

## FRIDAY MORNING SESSION

October 6, 1967

BRUES: Dr. Donaldson, you have us at your mercy!

DONALDSON: Mr. Chairman, Ladies and Gentlemen:

This morning we should be able to have free run of our scientific acumen plus the widest breadth of our imagination, for if we are to talk about the environment and man's relationship to his environment in the field of ecology, I'm sure we all have very specific comments and very specific opinions about how man relates to his environment.

In the area of weapons testing, I'm sure we have an equal number of opinions of the effect of the weapons testing upon man and his environment. I took our convener at his word specifically that we were not to write speeches; we weren't to deliver orations, but after 41 years as a schoolteacher I'm specifically tempted by almost heritage, for my mother and my grandfather were also schoolteachers, to deliver that morning lecture that should come 22 minutes from now on normal schedule.

FREMONT-SMITH: We have 30 years of interrupting practice! [Laughter] We expect to challenge your 47 years.

DONALDSON: Looking around, there are many schoolteachers I notice in this gathering. So I'm sure they will use the professor's prerogative to interrupt at any occasion.

Well, to more or less set the scene, I should like to, with your permission, somewhat limit the parts of the world we are going to talk about.

If you will just turn on the first slide, please.

[Slides] Well, each of us again have our own immediate interpretation of what we think of as environmental contamination. I think if we go back to the source area for many of our problems we would go to the Hanford work or to the Oak Ridge establishment and eventually to the Savannah

1 River area where materials are fabricated. We have learned  
2 to live with radiation in these areas and in the environment  
3 we have learned a great deal.

4 Then we could jump to the Japanese side, as we have  
5 in preceding sessions talked about the Nagasaki, Hiroshima,  
6 and on the mainland of Japan the experiences there or drop  
7 down to the Marshall Islands and concentrate on Rongelap  
8 and the fallout problems there, as we did in part yesterday;  
9 or to Bikini, to Eniwetok. But with a few jumps I would like  
10 to include some of the other areas in our discussion this  
11 morning to give those of you who have worked in other areas  
12 a chance to participate and to bring in some special problems  
13 at Johnson Island where we have some of your usual type of  
14 problems because of an accident that occurred that is not  
15 discussed usually but one that I think is germane to our  
16 operations here and to the Christmas Island area with yet  
17 another and even included the northernmost tip of the North  
18 American continent up at the Chariot site where Dr. Wolfe  
19 and his associates have gathered a good deal of both actual  
20 and projected information on this problem of environmental  
21 contamination. I did not include here the Amchitka area and  
22 the Aleutians where many of you are aware there have been some  
23 atomic detonations and they are preparing for one at the  
24 present time.

25 Well, this presents a very big order in itself. It  
26 includes about 50 per cent of the earth's surface and in a  
27 very unusual environment. I think it would be well if we  
28 could put some input on the British tests of 1952 and subse-  
29 quent years particularly one off the Great Barrier Reef which  
30 is germane to our discussions here and a word or two possibly  
31 about the Russian tests. The Chinese tests were mentioned  
32 yesterday. For some reason--I don't know whether it's policy  
33 or not--the French tests in the Pacific and in the Sahara

1 were not included in any of the conversations nor was there  
2 any comment. I guess this may be omission by purpose but  
3 it's not for me to decide in this case.

4 FREMONT-SMITH: There's no known policy behind that  
5 omission.

6 DONALDSON: Thank you. I think it's important we  
7 do consider them in the over-all problem of environment,  
8 particularly as far as the Pacific Ocean is concerned.

9 To be a bit more definitive as to locale and  
10 orders of magnitude, may we just by contrast superimpose  
11 the scale map of the United States over the area that we  
12 will concentrate on, I hope, and talk about the Pacific test-  
13 ing center with Johnson Island, Christmas Island and Bikini  
14 and the Eniwetok areas in this instance.

15 UPTON: Is that a Mercator projection?

16 DONALDSON: Yes.

17 FREMONT-SMITH: Be sure we get that in the volume.  
18 I've never seen this before and I think it's very striking.

19 DONALDSON: I think this is one to one, but I'll be  
20 very happy to leave the slide with you if you wish it.

21 Specifically again if we may just review our natural  
22 history for a moment, atolls are most unusual structures. I  
23 like the statement that you'll find in "The Voyage of the  
24 Beagle" and other of Darwin's writings, that no biologist  
25 can be really considered a qualified biologist unless he  
26 has lived and worked in a coral atoll. They are very unique  
27 biological entities, and I'm sure those of you who have worked  
28 at Bikini and Eniwetok or the other atolls probably have  
29 cussed them or enjoyed them as your temperaments would  
30 dictate your own behavior pattern.

31 There are atolls that are dead atolls, such as  
32 Christmas Island where the growth is not quite equaling the  
33 sloughing of the atoll. There's a great deal of scientific

1 discussion as to how the atolls were formed. There was an  
2 almost complete lack of understanding of the formation of  
3 atolls before the Pacific tests were initiated. I recall  
4 that the geologists in the group were convinced, and in some  
5 of the lectures on the HAVEN that were held under Dr. Warren's  
6 supervision, they told us that the coral was about 180 feet  
7 thick. This was so because during the formation of the  
8 atolls the water had receded to about that level and so the  
9 coral can only grow in the upper layers of water. So there  
10 would just be a little cap. And there were many discussions  
11 as to the possibility of blowing this cap off the top of the  
12 mountain that the coral was superimposed upon.

