plotting table. And I would stand by the plotting table and it would be, there would be a tape recorder, I was now in the command centre, CP, and we had our posts in front of this line of microphones and these command posts are just up with the infantry with the front line and when they hear an enemy gun being fired they would push a button which would start our pen writer going and there would be one pen for every microphone. So each microphone was being recorded on paper. And I'm looking at the sound wave recorded from these microphones. I would then work out the difference in time between the different microphones to see the sound. And from that you could then plot the position of the gun.

JA: So the assumption was that you could place a microphone well up, right up where the gun was being fired from?

PF: Just by the infantry, they would protect.

JA: I see. That was their job.

PF: Anyway they were carrying a gun; I was carrying a gun all the time too. So this was the way sound ranging works. Actually I heard a radio programme by Melvyn Bragg the other day in which he described how Laurence Bragg, a relative of his, was the first one who introduced sound ranging in the British Army.

And that's exactly the system I've described. One could then plot the, well, the difference in sound reaching the two adjacent microphones, in fact the difference in time. Sound waves reach two adjacent microphones lying on one arm of a hyperbola and in fact you know the gunner that had fired lies on this hyperbola in front of the line. But then of course you have, you can plot a hyperbola easily so we plot the tangent to the hyperbola, which is a straight line coming from the focus of the hyperbola, which is (you know where that is) between the two arms of the hyperbola.

JA: So you can triangulate the source basically?

PF: Yeah, and doing this for each pair of microphones, adjacent microphones, we could then get three, four, five straight lines and see where they intersected, or nearly intersect. They wouldn't intersect exactly because we're not plotting the hyperbole itself but only their asymptotes.

JA: Did you put this very sophisticated training into practice? Were you posted shortly after that?

PF: So I was Camp Gordon for quite a while, at least six months and while I was there I was in fact being taken over as a disciple, sort of, by someone called Sergeant Beams who was the head of this sound section where we were training. This sound section was part of B Battery of the 291st Sound Artillery Observation Battalion. And this Sergeant Beams said that he was going to build me up to lead this battalion, not the battalion, the sound section when we go overseas. He couldn't go. He was an American Indian, had been to Oklahoma University and damaged his knee in football there. And he was very tough. And he said he was once a weakling like me ... But he got tough and he beat his fists against a tree until they bled. And I would listen to this and we were sent out to dig post holes with a post hole digger, which is two blades on a stick which you drive into the ground and dig out, all this to put in posts. And I would give a couple of hits with this post hole digger and then hand it over to him and sit down and he would finish digging a post hole. But then one day he didn't come back after going out for a weekend and his body was found in one of the canals in Augusta. And at that point, it turns out he got into a fight somewhere. At that point I decided I was not going to follow him to be tough; I would just [go] on as I was.

1944–45

JA: Paul, tell us what happened then after you received your training and then moved forward into the Second World War proper?

PF: This was now getting to 1944 in fact. So after our training there we moved in secret to Boston, in a camp just outside Boston, and actually went into see a football game while we were in Boston and in fact we were told not to speak to anybody, not to let them know who we were, what we were doing because we were not allowed to speak to anyone when we went to this football game. And then we were loaded onto a ship which was said to be an old passenger ship, the Manhattan I believe. And off we went, ten days crossing the

Atlantic, without an escort as we were quite a fast ship. And apparently went quite a way south, it was quite warm. And then at the Princess Docks in Liverpool and then we unloaded our gear there. I was being a sergeant at that point, sergeant T4, technician fourth grade which is equivalent to a sergeant; it has three stripes with a T under it. And one night I went into the music hall in Liverpool, we were staying in a place called Kirkby just outside Liverpool, and with mattresses filled with straw. It was very cheap. Anyway we unloaded our gear there and went off by train, arrived from Liverpool, I suppose Euston station perhaps? And then into a bus, across London – that was quite an experience – to another station which I presume was Paddington [?Waterloo]. We went to Southampton by train and then we were sitting there for a couple of days.

JA: Was this the D-Day landing time?

PF: No, this had already happened then and I don't remember the day. It had already happened because it was October actually. The D-Day landing was in June. Yes. And we then sat there, it was sandy and I looked about and there were flints that I've never seen before, chert is the technical name, these things we call flints here. And I had only seen them in models with Neanderthal men in the Field Museum sitting on sand just like at Southampton chipping away at these flints, the stones having been imported to the Field Museum. Anyway we were there about several days and then we loaded up in ships. I don't remember what sort of ship. There was a story later that it was a fishing boat but it was something, some commercial vessel of some kind. And going up there, at the bottom of the ramp going into, from the lower, from the shed, there were women handing out cups of tea. Big mugs of tea. They must have handed out, well several million, not all of them at that shed; there must have been an awful lot of mugs of tea handed out.

JA: A very un-American activity.

PF: And upwards into the ship. Then we packed in and I remember, well it should have been only days crossing but in fact when we got to the beach, Omaha beach it was still, and this was in October, early October, the ship just sat there. For three days there would be announcements, "we're waiting for the weather to moderate." You were handed out a lump of cheese and a loaf of bread and I think maybe some dried fish at one point. And I slept under the table when others were playing cards. The trouble was they would throw their cigarette butts down on me. But there were very, very few hammocks for sleeping in. But eventually they decided the weather wasn't going to moderate clearly and we got done in the landing barges and climbing down nets into the landing barge. And there the problem was, you were carrying a rifle on your back. It's a carbine, a small rifle and with the muzzle down in case it's raining and it probably was raining, and you're like to get that muzzle caught in the net, in which case you're just hanging there. And you're also supposed to drop into the landing barge as it was going down rather than coming up towards you so you won't break your legs. Anyway got into the landing barge and ran up onto the beach.

And they were always concerned of course the Luftwaffe might come out and bomb us and strafe us but that didn't happen. I enquired from people who know it, since, why that didn't happen and they explained it. The Luftwaffe had no fuel or trained pilots at that stage. And so we ran up the shore, steep shore, to the top, to the grass where they were these beaches, the hedgerows of Normandy. Anyway we were told not to look into these hedgerows because they are bodies and they might have booby traps on and what not. So went off and camped just above the beach.

JA: But the fighting had more or less been finished at that point?

PF: It was finished. Paris was already taken by that stage.

JA: I see.

PF: By October. And we just camped there. Just in little pup tents. A pup tent, each man carries a half of a pup tent so you had to join up with someone else and you make a whole pup tent that you can crawl into to sleep. And we were lectured we should take off our boots and massage one another's feet so we wouldn't get trench foot since that was the greatest loss the American army was having was from trench foot, having to amputate feet. And we looked at our feet and, as long as they were pure white, it was alright. It's when they go brown you need to worry. Anyway I never did take off my boots, no one did. It's very uncomfortable to take off boots.

JA: So did you follow, continue with the army all the way through into Germany?

PF: No. After a while we then moved on, went down to Cherbourg. Cherbourg had been taken and they were, the port had been repaired because it was destroyed by the retreating Germans. But the way we never fought the 'Germans', it was always 'the enemy'. To speak of Germans would have been racist, so it was always just 'the enemy'. It wasn't like the First World War when they called them Krauts and Bosch and such things. It was just referred to as the enemy. Anyway the enemy had destroyed Cherbourg but it had been rebuilt and they were bringing in locomotives even and we became train guards to guard the trains going towards the front. And so I would then get on a train carrying goods mainly munitions and stay with the train until half way to Paris, unfortunately. Some men found that they were relieved when they got half way. Lisieux was the change-over place usually and some weren't relieved so they could get all the way to Paris. That never happened to me. I was always relieved somewhere. Caen was also another place because I remember stopping there and going to a cinema which was of course half destroyed and it was dark with all the GIs, the American Army, and they're all sitting there in the dark and I wanted to, I thought there were seats on the other side, so I ran down to the front and ran across and turns out it was all flooded in the front, splashing through the water and everybody laughed as I went splashing through the water. Oh, by the way Normandy, was flooded at that time. The Germans managed to break some dykes. And the whole thing was flooded. The train was going on the embankment which was just an embankment standing up out of the water for much of the way. There was some land, and in fact at one point as we were going along, somebody jumped onto the train just behind the engine – I was further back, usually I was on the top of the train, on top of one of the box cars. And this person was throwing coal off the train. And I thought, "God, we'll run out of coal before we get to our destination." And I shouted and shouted and waved my rifle, carbine, and I thought, "Should I shoot this man?" Oh God that will be worse than running out of coal. But fortunately he jumped off and went to collect his coal. The trains went very, very, very slowly, very slowly. In fact I'm not sure there was somebody walking ahead! And there wasn't!

JA: How far did you get towards the front?

PF: Okay so from there, we left Cherbourg and went to a place called Argentan in the south of Normandy [...] And we stayed there in the winter, it's late '44, Christmas '44 was spent in there in what I gathered was the main building of the Argentan. We spent Christmas there.

I don't really remember much of the place because it was dark all the time and snowing so we spent all the time indoors until on New Year's Eve suddenly we're told, "Get up! We're going off, off to the front." And so on New Year's Eve, and the reason we were going, which we just discovered later, we had to replace 285th Field Artillery Observation Battalion, Battery B which had been massacred at Malmedy. This was the famous massacre at Malmedy. They had been captured in the first days of the Battle of the Bulge and were captured and told they were going into a field and then machine gunned. A few, very, very few survived. I had met men of the 285th sound ranging battalion at Fort Sill in Oklahoma where I went for a training course while I was at Camp Gordon. Anyway, off we go, the day before New Year's and we travelled further east. Actually we weren't quite sure where we were going. And then we found, wound up in Aachen in the night, that was head command. And the harbinger, you know what the harbinger is? The one that goes ahead to find accommodation for the troops. The harbinger had already found accommodation for us in one of the houses in Aachen, which was largely evacuated since the Germans when they left said all the people of the city must leave or when we come back they'll be executed. So almost all of them left but some stayed behind. So anyway we slept there, got up in the morning, lined up for breakfast and then [makes gun sound] there was firing and the planes were coming over and attacking us. And so we all scattered. We lined up in a queue waiting for breakfast to get our food and so we scattered and I dived behind a tree in the snow and looked up and saw this plane coming down with flashing at its front. Clearly they were ...

JA: After you?

PF: After me. And since then just by chance I was telling someone about this experience being strafed lying in the snow in a street in Aachen and I thought, "Oh God, on New Year's Day. New Year's Day. Why could it happen just on that day?" So I put in on Google 'Luftwaffe 1st January 1945' and there it came up, the whole story of the thousand, I think there were nearly a thousand planes, the Germans had been saving all this fuel and brought it back, well along with preparation for the Battle of the Bulge from the Eastern front and they brought all their planes back for this attack. And the attack occurred on the 18th August but the weather was so bad – in fact that's the reason why the Allies never saw the preparation for this attack, the Battle of the Bulge. But at the same time the Luftwaffe couldn't fly because they couldn't see anything so they put it off until the first clear day, which happened to be New Year's Day, and then they came out with all the pilots they had and they actually destroyed practically all of the Allied planes that were in the neighbourhood. But they lost some. And in fact they lost a number of their planes, in fact quite a number, but their own anti-aircraft guns because the V2 emplacements for attacking London were all set up just north of Aachen and they had lots and lots of anti-aircraft guns to protect themselves from the Allied planes. But they were not, they did not, there was no time, it was highly secret this sudden attack on New Year's Day and they weren't informed and they shot down the planes they saw coming over which happened to be their own planes.

JA: Extraordinary.

1945

JA: Right. So there you were on New Year Day's strafed lying in the snow, take us forward ...

PF: Lying in the snow having been told not to look up at the planes because they could see your white face in the jungle but in fact we were in the snow which a white face. Anyway, none of us was hit but there was a story that a German army wagon had been hit but there were always rumours like that. Also the fact, the idea that civilians don't know how to look after themselves was still being said. Well, from there we quickly moved into a place just to the northeast, south of Julich and into a steel mill and we were set up in the basement of this steel mill and we had our microphones in front of us. We were on the northern edge of the Battle of the Bulge when the Germans were now in retreat. But this story came and we were set up and we were active sound ranging, locating enemy guns. And one day the story, one day we were told that the Germans were going to counter-attack in our sector and we were quickly moved out. And for the only time we actually had to dig into the ground, another deep hole for our command post and put in a big plotting table, which I would lean over all the time putting my plotting. Anyway we then, things quietened down and we moved further north slightly into Holland and set up in a farmhouse there. It was rather quiet there.

JA: And the V2 emplacement had more or less been taken over at this stage, is that right?

PF: They had been taken over.

JA: Yes. Were any of your technical people involved in doing the survey of the V2 site?