13 These discussion went round and round, Dr. Warren,  
14 you recall, during the voyage of the HAVEN out to the test  
15 ground and we listened very intimately and in subsequent  
16 expeditions out there it was possible to drill in the atolls  
17 to see how thick the coral might be. In the 1947 expedition,  
18 particularly, the drilling was geared to go down as much as  
19 possibly 1000 feet into the base. But each morning when the  
20 assembled group would go out to drill we would ask them how  
21 they were coming. "When you're down to 100 feet you ought to  
22 be striking base rock the next day."

23 "Yes."

24 "Then we'll be able to tell how old it is. You'll  
25 be able to tell how old it is because geology is an exact  
26 science."

27 FREMONT-SMITH: You remember I mentioned the half-  
28 life of facts are getting shorter and shorter.

29 DONALDSON: Yes.

30 FREMONT-SMITH: I'm glad to have it illustrated.  
31 Go to it!

32 DONALDSON: The next day they may be down 200 feet,  
33 350 feet, 400 feet, 500 feet, 600 feet, 700 feet and they were quite

1 convinced they were in a hole and they had to change their  
2 estimation about the thickness of the coral, which meant some  
3 change about the age of the earth, which meant some change of  
4 their concept about how the moon was formed.

5           FREMONT-SMITH: And that includes the tides.

6           DONALDSON: Yes! [Laughter] And this went on until  
7 they finally reached a fantastic depth of about 1200 feet  
8 and they still hadn't found out how old the earth was nor how  
9 thick the coral cap might be. By this time we were running  
10 out of food and we were running out of drinking liquor, which  
11 everybody worried about because the supply vessels were bring-  
12 ing mud to grease this hole that they were drilling down into  
13 the atoll.

14           The following year they moved over to Eniwetok and  
15 began to drill there and the element drilling went down to a  
16 total of some 4300 feet before they came to the basal strata  
17 on which the coral was anchored.

18           FREMONT-SMITH: They did find it there?

19           DONALDSON: Yes. They actually found that there was  
20 a bottom to this boundless pile of calcium carbonate.

21           The illustration I hope is not wasted. But it's  
22 indicative of some of the needs to know in the natural environ-  
23 ment in which we are working. The seas and the atolls within  
24 the seas are so imperfectly known that we sometimes find such  
25 great gaps in our thinking because we don't have the physical  
26 and biological parameters upon which to work. Like the state-  
27 ment of the Senior Senator from our State who repeatedly has  
28 made the statement that we know a great deal more about the  
29 back side of the moon than we do about the oceans that cover  
30 72 per cent of the earth's surface. Well, with this as a  
31 background maybe we can be a bit more specific in the things  
32 that we are going to be talking about.

33           The tests were conducted, as I mentioned, at these

1 various atolls and we may take a quick look at, starting in  
2 1946, and not 1947, as in the statement in your first volume.

3 FREMONT-SMITH: 1946 is right.

4 DONALDSON: 1946 is the correct one, not 1947.

5 But we may take a quick look at Eniwetok on the next slide,  
6 please.

7 The atolls were selected, according to the Task  
8 Force reports, because they presented an ideal environment  
9 in which to work. Of course, they were isolated; they were  
10 in relatively favorable weather areas and they did provide  
11 a safe anchorage for the fleet and probably equally important  
12 there were a number of outposts upon which instrumentation  
13 might be based.

14 As far as we who were interested in the environ-  
15 mental sciences, they were quite ideal because they did  
16 provide a native flora and fauna that gave us a good cross-  
17 section of what we might expect. Now, you see these tiny  
18 little islets each with a peculiar environment quite its own,  
19 as the entire atoll type of environment is peculiar.

20 The land emerging area, about three square miles  
21 in each of the atolls, divided up into some 20 little islands  
22 in each atoll. The land plants, the fauna, is relatively  
23 limited. It's limited to those forms that can survive in a  
24 tropical environment that is subjected to wide temperature  
25 and salinity variations. The land and animals are limited to  
26 one group of mammals divided into three species of rats that  
27 were introduced apparently at the time that the native  
28 people came there. The birds are limited only to those  
29 aquatic birds that can fly long distances. Insects, there's  
30 one amphibian and one introduced, a reptile.

31 On the contrary, the marine fauna and flora is extreme-  
32 ly diverse. There are about 700 species of fish in contrast  
33 to Puget Sound where I work in my normal activity. There

1 are about 50 to 70 species of fish, probably tenfold as many  
2 species of fish. The same is true with the algae groups of  
3 great diversity and, of course, then the corals are something  
4 unique to this part. One might go through the other biological  
5 cal forms.

6 UPTON: To what extent do you think the limit in  
7 number of species in Puget Sound may have resulted from the  
8 effects of man on that basin?

9 DONALDSON: Well, these are forms that were native  
10 there. We have introduced some forms there. There are no  
11 species that have been exterminated in Puget Sound. All the  
12 native forms are there.