PF: No, we weren't involved in that. Actually our casualties, the worst were mainly the wiremen climbing up trees to put in wiring. Everything was done by wire; we didn't use radio. Everything was done by wire. Well you've seen photographs where there's just wires strung all over the streets and cities everywhere. Okay so we moved into the farmhouse and we set up there and then we were there quite a while. In fact we were in front of the River Roer, which is a tributary of the Meuse, which itself feeds into one of the mouths of the Rhine. But this is the Roer. And then we were waiting to cross the Roer since there were dams further up the river to the south that they were afraid the Germans will breach as soon as we try moving forward and then the whole countryside would be flooded and the tanks couldn't go forward. So we were just waiting there. In fact planes did bomb; one of the dams was destroyed and in fact the Germans opened up the sluices on one of the dams and quite a bit of the land was flooded so the tanks couldn't go. At that time there was so much snow about that we were worried there would be mines under the snow which at any time going over, even though the traffic had gone over it, it might be released by melting snow and we'd step on it and be blown up. And in fact we were given in place of Jeeps vehicles like Jeeps but with tracks instead. And I was amazed by them. The men and I could just jump into these track vehicles, no steering wheel of course but two levers and just drive away. Of course they'd all driven tractors at home so they had no trouble to have to train anybody to use a track vehicle. Anyway we were there for quite a while and one evening, oh yes, there was a tremendous bombardment, we know that was preparation to go ahead and cross the Roer and get onto the Rhine. And strangely enough it was in a broadcast, actually we never used radios at that stage, but it was a live broadcast from Montgomery who was in charge of the army group. I was in the army of the American Army, in fact he visited a British sound ranging unit while we were there and Montgomery announced that, "We have chased the enemy from pillar to post" and there was such uproar, like a dog going from pillar to post [...] each one. Anyway Montgomery made this announcement to attack across the Rhine. And of course it was thought there would be

great trouble getting across the Rhine but there wasn't at all. That big bombardment went ahead and there was one bridge that was captured but that was quite far south. Another bridge, pontoon bridge, would be built across. And Winken Gardbas [??] is I think where we crossed and the pontoon bridge. [A Pontoon bridge was built by the 291st Engineer Combat Battalion between Remagen and Erpel in March 1945.] Then we went on and on to the east and along the Lippe Canal. We had maps. I had a great collection of maps because all of the German maps, I think they were 25,000, more than 25,000 maps which were stored by the American War Office. In fact they have maps from every country in the world I think in preparation. So we had lots of maps. We went along the Lippe Canal and frequently being shelled but other than that there was no trouble with an attack by air, but shell fire.

JA: So you didn't lose anybody in your group at all then?

PF: Not at that point. And usually had our CP, the command post, set up in the basement and we'd sit at the house and then we'd sleep in the beds upstairs. It's a very nice, I remember distinctly one time, we heard gunfire and then it's boom! Next to us and everybody scrambled down into the basement. At some point I think the enemy would suspect that we are of some importance and they would try to get us. This has happened a number of times; they would range in on us. So we went on along the Lippe Canal and then we were on the north side of the Ruhr Valley and the German army remained in the Ruhr Valley; they could not retreat. And the American Army was then trying to encircle it and we were just north of Dortmund, I believe. We were looking down into Dortmund lobbing shells; shells being lobbed into it. Oh yes, while we were there all of our lorries were taken with our drivers to carry equipment for the army that was going further east, to get to Berlin before the Russians. And so our drivers and lorries went, and one of the drivers who was a great friend of mind, in fact worked with me, he was a corporal, didn't come back. But he happened to be in a lorry with another one of my unit, these two were driving alone across the country and they were machine gunned and this one [was killed]. His name was Greenup. We called him Rabbit since he had protruding front teeth. And he didn't come back; he was killed. And the other one was captured and then actually they told them they actually they wanted supplies they thought they might find in the lorry, the Germans. They told them, "Raus! Get out" and he ran off. He thought he was going to be shot as he ran but they didn't shoot him and he managed to find his way back. Anyway I won't go down that road; there is more I can say about that but ...

JA: So we're now moving towards the end of the Second World War, although there was a lot of action still to go before you reached Berlin. So at the most advanced position, were you part of the troops that moved into Berlin at some point?

PF: No, no, no, no. The Russians did that. With their machine guns, you know. In fact we were sitting for some days by the Ruhr Valley looking down, so that eventually it was cut off, they did surrender despite Hitler saying they must never surrender and we moved in, I went into Dortmund. There were body parts stuck on walls and things; our shelling had done that and been effective.

JA: Soldiers and civilians? One doesn't know.

PF: Who could tell?

JA: One doesn't know ...

PF: There were some bits of clothing and stuff but ...

JA: Was that the first time you'd come across, as it were, the more unsavoury aspects of the war?

PF: Yeah, I didn't think much of it, I'm afraid. I don't somehow believe these stories people tell about these terrible things, always about children. I don't believe these stories. So then the Ruhr had fallen, we got our vehicles back and off we went further east. And we went on until right up to the Elbe and then we told to halt there because the American Army had gone beyond the Elbe and then found they were running out of supplies and it was not entirely peaceful and so they came back and agreed with the Russians the Americans would halt at the Elbe. And we were sitting there at the shores of the Elbe looking at, waiting for the war to finish.

1945–48

JA: So now we are in April 1945.

PF: So then we withdraw because the Russians were going to occupy the area where we were then and going up further west. So we went back and stopped in various places – Butzbach is a place I remember near Bad Nauheim – and what we were doing was waiting there, waiting and waiting to go to Japan. [laughs.] And I would hitchhike into Bad Nauheim, which was a very, very pleasant place; it's a resort, sanatoria place. And then one day I came back and then, ah! the bombs had dropped on Japan and the war was over. Hurray! That's the way we felt about the double bombs; we're not going to Japan now. Should we had felt differently? I did know the exact details about of how many people were killed but more people were killed in Tokyo than Hiroshima.

JA: How long was it before you were then sent back again to the States after the war had finished with Japan?

PF: Then there was a logistic problem of getting all these millions of men back to the States; there were millions. And so after some time I wound up at Étretat [...] It's a lovely, lovely place.

JA: It's what, on the channel coast?

PF: It's just north east of Le Havre. In fact recently I've been there, gone recently, such a lovely place, gone via Dieppe. Dieppe and then you get a bus into town. Anyway in Étretat there are cliffs there to climb and lovely beach things and we were probably staying in what had been a First World War hospital for American soldiers. And then from there we were waiting to get a boat from Le Havre and we got a boat from Le Havre and we landed at one of the channel ports. And then I went to Shrivenham [near Swindon] which of course I don't know why they did that.

JA: Did you know what you were going to be doing at that stage? Had you thought about your next steps?

PF: Well I had been ... yes, I was going to do biochemistry.

JA: Did you know where you were going to be doing your biochemistry?