13 UPTON: I see.

14 DONALDSON: Well, added to the complexity of the  
15 environment and the great distances, we have a great diversity  
16 of energy releases and the types of releases. Just to review  
17 rather quickly, there have been 59 detonations at this test  
18 site. They vary in size from the normal device that we've  
19 talked about, some 20,000 tons of T.N.T. on up to, well, a  
20 statement was made it might have been 11, 12 megatons. That  
21 is the March 1st test of 1954.

22 These devices have varied from rather primitive ones  
23 by present standards to some very sophisticated ones by the  
24 measurements on up to 1958. They were detonated under a  
25 great variety of conditions and this is germane to the subject  
26 we're talking about; from under water to high in the skies,  
27 from tower tests to tests in barges sitting on the water.  
28 This means that fission products varied not only in quantity  
29 and some in composition but the induced radiation varied very  
30 fantastically in quantity and composition. So the numbers  
31 and amounts of radioactive nucleides introduced into the en-  
32 vironment runs almost the entire gamut of possibility. Stafford Warr.  
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33 Now to try to evaluate in this weird and wonderful 2

1 environment, to try to evaluate the impact of the detonations  
2 upon the biota presented a task that would stretch the imagi-  
3 nation, I guess, of most of us, at least it stretched ours.

4 We tried to determine--and I'll enumerate these  
5 rather quickly and then get on with the discussion aspects--  
6 the amount and kind of radioactivity released into the environ-  
7 ment quite obviously is one of the important things, but I  
8 would call your attention to the primitive nature of the  
9 instruments and the evaluation techniques that were avail-  
10 able particularly during the early years. We are inclined to  
11 think in terms of what's available today rather than what  
12 was available in the hectic 1943 up to 1946 and even in sub-  
13 sequent years as we went along. I recall that we used to buy  
14 a scaler, an old Victory scaler from some of Dr. Warren's  
15 people and we would chop off a piece of fish tissue or some  
16 algae and push it in and if we went off scale we would say,  
17 "Well, there must be some radiation there. Throw it away  
18 and push in the next one." So it was essentially a presence  
19 or absence situation in the some of the instances. There was  
20 either some radiation or there wasn't. But I would have to  
21 qualify my statement as to the amounts and kinds of radio-  
22 activity which came somewhat later in the entire series.

23 We were particularly interested in the radar uptake  
24 particularly by biological systems and this again was depen-  
25 dent upon good instrumentation that wasn't available during  
26 the early years. We were interested in the amount and kinds  
27 of radiation within various systems; the selection and the  
28 concentration, and this becomes germane when we begin to talk  
29 about permissible levels because we have selective concentra-  
30 tion. Some of the algae groups will take out one entity,  
31 for example, which will pick out iodine with tacticability  
32 to concentrate into the orders of magnitude of a millionfold  
33 for short periods of time. These blotting techniques then

1 are very germane to over-all evaluation because this clerpa  
2 or this algae is eaten by some of the fishes and the fishes  
3 in turn then will pick up the iodine, and the most specific  
4 radiation damage that has been measured in direct measurement  
5 have been the destruction of the thyroid in some of the algae-  
6 eating fishes. We were interested in the metabolic transfer  
7 and the---

8 DUNHAM: May I interrupt and ask you what kind of  
9 stable content this does have normally?

10 DONALDSON: It has so much that we would not eat it  
11 because it has a bitter iodine taste. It's red.

12 DUNHAM: Does it have a high iodine requirement  
13 for survival?

14 DONALDSON: I don't know the physiology of it.

15 DUNHAM: When you say it concentrates perhaps a  
16 millionfold, you mean compared to the concentration of radio-  
17 iodine in the water?

18 DONALDSON: Yes.

19 UPTON: Rapid iodine turnover in this organism?

20 DONALDSON: I rather doubt it. I think it probably  
21 is always at a relatively high level and the limiting factor  
22 may be amounts of iodine available to it.

23 UPTON: Is it a rapidly growing plant?

24 DONALDSON: Yes. It grows rather rapidly.

25 UPTON: So that it's building a new cell and build-  
26 ing in new iodine.

27 DONALDSON: Yes.

28 WOLFE: We have in Canada an algae in the Aegean  
29 Cara in the river which have very large amounts. Yet it  
30 could be taken into the water except for sophisticated  
31 techniques and we analyzed the coral for manganese and found  
32 that 20 per cent of the ash was manganese.

33 DONALDSON: I think the specific concentrations

1 are really germane to this sort of discussion because we  
2 base our interpretations on the familiar and forget to realize  
3 that in nature there are a wide variety of spectra of uptake.

4 We were also interested in the rate of transfer  
5 and elimination. In the discussion yesterday Dr. Warren  
6 mentioned the uptake on the side of the ships, but if you re-  
7 call, these ships were always upwind from the detonation and  
8 so the question would be how did the radionuclides that  
9 would normally drift downwind work their way upwind and come  
10 up underneath the ships and be attached to the ships? So  
11 these are problems of interest.

12 We were interested in the disposal out into the  
13 open ocean, and one of the intriguing things was the more or  
14 less breathing of the atoll. Of course, the nature of the  
15 atoll allowed the constant thrusting out to the open sea.  
16 There are other interesting transfers that we will be talking  
17 about, I hope, as we go along.

18 The usual transfer in our terrestrial area is from  
19 the land to the sea, but in these atolls there is a very  
20 appreciable transfer from the sea back to the land or the  
21 limited terrestrial area, which comes from a variety of ways:  
22 by transfer from spray into the vegetation, and we find that  
23 this is a very positive transfer. This occurred in Japan to  
24 some extent, for those of you who followed the movement up  
25 on to the terrestrial area there. As a matter of fact, spray  
26 along the coast from the downwind drift was transferred up  
27 onto the land there.

28 In the atolls the more specific ocean-to-shore  
29 transfer is carried on by aquatic birds and this is very  
30 complicating, a very complicated thing in the evaluation, for  
31 the birds to transfer back on shore and upset the nice  
32 spectral establishment that one would establish when the  
33 first fallout comes. You have this group of nucleides;

1 you wish to follow them and then suddenly or gradually there  
2 is an overlay of others that have been selected out of the  
3 sea by selective concentration in an uphill migration.  
4 These further complicate but add a spice of interest to the  
5 evaluations that go on.

6 Then, I guess most specifically we are all inter-  
7 ested in the amount and kind of radionuclides concentrated  
8 by various tissues. In making evaluations, we are always  
9 hard pressed to sort out the various parameters that are in-  
10 volved. We have the overlay of a blast effect and fire and  
11 radiation intermingled especially in the closed-in areas,  
12 and, if I may, I would like to use an illustration or two  
13 to point this out. May I have the next one, please.

14 Let's just take a quick look at what I think is  
15 one of my favorite photographs. This was made under rather  
16 unusual circumstances possibly, but since we do not rate  
17 sufficiently high on the Task group priority list who have  
18 the luxury of a photographic plane and we do occasionally  
19 travel--we did in the early days--by the older PBYS, and  
20 those of you who remember those old flying boats, you re-  
21 member that they usually didn't have the usual facilities  
22 that are now found on modern planes but did have a place in  
23 the back that they called an air-flush toilet and by flipping  
24 up the lid of that you had a place to take a photograph!  
25 [Laughter] This may be a bit unusual.

26 May I have the next one, please. Let me use this  
27 as an illustration of the type of proposed thing one might  
28 use to document some of the things that I've been talking  
29 about. We, like the rest of you, tried to be very exact in  
30 our planning. We planned very carefully to document the  
31 distribution of radionuclides in this great mass of moving  
32 water, a 3-dimensional plot. In order to do that we have  
33 to occupy various stations in some logical sequence. So

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1 I drew these nice plots of the way we should do this sort  
 2 of documentation. We will start over here at the point  
 3 near A, A-1, and we will make these zigzags on this sort of  
 4 a track, cutting back and we'll finish up some weeks later  
 5 over here at a point E-10. Everything is very nicely in  
 6 order now. May I have the next one, please. This is the way  
 7 it eventuates! [Laughter] We started, we went along very  
 8 well, everything was going pretty much on course except the  
 9 problem of doing oceanographic work from a destroyer has its  
 10 own problems. But when we first started out we asked the  
 11 skipper, in case the WALTON, to let us go 50 miles this way  
 12 and then we'll stop. "Stop? I don't know how to stop. I've  
 13 never stopped this in the sea. What will happen if I lie  
 14 there? [Laughter] You can't put this group of wire lines  
 15 and rope lines over the side. You may get them caught up in  
 16 the propeller if we stop." Then he decided to stop. Then  
 17 after he stopped he drifted some and then he quite lost his  
 18 course and he couldn't quite go back on course again.

19 If you just turn it off for one minute, do you have  
 20 room for one story?

21 FREMONT-SMITH: At least. One and a half! [Laughter]

22 DONALDSON: This problem of navigation really sur-  
 23 prised me out there. It becomes almost--Bob, you have lived  
 24 with it for years, but it's so much better now than it was in  
 25 the early days.

26 In 1948 when we were out there all by ourselves,  
 27 all nice and lonely, we had one little ship that had no way of  
 28 producing water. So very helpfully the Navy would send us a  
 29 ship every four weeks with a new supply of water. The water  
 30 would get pretty stale and they would bring us some food and  
 31 some mail. But on the back of this little supply ship was a  
 32 little box and in this box lived six Marshallese boys. And I  
 33 asked the skipper of this ship, "Why do you have these

1 Marshallese boys on this box in the back of the ship?"  
2 Actually it was a little cover on deck where they lived. And  
3 he said, "Those are my navigators!" [Laughter]  
4 "Well, you have all the modern equipment." He  
5 said, "Oh, we have a compass and the sextant and the usual  
6 things but we don't have radar and any of the sophisticated  
7 equipment on this little ship." He said, "I couldn't just  
8 do without these boys to do the navigating."