- PF: Okay so at Shrivenham, was there a month or so doing various courses, I think it was mathematics. It was almost mathematics; that's the thing I could do. Okay and so from there we got a boat to, an aircraft carrier I'm not sure from which port, it was an aircraft carrier where there were 10 or more bunks on top of one another. But you couldn't really fall down because the passages between the bunks were so narrow you'd just fall into the bunk on the other side of the aisle and in theirs. This was in winter so beginning of '46, end of '45 beginning of '46. Then I got back to Los Angeles somehow where I had started. And from there I applied and did biochemistry at the University of California Berkeley.
- JA: This was on part of the GI Bill?
- PF: With the GI Bill, of course. And I got a, what do they call it, a BA.
- JA: So did you enjoy your time? What was the atmosphere like at Berkeley between, from 1946 to 1949?
- PF: It was sort of largely medical biochemistry by ... Greenberg was the head of the department. But no it was fine and I met an older type professor who got his degree at Helsingfors, which is now Helsinki, and I think he did something because I actually can't think now. I wanted to get away from the United States; get back to Europe. When I was at Shrivenham I would hitchhike frequently every weekend, I must have been there for a couple of months, to London and I liked it. And I was not happy back in America where people would say, "Ah, you talk like a foreigner." Well they still do, I should think. "Are you a commie?" It was getting already then it was coming up. Oh yes, yes. No. I did biochemistry so I was there for, must have been two years. They accepted all my ASTP and what not and the Los Angeles City College as part of my degree and so I got a degree in two years, I think, in biochemistry. And then I went into biophysics.
- JA: Why did you go into biophysics?
- PF: Well I didn't particularly care for all this medical biochemistry. I wasn't into medicine. In fact most of the people there were going to apply to take a medical degree and they wanted something in advance that would help them get accepted so they did a degree in physiology or a degree in biochemistry or anatomy and then get into medical school. I wasn't going to do that. I wanted to use mathematics and physical methods. I wanted to be using physical techniques.
- JA: Were there particular teachers running the biophysics programme at Berkeley that attracted you to biophysics?
- PF: They were good and there was somebody, Vernon Brooks, a zoologist. So I did a course in zoology, was very good. Oh, he encouraged me to write to A. V. Hill in London and so I wrote to A. V. Hill – and you know where he would have been, at UCL – about could I be a research student there. And when I got to London later people said that I had phoned A.V. saying that I wanted to come. I have never made such a telephone call; I wrote a letter. And I wouldn't be surprised that this man, Sundstrom, I think his name was (God! I can remember these things, I'm amazed) had phoned to speak to him.
- JA: Did you get a reply from A. V. Hill? Did you get a reply to your letter from A. V. Hill?
- PF: Yeah, he said, "Come on, you don't need stipend" because I'm being paid by the GI Bill.

JA: I see. And how long was your support from the GI Bill going to continue?

PF: I think it was three years. I'm not sure.

JA: So you still had another two years or something ...

PF: Oh yes, I had used ...

JA: Were there many people in your position who used the GI Bill like this?

PF: Only Americans that came over. Oh everybody.

1948–50

JA: So tell us a little about the GI Bill level of support.

PF: You got, well tuition fees were no consideration somehow. At that how you had no tuition fees anywhere in the world. So you went to California, you were accepted and taught. Here too. Everywhere. They still have that in Cuba. Denounced for that reason. So I came under the GI Bill, oh yes, I'd used up some at the University of California of course, two years. So I probably only had two years left. I think it was time you'd spent in the army plus a year. I'd spent three years in the army so I got four years on the GI Bill. Yeah, that's it, that's exactly the way it worked. And it was \$90 a month.

JA: That's a pretty reasonable stipend.

PF: And I come here and it's \$4 to the pound. So you divide 90 by 4 and what do you get?

JA: About 23 and a bit.

PF: And I thought, "That's not enough to live on." I was told by other people there that they were getting a lot more from the British government. Oh yes, how much it cost, [and] there were restrictions.

JA: So did A. V. Hill or Bernard Katz support you during your time here?

PF: No, no, no. I lived on \$90 a month. A third of it went for lodging, 25 shillings a week, maybe 30 shillings, maybe higher. And if I was going off for a meeting I might even leave it and find another one when I came back. And then half of it on food and half of it on beer and what else you need for living.

JA: Sounds a very frugal existence, Paul.

PF: No, no, I loved it. I liked it.

JA: Where were you staying?

PF: I had a friend in Berkeley, whose name was Leonard Yubsher, who was a student of Robert Oppenheimer, which is rather interesting. And he gave me an address of somebody in Finsbury Park and I walked about in the park and then I found there was Hampstead and A.V. lives in Bishops Road in Hampstead and so I moved in to South End Green. There's a block of flats above what used to be the post office – it's gone – where I used to have a room. And then as I said, oh no, probably not initially but I did change rooms.

JA: When you arrived here at University College London did A. V. Hill say, “Yes, you’re going to be my PhD student” or was it some different arrangement that happened?

PF: So I arrived in the summer and nobody was about; it must have been August. What year is this now?

JA: '48.

PF: 1948. Nobody about except, well, oh yes, so I watched this analysing experiment on heat production of muscle contraction. You know it’s heat production, heat of this and that. And then there was nobody around so, oh yes, one thing I did, I went to Wembley Stadium to watch the Olympics. It cost hardly anything to get in and I saw this Dutch runner going like mad; it was great. And then he told me, “No, go to Plymouth where everybody is, and decide what you want; that’s where you can get materials.” So I went to Plymouth and there they were, Katz and Hodgkin and Huxley, the three of them, working with squid axons. And you know the other group, Richard Keynes, everybody was there. And somehow I got attached to Katz because he wasn’t happy with all of this, he liked to see action potentials and here they are suppressing them; they’re actually stumping them, they won’t have action potentials. He liked action potentials. And he wasn’t going to be on this analysis.

JA: What was your impression of that group? What was the atmosphere down at Plymouth while they were doing this work?

PF: There was no particular atmosphere; they were all worried about not being able to get squid. Getting squid and dissecting it. Oh, Katz I think, was dissecting them; that’s the only thing he was doing because he didn’t like this no action potentials. And then I would be given squid when they had an excess and badly damaged ones or dead ones so I could dissect it and I recorded action potentials actually. Poor action potentials, poor squids and poor dissection combined.

JA: Did you use their equipment or did you have your own equipment?

PF: No, oh there was equipment there that the other group had left behind. Oh no, it was there, everything. I didn’t require much for that. Usually one was recording with an AC amplifier. For action potentials that would be fine. And with electrodes, well for action potentials you can use a platinum wire electrode, you want to make sure you’ve got the whole thing, platinum wire, or you use platinum. Or you can use a cotton thread dipped in saline agar and if you had a DC amplifier – but I don’t think I had a DC amplifier there.

JA: Were there other students there like yourself working on any of these projects?

PF: No, I don’t remember anyone else. I think the others had gone home for vacation. This was vacation. And then I got the vacation over and I went back to London, and moved into, I don’t know exactly where, maybe that point is where I moved in around Hampstead: discovered Hampstead.

JA: A what stage then did you decide what your PhD project was going to be with Katz?