9 CONARD: Did they stick maps?

10 DONALDSON: No, they just used their own intuition  
11 in this case.

12 FREMONT-SMITH: And their ears.

13 DONALDSON: Yes, and their ears and their eyes and  
14 their built-in compass. The story that he told seemed per-  
15 fectly fantastic, so fantastic that it's worth repeating be-  
16 cause it's incredible, as Wright was saying yesterday.

17 It seems that when he first arrived there to this  
18 command, he was asked to take this ship from Kwajalein to the  
19 Atoll of Wotje. Wotje is east of Kwajalein 200 miles. Some  
20 of you who were out there in the war remember it was the place  
21 they used to have the milk run. They would go out and bomb  
22 it every day. So he set out from Wotje. His Executive Of-  
23 ficer also was new, they plotted their course--just two of-  
24 ficers aboard this little boat--and they plotted their course  
25 and when they arrived just where they thought they should be,  
26 there was the great big Pacific Ocean. So they looked around  
27 and, well, they talked to the sailors a while and the sailors  
28 were very reserved, of course, as sailors would be. This is  
29 the new Exec and the new skipper and they don't want to com-  
30 mit themselves. So they said, "Well, we'd better plot it  
31 again." So they plotted again and they came out with this  
32 point and they were in the big Pacific Ocean. Now, in all  
33 fairness to them, atolls are very difficult to spot. They

1 stick up, atolls of about eight feet with palm trees mixed  
2 in the haze and the waves, and they're very difficult to spot.  
3 So they couldn't see it. They weren't close enough even to  
4 see it. So finally one of the sailors said, "I suggest you  
5 ask the Marshallese boys." Whereupon he says, "I'm a graduate  
6 of Annapolis. I know how to navigate a ship," and his back  
7 went up. But finally in desperation he said, "Well, do you  
8 fellows know where Wotje is?" And again this is typical of  
9 their behavior, never a direct response. "We'll think about  
10 it for a while"; and this is a lesson some of the rest of us  
11 might learn. Rather than blurt out a quick reply, "Why, let's  
12 think about it for a moment."

13 So they had a little huddle; they walked around the  
14 edge of the ship; they looked in the water; they looked off  
15 at the sky and they had another consultation and they said  
16 "Wotje that way [indicating]." This was a real big help. At  
17 least he knew the direction to go! [Laughter]. He thought  
18 maybe this fellow is so damned smart, maybe I could ask him  
19 another question. So he said, "How far is it to Wotje?" Well,  
20 another consultation, another walk around the ship and another  
21 huddle and "Wotje ,40 more miles."

22 "Well, we're lost. We might as well try this." So  
23 he said, "Sail that way 40 miles." They went into the harbor  
24 and dropped the anchor and everything was lovely and he began  
25 to think about this. So he gathered them together again and  
26 he said, "How did you know where Wotje was?"

27 "Oh!" This was a very serious problem. So another  
28 huddle, and another bit of discussion and then the great  
29 announcement: "Wotje always right here!" [Laughter]

30 FREMONT-SMITH: I think I have to give another aspect  
31 of this same story because as I was coming back from Bikini  
32 I was on a plane with a Navy captain who told me a very  
33 similar story.

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1                   They were in the fog trying to get into the entrance  
2                   to an atoll--and I've forgotten which one; it may have been  
3                   Kwajalein; I don't think so. And the navigator was navigating  
4                   and they had a native on the bridge and the native said to  
5                   the skipper, "I think you've gone past the entrance," and the  
6                   skipper turned to the navigator and the navigator said, "No."  
7                   And so then they tried to get in and found they were up  
8                   against the sand. And they went on and they came back again  
9                   and then the native told them just where the entrance was and  
10                  they went in there and he was right. So the man I was with,  
11                  the captain, said that he spoke to the native and said, "How  
12                  did you know?" And he said, "I could tell by the sound of the  
13                  waves." And you probably know this very well, the winds pro-  
14                  vide waves that hit the atoll which then have a backwash  
15                  that flows a way out from the atoll and these make a per-  
16                  fectly steady lap, lap, lap on the side of the ship. And when  
17                  you come to the break where the entrance is, there is a shift  
18                  in the sound because the waves differ. And the captain told  
19                  me that this was so fascinating to him that the next day he  
20                  flew over the atoll and, by jingo, you could see these waves  
21                  flowing out in circles and the break in the waves at the point  
22                  of the entrance.

23                   Does this fit in with your experience?

24                   DONALDSON: Yes.

25                   FREMONT-SMITH: But I like your story better!

26                   [Laughter] "It's always right here" is the best thing I've  
27                   ever heard.

28                   DONALDSON: Then in addition to the problem of living  
29                   and organizing, may we just take a look at another illustra-  
30                   tion or two and then we can get on to the particular problem.

31                   In the detonation, of course, we have produced some  
32                   blast, some fire and some radiation. Now, the next one,  
33                   please.

1 EISENBUD: Which detonation was this?

2 DONALDSON: We weren't supposed to say that, but  
3 it's Okinawa.

4 This is going to go this way or that way. It will  
5 carry you off in some manner that the meteorologists always  
6 are very exact in determining the direct way it is going to  
7 go. Sometimes they are right. And then it will leave a trail  
8 across the lagoon or into the sea that one may be able to  
9 find or not find.