PF: Well at the time then Katz was working on recording from muscle spindles, you know he did that work. And I sort of gave him a little assistance. I still have a scar here where you know to photograph the cathode ray tools it wasn’t in a box, you had to darken your room, you

had a camera sitting out from the front of the oscilloscope and darkened your room and get your two wires and get mains on it and it just sizzled. Anyway, so I was giving him assistance, not very competent, and then he put me on ... Oh the way it was setup in Biophysics: A.V., who was of course the Head of Department; and he had with him J. L. Parkinson as the Chief of Laboratory and A. C. Downing. They had been with him since before the war. Maybe even before the First World War! A very long time ago. And Parkinson was a mechanic, did everything mechanical, and Downing built galvanometers and I don't think they had any amplification. Oh no, sorry. Thermocouples. He built thermocouples.

JA: With torsion galvanometers as well.

PF: Galvanometers. But he built the thermocouples. Maybe just the thermocouples. I think the galvanometers were bought off the shelf. He built the thermocouples.

JA: And who else then was in the Department as well, or the Unit, as well as A. V. Hill?

PF: A [...] technician called Audrey Paintin [...] Did you know her?

JA: Absolutely.

PF: You saw her? And she would carry oxygen cylinders under her arm, running up the spiral staircase [...]. And there was Atree who built the electronics, and there was Copeland who was an assistant. And then of course, now I'll get to the people that I'm involved with, spiral staircase, do you remember the spiral staircase?

JA: It's still there.

PF: It's still there? Okay we go up the spiral staircase and on the left is E. J. Harris and he was a genius; an utter, total genius at everything. Everything mechanical. Electrical, technical, anything radio electrical. Anyway that was E. J. Harris. And on the right of the room there was Eric Denton, Murdoch Ritchie and Bud Abbott. Murdoch Ritchie just, and then they moved to America.

JA: Let me be clear. We're still talking about 1949? All these people were present in 1949?

PF: '48. Is there anybody else I should notice? Let me think.

JA: And these people have come together immediately after the Second World War or A. V. Hill brought them together?

PF: Ritchie, Abbott and Denton had all been together at TER: Telecommunications and Radar. TRE. Telecommunications Radar Establishment at Holborn. I think they'd all been there, those three. Ritchie, Abbott and Denton. And very soon after I arrived Denton left and I more or less moved into his desk and I heard Denton went to Plymouth where he remained for the rest of his time. And you must know him? And of course so those were the people, and down below was Katz and A.V. and there must be somebody else?

JA: Did Bernard Katz have his own separate laboratory? No laboratories were shared?

PF: He had a separate laboratory. In fact it was at the bottom of the spiral staircase, facing the spiral staircase actually it would be to the left. And it was ... no, you went to the left, you went into what was called the Preparation Room where Parkinson was supposed to

prepare the Ringer's. Nobody else knew how to prepare the Ringer solution back then. Oh God! And then a door from there led to the right into A.V.'s lab. Memory!

1949–52

PF: Bernard Katz was doing spindles and he said, oh what I could do as my project was look at the depolarisation of striated muscle by acetylcholine. And someone else had worked on it before, Conway somebody, I'm not sure now, and had reported depolarisation of the endplate region of muscle by acetylcholine. Now the whole idea of the resting potential then was questioned. And here was a depolarisation.

JA: And what about the idea of using microelectrodes or was that already current?

PF: That was in Cambridge. Somebody by the name of Nastuk came from America and he brought it. Worked from Grundfest's lab was it? Yup. They were using microelectrodes to go into single fibres. Well actually if you're going into single fibres, it was done on a squid axon by Kenneth Cole: Curtis and Cole and Marmont. And in fact they recorded the action potential with a long internal electrode.

JA: Right, the idea of going through the membrane was something that Nastuk brought with him?

PF: I think Nastuk's idea was penetrating with a very fine glass tube. No, Curtis and Cole had a glass container that somehow you put the axon in and electrodes are inserted in the middle. Anyway, he was my best friend, was K. C. Cole, I thought. I did like him.

JA: How did you learn how to do this microelectrode recording?

PF: Well that's some time later that the penetrating microelectrodes came in. No, no, so when I was recording the depolarisation at the endplate with acetylcholine, in fact I worked out a way of just sweeping along the muscle by changing the level of the water, saline, that's in contact with the muscle. Having one electrode on a thread on the top always soaked in saline, Ringer's solution, and then lowering to the level of the water with the other electrode and then dipping into this water and you can just sweep across the whole muscle and see the endplate region depolarise. So I was doing that while Katz was working on the spindle. I think I was in the preparation room which was just next door. And then Katz finished with the spindles he was going to ... well, no, no, no. So then in fact Nastuk came down. Katz had communicated with Hodgkin, and Nastuk came down and showed me how to make microelectrodes using a tiny little flame and you hold it and you pull out the glass and then you hold it and quick pull; no machine. I really never could get a proper machine. And sometimes, oh you hold it up (I think I said all of this at that talk I did at University College!), you'd hold it up to the light and you'd see the play of colours at the tip and you'd decide from that whether it's a good one or not: from the feel as you're pulling it and from the play of colours.

JA: And what about filling it?

PF: And then you put it into 3 M potassium chloride and with a rubber band on and ...

JA: And boil.

- PF: And you boil it till it filled. And if they didn't fill then you'd throw it away, they were probably blocked.
- JA: Do you remember the first time you got a successful penetrating recording?
- PF: Nope. But anyway it was ... then Katz decided we should work on recording from muscle fibres just as Hodgkin and Nastuk had done on squid axons. "Okay," I said. "But they were using a micromanipulator." In fact we were always using a micromanipulator.
- JA: So what sort of micromanipulators were these?
- PF: Micromanipulators made by a French firm [LeBruin?] which worked with plungers, I suppose it was mineral water and another syringe-like plunger used to drive the liquid.
- JA: It drifted, no doubt.
- PF: You mean you haven't seen one? Haven't used one?
- JA: Related, but not that one, no!
- PF: Micrometers were used then. So this was before the use of micrometers; this was bought, when they were not off-the-shelf. So we recorded resting potentials and there were 90 millivolts hopefully. And there's a question what resting potential should be. And in fact it was Cole, Kenneth Cole, who first noted the action potential overshooting the resting potential. Trouble is he overshot too much.
- JA: But at what stage you start seeing the endplate potential mechanisms. Were you looking for the endplate potentials?
- PF: Oh yes, that's what we were looking for; that's what it was about. Katz would do the dissection and I would make the microelectrodes, then I would manipulate the microelectrodes while Katz ground his teeth as it wouldn't go into the muscle fibre where we wanted it to. And then he did the photography.
- JA: So what were the working conditions like? When did you start in the morning and when did you finish?
- PF: Well Katz would get there before me. I think I mentioned all this in the other lecture, but anyway, Katz would get there before me, he would start in the dissection and then I would come along and then set it up in the chamber bathing it in Ringer's solution. But the night before I had stayed late, you see; Katz wasn't going to stay. Seven o'clock was cut off time for him; he had to go home. But I would stay late and make electrodes. I could only do it at night because it depended on the colour of the flame and the refraction at the tip of the electrode; I could only do it in the dark. You see so I stayed there late into the evening to make the electrodes and boil them and everything at night. And so he would get there before me in the morning and did the dissection. And we would mount it up and with the micromanipulator poke the thing into muscle fibres and go along. And what we tried to do was to go along different points of the same muscle fibre and then stimulate the nerve.
- JA: Now just to jump ahead a teeny weeny bit: what stage did you start seeing miniatures, do you recall it? Do you recall the experiment when you first noticed the miniature endplate potentials?

PF: Oh that came later. You see the endplate potential was known, Katz and Kuffler, and Eccles, Katz and Kuffler had been looking at endplate potentials in Australia, in Sydney. And so we knew about endplate potentials. And so how do you go from endplate potential to the whole thing? And there of course was a big problem because you get a contraction, you know the thing would jump off the electrodes. And so it is how you fit from the endplate potential selection and that's what we did to begin with: to look at different points. And then one saw, when you were at the endplate, you could actually see the endplate potential coming up, reaching a threshold about 14 millivolts, and depolarisation and action potential takes off to 135 millivolts or something, with the resting potential about 90 millivolts.

1950–52

JA: Can you tell us a little bit about your discovery of miniature endplate potentials?

PF: Katz initially saw them when he was working on the spindles; he saw some spontaneous activity which seemed very odd, where there were action potentials. We could tell there was some spontaneous activity going on in the muscle fibres and the spindle. Okay? But then we also noticed when we were at an endplate of a muscle fibre and turned up the amplification, I don't know how that happened or why that was done, except it didn't need much amplification to see the endplate potential going off into an action potential. They were little, little endplate potentials coming along and immediately we thought, Bernard Katz originally, that all this was linked to spontaneous fluctuation in the membrane potential. But then they were in an all-or-none form: they were nearly all of the same size. So it wasn't just thermal agitation. We thought, "Oh well, but thermal agitation might somehow excite cause this, not the endplate potential but the electrical activity of the muscle fibre." Then we would find that it only appeared at endplates. And also they were suppressed by curare, tubocurarine, and so it had to do with endplate activity. And then we measured them: oh, we tried to just sit on an endplate exactly and measure these things. And the rate of occurrence, the intervals between miniature endplate potentials, was then analysed. And Katz found someone in the Anatomy department (which was run by J. Z. Young) – his name was Scholes, or even Schole, I'm not sure exactly – who pointed out this was a Markov process in statistics. It's just like if you go to a bus stop and wait for buses, they are perfectly random. And the interval between buses passing, if they're perfectly random, would be a Markov process. And Katz then went ahead and analysed them and also looked at the heights of these miniature endplate potentials. There was a suspicion that some were too big and didn't fit, but nevertheless on the whole it was a Gaussian distribution. And what they were caused by, we just speculated; but perhaps it was acetylcholine bundled up in the endplate region.

JA: Did you think that as well? Or did you find yourself arguing against Katz's hypothesis?

PF: There was speculation. Yes, in fact I think we did look at electronmicrographs. There was somebody in the Anatomy department who did electronmicrographs for us at the endings, at the nerve endings. We did think about it. But something came out later that there were actually such things in the nerve ending.

1952–56

JA: What were the other projects, as well as the neuromuscular junction, that you were working on?

PF: One summer Katz and I were in Plymouth and Katz had given up with Hodgkin and Huxley, as I told you, and we looked at crab muscle, the neuromuscular junction, because the interest that there is that there is both excitation and inhibition. And so we worked, we had microelectrodes already and were putting microelectrodes in to see the effects of inhibition. And it turned out there were two ... well, there was one obvious effect, that stimulation of the excitatory fibres would produce something like an endplate potential. Then simultaneous stimulation of the inhibitory fibre would suppress that endplate potential. And it was clear that the nerve endings of the inhibitory fibres were releasing a substance that was then suppressing the action of the excitatory fibres: a presynaptic action. But then what we also did was to put in two electrodes and shifted the endplate, the resting potential, and then we found that in fact stimulating inhibitory fibres would cause a change in membrane potential either one way or another, bringing it back toward the initial resting potential, or close to it. So there are two effects of the inhibitory fibre. We continued this study on crayfish in London. We could easily get crayfish there alive. And they in fact were most convenient for doing excitation and inhibition. But the result showed that the inhibition was in fact acting in two ways, both presynaptically and postsynaptically.

Well anyway now we go on: Eccles came along. He had been in Dunedin after Katz, Kuffler and Eccles had been working in the Kanematsu Institute in Sydney. When that broke up, Kuffler went off to America, Katz went to London. Eccles went to New Zealand, Dunedin, and had a laboratory there. And then, oh I've forgotten, Macintyre, I think, and when he was invited, accepted the invitation to go to Canberra to set up a school there at the Australia National University. And the Physiology Department within the John Curtin School. And while he was in the process to moving from Dunedin to Canberra he came to London. And I thought, "I should now try Australia, something different." And maybe I was getting tired of this routine. I must say that's my big failing. Getting tired and bored; it was obvious which way it was going.

JA: But you'd submitted your PhD by then had you not?

PF: Oh I did my PhD some time before. Oh yes.

JA: So you were already a postdoc, essentially?

PF: Yes, I was already post doctorate, already run out of my GI Bill, so I was getting some support.

JA: So the MRC was paying your salary at that stage? Good.

PF: Oh yes. Because it was four years that I spent in London. So the first two years would have been under the GI Bill and then the MRC.

JA: So you left for Canberra at the end of '52, is that correct? Or '53?

PF: '52. I think it would have been the summer of '52. Well things tend to close down in the summer. Anyway I went on the Mauretania first class which had been paid for by the Australia National University. I'd never done anything like that before.

JA: First class flight or boat?

PF: By boat. On the Mauretania. It's the second Mauretania. The first one was sunk. Oh before this, in 1950, I did something else; I'm going backtracking now. Before this one summer, as I said people would leave, does it still happen that people leave in the summer?

JA: Not so much. People work the whole time now.

PF: And I went with Alan Goodman, oh various people as friends. One of them was my good friend was David Maurice who worked on the eye. Irving, my older brother, had contact with David Maurice. But David Maurice was at the Institute at Ophthalmology. He was a friend of Murdoch Willkie, sorry Murdoch Ritchie. And also working at the Institute of Ophthalmology in Judd Street was Alan Goodman. And I'd arranged for Alan Goodman to go to Arcachon which is a seaside place, the marine biological laboratory belonging to the University of Marseille. And then Alfred Fessard came there from the College de France and worked on torpedoes, the electric organ torpedoes, the salt-water electric fish. The idea was to look for the ions that were actually producing the endplate potential, since in the torpedo the electric current that it generates is in fact an endplate potential. And we worked on that and considered the possibility of chloride being the ion. It wasn't, in fact, from the work that Katz and I had done, sodium because you got it to reverse when shifting the membrane potential: you got reversal around the normal resting potential, not the sodium equilibrium potential, as you get with the normal action potential. And so we thought, "Oh, it must be some other ions; chloride is in great, large quantities there." And so he was a chemist and he could do chloride analysis and so he dissected electric organs. You had to be very careful not to be knocked off the stool when dissecting it.