10 Now if we may see the next one, please. This on the  
11 islets will produce various and sundry effects. It will knock  
12 some palm trees over, break them off and you can say, "Yes,  
13 the blast pressure was such," and here you can make a very  
14 direct measurement of the amount of blast it takes to knock  
15 a palm tree over. Well, it's a very appreciable amount of  
16 energy. Palm trees are made to resist winds of almost hurri-  
17 cane force.

18 The next one, please. Then it will take a certain  
19 amount of energy, thermal energy to burn the leaves and one  
20 can make some rather exact complications here of the amount  
21 of thermal energy that was produced at X number of miles. And  
22 here you see the leaves are burned and you can make this  
23 measurement very directly.

24 The next one, please. Then there are the other ef-  
25 fects on the animal populations. The aquatic birds are in  
26 fair number in the atolls although the speciation is limited,  
27 as I mentioned, and one can make some measurements here. We  
28 see these birds are flying around very nicely and they seem  
29 to be all right. So nothing happened to them.

30 The next one, please. This little fellow forgot to  
31 take off when the rest of them flew. So we'll take a look  
32 at him a little closer.

33 Now, if we can go back to the next one. So I'm going

1 to try to sneak up on him and see if we can catch him since  
2 he doesn't fly very well and it's obvious that he has some  
3 particular problem. So we'll take a closer look at this one.

4 Next, please. Well, he was pointed the right way,  
5 I guess, as he should have been, for he was looking away from  
6 the blast and he had gotten his tail feathers singed and some  
7 of the primary wing fins or feathers have been burned. He's  
8 in about the same shape, the same problem as a ship without  
9 a rudder. So we'll put him down and go back and go to the  
10 club for a while and come back the next day.

11 So we come back the next day and here are numbers  
12 of dead birds on the beach. Well now, the logical assumption,  
13 I guess that one makes is that, well, these birds must have  
14 died from radiation damage. They were all right yesterday,  
15 at least they were alive. So we assume that they died from  
16 radiation damage. We have a look. We examined them very  
17 closely. We tried to measure this, measure that, do the best  
18 autopsy we could and find little or no radiation or they are  
19 too far away for any neutron flux. So why did they die? This  
20 is the question you have to answer.

21 In our report we would just write a simple thing. We  
22 would just say they died of radiation. Then we have to draw  
23 upon a little bit more background. We have to draw upon the  
24 natural history of these beasts. We have to realize that  
25 there's no water on the island for them to drink. If there's  
26 no water on the island they don't drink it. They get their  
27 moisture from their food, their food being the fish in the  
28 sea.

29 Well, the salinity of the fish in the sea is the same  
30 as yours and mine and it's about 75/100 of 1 per cent, and  
31 by getting the moisture from the sea they're able to maintain  
32 their moisture balance if they feed. But if they don't feed,  
33 they can't maintain their moisture balance. So they die of

1 desiccation. So these birds died of desiccation? No, they  
2 died from thermal burns because they burned their "rudder"  
3 off and they weren't able to fly. So you can by elimination  
4 sometimes arrive at a reasonable solution of things that  
5 are happening.

6 Now, if I may have just another minute or two.

7 CONARD: Did those birds die in one day?

8 DONALDSON: Yes. These pictures were made on sub-  
9 sequent days.

10 CONARD: It seems like it's a pretty quick death.

11 DONALDSON: But it's terribly hot.

12 FREMONT-SMITH: They dried out fast.

13 DUNHAM: Did you decide these fish died from desic-  
14 cation or from thermal burns? I wasn't clear what your con-  
15 clusion was.

16 DONALDSON: Desiccation, because the burns weren't  
17 there.

18 UPTON: But the burns prevented them from feeding.

19 DONALDSON: Yes, it's the cause and effect relation-  
20 ship.

21 UPTON: They couldn't eat and therefore they  
22 couldn't maintain their food balance.

23 DONALDSON: Yes.

24 ROOT: This was obvious in the autopsy, too.

25 DONALDSON: Yes.

26 CONARD: Could this have been anorexia from radi-  
27 ation, loss of appetite so that they didn't want to eat any  
28 fish?

29 BRUES: This is the old problem that the pathologists  
30 and the epidemiologists have. What is the cause of death?

31 DONALDSON: That's right.

32 FREMONT-SMITH: Multiple causality enters into it.

33 DONALDSON: Surely. Multiple causes that

1 complicates this.

2 Of course, the real differences that we have to come  
3 to grips with now involve the---

4 AYRES: May I interrupt for a second. Did you see  
5 any signs of birds whose tail feathers or wing feathers were  
6 lost later on because of beta burns?

7 DONALDSON: I don't think we have. I'm trying to  
8 recall.

9 CONARD: The feathers would protect the skin from  
10 beta burns.

11 AYRES: I'm just wondering whether the feathers  
12 themselves might have been burnt?

13 DONALDSON: The birds that survived two or three  
14 days almost invariably were in good shape. They set up  
15 housekeeping somewhere else, except for those that can't fly,  
16 the young birds.

17 TAYLOR: Didn't some of the birds, because of ex-  
18 posure to the thermal radiation, lose their ability to shed  
19 water so that they couldn't swim?