JA: [laughs]

PF: It's a tremendous shock you can get from a torpedo.

JA: Yes.

PF: Have you ever worked on them?

JA: Never, no. With alarm; with alarm. [laughs]

PF: The organ is about the size of a hand; there's two of them.

JA: They are usually charged up by the time you get around to dissecting them, are they not?

PF: Yes. It's resting! It doesn't waste its electricity. There's a big endplate potential and I think we did produce a paper but it wasn't very good because in fact it would seem that it's a non-specific ion-exchange that produces it.

JA: I see, because all permeabilities were thought to be specific in some way at that stage, is that right? People hadn't thought about non-specific mechanisms.

PF: Well we found this for the action potential.

JA: I see.

- PF: We certainly thought about it, yup ... Okay so I'm going off to Australia on the Mauritania. In fact Goodman was along in steerage; God, I've forgotten where he was going to work. I also went to California to see my parents and brothers and then went up to, what's the city, in Canada ...? Vancouver, where I got a boat, the last of the passenger boats to cross over, a New Zealand Boat, and went to Sydney. It took 20 days stopping at I don't know, Suva in the Fijis, Auckland in New Zealand and then Sydney.
- JA: So two months later, two months after leaving London you got to Canberra? Pretty nice!
- PF: Travelling on the surface. No, but while I was on the way I would read reprints, I had a collection of reprints, all Eccles's reprints of course. And I had David Lloyd's reprints and Harry Grundfest's and all these people. And I got ideas from these reprints about ... actually, at this point there was this endless, endless argument about chemical or electrical transmission. Grundfest argued that the action potential was a chemical process controlled by acetylcholine. No memory of this, I don't suppose, in your mind? And Eccles in fact was in favour of chemical. No, no! He wanted electrical transmission in nerve endings. And there was this electrical versus chemical. Oh and then going across the States before I got to Los Angeles or to Vancouver, I visited David Lloyd and Grundfest and Gerard in Chicago, and at all of these people and collected reprints which during these 20 days on the Pacific I could study. So I got various ideas about, for instance, you have the monosynaptic the excitation of the motor neuron where there are particularly large fibres, the IA type sensory fibres in the dorsal route and excite motoneurons monosynaptically, they go straight onto the cell body in the whatever you call it ...
- JA: Ventral horn.
- PF: And then they also had the idea about inhibition: inhibition by inhibitory nerve fibres from the contralateral muscle that would in fact cause inhibition of the motor neuron firing. And they thought, "Oh, that was also monosynaptic because if it's stimulated simultaneously you could get the suppression of the action potential in the motor neuron." But I worked out that it wouldn't work: that it couldn't work that way. There had to be a delay in the inhibitory one. The logic of this now escapes me.
- JA: Now it's always been a mystery as to why the argument for electrical transmission has any water at all. What was it that really persuaded Eccles that transmission was electrical in the system?
- PF: Um ... well action potential is transmitted that way on the fibre. I don't know. I'm not sure now. I'd have to think about that point. And why did Grundfest insist that the transmission of action potential along a nerve fibre was chemical, that it was acetylcholine?!
- JA: [laughs]
- PF: And we have similar false ideas I should think. Anyway, so I was reading all this. And also there's the other thing: when you stimulate the ventral route you get various things happening which seem very, very odd, which was studied by Renshaw.
- JA: Right.
- PF: He died from infantile paralysis.
- JA: I didn't know that.

PF: At an early age.

JA: Really?

PF: So he wasn't around when I was travelling.

JA: So you were giving seminars about your work at each one of these places as you went through and then ...?

PF: In Chicago, yeah. I can't remember elsewhere. Again it was probably summer time and everybody was away. But I did meet quite a number of people.

JA: So ...

PF: So I sailed across the Pacific and came into Sydney. You know what arriving by boat in Sydney was like. When Captain Cook was sailing along there, he saw this, he went into, what you call the thing at the mouth of the bay? And then we went further on. And all he'd see was cliffs and cliffs all along the way. And so he never found the entrance to Sydney harbour.

JA: [laughs]

PF: It's so narrow. And you think you're sailing into these cliffs and there's a little gap going into Sydney.

JA: Magic.

PF: Botany Bay. That's where Captain Cook landed and thought, "Oh yes, this is Australia."

JA: Very good.

PF: But he missed Sydney Harbour. Anyway so I arrived, there and very, very quickly went down, flew, probably did fly then or maybe not, there were trains running, would have taken the train down to Canberra. There they were just building the lab, putting it all together. And I think at that point I just, I bought a car, an ancient Vauxhall, one that had been last to be built before the war, 1940 Vauxhall, and drove down. In fact I went down to the coast from Cooma and it was sometimes difficult to find the road, to distinguish it from the river bed, so I'd be driving along and it turns out to just be a river bed I'm driving on. So at that time the road tended to disappear in heavy rain, which only happened once in several years. I went down to the coast and up along the coast to Nowra and I told you there I saw all sorts of people, and looked at the animals and then went back to Canberra, got going ...

JA: So there was a pause of about what, another three to four months or something?

PF: No, I don't think it was long. A few weeks.

JA: Did you find Eccles and easy man to work with?

PF: He was one that was just be shouting (you've met him); he's really loud and he would shout at me abuse and then I would laugh at him and he would laugh too, understand. But he had other people who were frightened of him. Coombes, who would build the electronic equipment. But no, I actually had no trouble with him, but he could be very, very difficult [...] And insisted, determined and would say "Oh yes yes yes", that was a common thing. He

was so insistent and argued with you against something. And the next day he'd come along and present your story.

JA: [...] How interesting.

PF: He was not aware of it, totally unaware of it. It happened several times. That was Eccles. But his daughter as also in the department. Actually he had nine children.

JA: Goodness.

PF: Anyway I don't go into personal things.

JA: So was this the first time you had worked on whole animals, done whole animal experiments, I suppose. Is that right?

PF: Yeah.

JA: And at that stage there was no difficulty in moving to another animal?

PF: But it's still what you had to do on a frog. You have to pith it and dissect it so you were working on a whole animal in that process. You have a lobster, crayfish, you have to take the leg off and hope it doesn't hurt too much.

JA: So were you the person, did you do all the preparatory work for that as well or was that Eccles?

PF: Arthur Chapman. He was amazing.

JA: Yeah.

PF: He was the technician. And the cats, we worked on cats; and the cats were feral animals that were caught in cages out in the bush. They were just outside of Canberra, I suppose, or in the city. They had cages with a trap door that only a cat would go in to get a piece of meat or a mouse that we had in there, and it got caught and brought in the cage into the lab. And then Chapman had to deal with it, Arthur Chapman. And he had been in Birmingham in the Salvation Army. He would still play this, it was some big instrument, a big brass instrument, and somehow, what he did depended on what he could do because of his Salvation Army duties. And yet he had time to play his big brass instrument.

JA: In the lab?

PF: No, no, he'd didn't play in the lab. But when he got an animal in the cage, it was delivered to him in the cage. You couldn't open the cage because these were really fierce animals. These are cats that are just wild. Actually I'm surprised they hadn't exterminated all the other animals. Anyway, so he would poke it with a syringe while it's in the cage, so right through the cage bars, and anaesthetize it and bring it out and prepare it. But not the final dissection. I think Eccles would do that, yeah.

1956–64

JA: Right. So the work you were doing in Canberra concerned inhibition in motor neurons.

PF: And excitation of motor neurons, the motor neuron, in fact. And that was I think quite useful work: excitation and inhibition of the motor neuron. At one point, actually I started

before I left, Katz was away in America and in Europe as well and I found that I could excite a single motor neuron from the ventral root and I plotted out the electrical field around that single motor neuron. It was excitation and inhibition in the motor neurons.

JA: There were several papers that came out of your time in Canberra, and I'd say each one was pretty key in determining the future of the field.

PF: We thought that there must be something from the Renshaw cell, which must be a small cell since once couldn't get into it but at the same time [we were] aware of its presence nearby.

JA: Yeah.

PF: They're also the same is true of the interneuron which must lie on the inhibitory pathway.

JA: So how long did you spend in Canberra altogether?

PF: Another four years, as from '48 to '52. I think so. That was '52 ...

JA: To '56.

PF: And again I felt I wanted to move. You know I think probably it's true that I get a little bit oppressed with these very powerful men.

JA: So were you offered a job back in London at that stage?

PF: Yeah.

JA: And you jumped at it?

PF: Yeah. Well I was, it wasn't just that, I was expecting to go back all the time. I must have written to Katz telling him that I'd come back.

JA: And how did you choose the next project you wanted to work on?

PF: Well there were various things, very odd things which probably nobody else had ever followed up. Well Katz was expecting me to continue on the motor neurons in the cats, but I thought I couldn't quite organise it all. It would require quite a good organisation and I thought I'd better work on my own. So there were a number of things. Well, I looked at frog muscle, and Kenneth Cole had studied the impedance of the muscle, our X vs. R, imaginary against real part of the impedance at different frequencies, and you could see differences, the circuitry of the muscle, the membrane interior. And I found there seemed to be two channels in this, one of them would have been current core flow. Oh yes, the other thing that Katz and I found in the frog muscle was the capacitance of the membrane was so large. The capacitance of the membrane is expected to be like 2 microfarads per square centimetre. And here were getting 7, 8, 9, 10 microfarads per square centimetre. It just seemed too large for a membrane of that type, a thin membrane. And so I thought, "Well, some of this must be due to the mechanism, channel by which the contractility occurs," because in fact at the time one would just say, "Oh you get contraction of the muscle fibre when it's depolarised." Well that's nonsense because you affect the interior and you can't just change the membrane potential at the surface and not have anything in the interior. There has to be a channel whereby current will flow down into the interior.

JA: Had you seen Andrew Huxley's movies of contractions at that stage?

PF: No. I thought at the time it's probably some protein, electronic conduction by a protein. So I looked at the impedance by having a sartorius muscle between two large electrodes and looking at the impedance, the way the current flows across it at different frequencies and there I saw two parts to this impedance. I thought: well one is a core response with 2 microfarads per square centimetre and the other much larger. The other one I thought would be electronic conduction by protein at the interior. Huxley had the idea about tubes. In fact I thought tubes would be so tiny they couldn't possibly carry anything.

JA: Was there electron microscopy that was helpful at the time or not really?

PF: There was evidence from ordinary microscopy, the name of the man I've forgotten, published many, many years ago seeing all these different things: the Z lines all along the fibres, the fibrils.

JA: I see.

PF: So anyway I worked on that for a while, it didn't lead anywhere, except that I published something, and then I also worked on, oh yes, yeah, I wanted to be able to excite tissue without getting near it. I forget now what that was about. But anyway I came to the idea of studying photoreceptors, the outer segment, which you can excite at a distance and see how its impedance changed, which I was doing. And again with large electrodes and just sedimenting the outer segments between them. And looking at the impedance and how it would change on flashing a light and I found several, well at least two, components to it.

JA: Why did you choose photoreceptors? Were you having, did the topic of sensory cells come up in conversation with anybody else?

PF: I liked the idea of being able to excite something from a distance with the light. And some other things like that. There was a bit of microscopy; and electron microscopy. Somehow as it has become more recent I have less of a memory of them. Maybe they're less memorable.

JA: So if you look back at the range of different topics that you've been working on, which one now still excites you and gives you the most pleasure to think about?

PF: Probably my work with Bernard Katz. I would say the miniature endplate potentials. Although [perhaps] the endplate potential, leading to the action potential before that ... even the earliest things. Because somehow one's ideas were so uncertain at that point. So uncertain. Endplate potentials had been seen after treating muscles with curare to suppress the action potential. In fact what we were doing was suppressing endplate potentials that wouldn't reach threshold. And even the idea of resting potential was rather vague. And so the work cleared a way.

JA: Very good.

PF: They were interesting times then. 1948 was an interesting time. Hodgkin and Huxley got working on the squid axon, Katz and I were working on the endplate. They were interesting times. Even though London was smoky and there were food stamps (they made everybody stressed for their five shillings you know!).

JA: Marvellous. Paul Fatt, thank you very much indeed. Wonderful, wonderful discussion.

PF: Thank you.



Paul Fatt photographed by Martin Rosenberg at UCL in 1979.



The Biophysics Department, University College London, about 1963, photographed by Audrey Paintin (who is also in the photo) and identified by Sally Page. Standing, from left: Audrey Paintin (technical), Mary Keenan (PhD student with Rolf Niedergerke), Mrs White (cleaner), Keith Copeland (electronics), Radan Beranek, John? (Keith Copeland's assistant), Sidney Ochs, Clarke Slater (Ricardo's PhD student), Zann Murphy (secretary), Dick Orkand, Mary Windley (EM, photographic technician), Paul Fatt, Bob Eisenberg (Paul Fatt's student), Sally Page, Gertrude Falk. Sitting from left: Ricardo Mileti, E. J. Harris, Parkie (Parkinson, superintendant), Bernard Katz, A. V. Hill.



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