20 DONALDSON: Yes.

21 TAYLOR: Are these birds that normally would fish  
22 by landing in the water and then diving?

23 DONALDSON: They simply pick them off, they don't  
24 dive.

25 TAYLOR: I see.

26 DONALDSON: The major other problem I guess one  
27 might call attention to at this point is that we are dealing  
28 in really two environments: The birds living in both, but  
29 the other animals essentially living either terrestrially or  
30 in the aquatic environment. And the quite obvious situation  
31 that existed immediately is that there is the stratification  
32 of the fallout into a finite layer essentially on the terres-  
33 trial area where there is a three-dimensional distribution

1 in the sea. This immediately changes all approaches of one  
2 or the other. In the terrestrial area the fallout is avail-  
3 able to the biota most specifically if it's in a soluble  
4 form. In the soluble form it's picked up by the plants and  
5 enters into the food chain of the animals that feed upon the  
6 plants.

7 [Blackboard] I put down just a partial illustration  
8 of the sort of fractionation that takes place in the land  
9 area. This is part of a very complicated long table, but  
10 just as an illustration let's look at it. All the spectra  
11 of radionuclides, of course, are available on the land as  
12 they fall out there. This is from Eniwetok. The particular  
13 island, Cabell Island spectra. The soil has, in 1961, this  
14 configuration of presence or absence of radionuclides. The  
15 plants substantially pick up only four out of this complex  
16 and of the four that the plants have, the rads essentially  
17 concentrate too: strontium and cesium or cerium. The fish,  
18 on the other hand, have essentially available, one would  
19 assume, the same complex of radionuclides since they also  
20 fell upon the water but the fish in the main pick up manganese,  
21 cobalt-60 and zinc-65.

22 Now, we might add to this, if we take the dominants--  
23 in this particular one we don't have iron-55 but in the open  
24 sea iron-55, along with cobalt, at the present time are the  
25 two most dominant radionuclides.

26 Well, in a sweeping statement of generality, which  
27 is always ridiculous, but in the main the terrestrials are the  
28 soluble nucleides in soluble form, those in the sea of par-  
29 ticulate form are concentrated most. Since the induced radio-  
30 nucleides of the cobalt series and iron series are in par-  
31 ticulate form, although the finely divided form, they enter  
32 through the food web more dominately than do the soluble  
33 forms that are more distributed through the water.

1           Then we might comment on the competition that exists  
2 in the sea which is quite completely different than the com-  
3 petition that exists on land, for on land there are nutritional  
4 mineral deficiencies that for the most part do not occur in  
5 the sea. Now, this seems to refute the comment I made earlier  
6 about the iodine, but again generalizing, the cesium uptake  
7 on land is directly related to the deficiency of the fat.  
8 The strontium-90 on land is an uptake we say because you have  
9 the calcium deficiency, and I just mentioned a few moments ago  
10 that there billions of tons of calcium in an atoll that's some  
11 4300 feet thick column that grows on the island. But this is  
12 in insoluble form and only when it's made soluble does this  
13 become in evidence.

14           So, in the sea the potassium ratio is about 360 parts  
15 per million and on land the calcium is about 440 parts per  
16 million. So it's not quite obvious that a straight atom or  
17 two of cesium or a straight atom or two of strontium in the sea;  
18 we can't get excited at all about it. So when we have this  
19 great nuclear war, I'm going to run out and catch myself a  
20 fish and eat it entire and feel quite secure that my food  
21 supply isn't in jeopardy.

22           Well, if we may have the next slide, please.

23           AYRES: May I just interrupt. That's cesium there,  
24 isn't it, Cs?

25           DONALDSON: Yes.

26           In terrestrial areas it's quite obvious that in some  
27 instances there's little chance for re-vegetation or regrowth.  
28 The soil is burned away; the seeds have been destroyed; the  
29 entire fauna and flora one would assume in this place would  
30 not be re-established.

31           The next one, please. Now, in areas where the soil  
32 has not been burned and has not been removed, you see in  
33 this illustration the soil core where the organic material

1 on the upper inch is and on the right the radioautograph  
2 with the distribution of the remaining radionucleides in the  
3 upper inch.

4 Next one, please. This means that plants that have  
5 shallow feeding roots that feed close to the surface have  
6 a better chance to pick up these soluble forms, to incorporate  
7 them into their tissues, and those plants that root deeper,  
8 like the coconut, for example, do not have radionucleides  
9 available to them in the soluble form. They are feeding  
10 deeper in the substratum. So you have a different accumula-  
11 tion depending the zone of feeding of the plants, as do the  
12 zone of feeding of the animals.

13 The next one, please. The plotting of the distri-  
14 bution in the sea is one that is a constant shifting pattern  
15 that changes with the seasons, that changes with time, of  
16 course, the direction flow of the currents, the distribution  
17 carried on, and it changes from hour to hour and at least it  
18 changes from day to night.

19 The radionucleides in the sea are incorporated in  
20 the lower strata first since they absorbed on the small biota  
21 and then absorbed up the food chain. Many of these organisms  
22 are in the deeper layers in the hours of darkness and migrate  
23 to the surface during the hours--the deeper layers during the  
24 hours of day and migrate to the surface during the hours of  
25 dark. So there is a vertical diurnal migration as well as  
26 this constant shift, depending upon the direction of the pre-  
27 vailing currents.

28 AYRES: Is that deep water?

29 DONALDSON: What?

30 AYRES: Is that deep water?

31 DONALDSON: It's surface water.

32 AYRES: Diurnal doesn't normally extend into shallow  
33 water, does it?

1 DONALDSON: Well, speaking of deep water. I'm  
2 speaking of deep water as water--shallow water as being the  
3 water in the mixing layer which in this area is about 600  
4 feet.

5 DUNHAM: You don't mean shore water?

6 DONALDSON: Not shore water, no. I mean open ocean  
7 water.

8 WYCKOFF: I'm sorry. What do the numbers represent?  
9 But then the lines? Okay, they are contour lines.

10 DONALDSON: They are contour lines, distribution  
11 lines. These are the planktons that do migrate up and down.  
12 This is plankton that was collected through the entire mixing  
13 layer. So this shows that there is this distribution out  
14 on the sites with a concentration closer to the island as  
15 it's coming from a point source driving out into the sea.

16 UPTON: How long after detonation were these measure-  
17 ments made?

18 DONALDSON: I will have to go back and look at the  
19 original. But this is just some weeks at most. That's one  
20 of the tests, but out of the family of curves I just picked  
21 an illustration.

22 UPTON: I see.

23 BUSTAD: But lower than that in spite of these high  
24 levels, incidently, these three in the fish, the only damage  
25 that was observed in the fish from the radionucleides was in  
26 the thyroid, wasn't it?

27 DONALDSON: Yes.

28 BUSTAD: Even though it was, as you pointed out, mani-  
29 festing a high concentration of water, it certainly was in the  
30 herbivorous fish.

31 DONALDSON: Yes.

32 BUSTAD: Now, do you have any later results than  
33 that of Boardman? I think you lined him up to come out and

1 study these and he did describe pretty serious thyroid damage  
2 in some of these fish.

3 DONALDSON: Yes.

4 BUSTAD: Have you run across any fish in later times  
5 in your collections that might have manifested thyroid neo-  
6 plasms, say?

7 DONALDSON: I think so.

8 BUSTAD: Because the stage was set for it, sort of.

9 DONALDSON: Yes, the stage has been set.

10 BUSTAD: Or couldn't they compete? That's it?

11 DONALDSON: We have looked diligently over the  
12 years but we haven't actually seen nor found fish that we  
13 could say was specifically killed by thyroid damage or other  
14 radionucleid damage. Now, there's always the complexing  
15 situation here as far as the fish are concerned. And the  
16 complicating one is that immediately, no matter what the  
17 radiation levels are, no matter what the peripheral problems  
18 are, the cleanup squad move in almost immediately and clean  
19 things up. This means that a fish that is just a wee bit  
20 incapacitated is removed within minutes, at least within an  
21 hour or so. Sharks move in and they scavage the place with  
22 a great regularity. If it isn't the sharks, some of the other  
23 predaceous forms. So one's chance of actually finding or  
24 seeing a fish or an aquatic animal that has radiation damage  
25 would be very remote.

26 AYRES: Are there any top carnivora that might  
27 survive, like sharks themselves, even if they are somewhat  
28 damaged?

29 BUSTAD: The problem there as far as radioiodine  
30 goes is that they show the lowest concentration. They're  
31 not really getting very much radioiodine compared to herbivor-  
32 ous animals.

33 WARREN: Per body mass.

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1 AYRES: You mean the concentration phenomena  
2 doesn't extend right up to the top?

3 ✓ WARREN: There isn't very much ingested with any  
4 one fish, is what he's saying, of the radiiodine because the  
5 thyroid is so small in terms of the body mass of the shark.

6 AYRES: So peak concentration is featured in the  
7 lower forms then?

8 BUSTAD: That's right, and they may destroy the  
9 thyroid or severely damage it and they shall be no radio-  
10 iodine left by then. Time competes with it, too.

11 DONALDSON: There's a big difference. The physi-  
12 ology of the shark is quite different than that of the bony  
13 fishes.

14 AYRES: Of course.

15 BUSTAD: But we have to admit, I think, that many  
16 of those fish that Boardman picked up down there relatively  
17 early manifested severe thyroid damage were probably not a  
18 compromise from the standpoint of your cleanup squad. I mean  
19 he got there before the cleanup squad.

20 DONALDSON: Yes.

21 AYRES: Are there any turtles in the area?

22 DONALDSON: Turtles are very secretive beasts.  
23 They just don't like people about. There are turtles there,  
24 true, and when the 4000 or the 5000 members of the test group  
25 descend on the place, the turtles go somewhere else.

26 AYRES: I see.

27 DONALDSON: The turtles are back at Bikini now,  
28 and I hope we can see if the Chairman will allow us to take  
29 a look at what the place looks like now.

30 WARREN: One thing I think we've left a little  
31 dangling in the discussion. You said the plankton with the  
32 diurnal <sup>change in depth</sup> ~~variation there~~ in their location, does it occur in  
33 the atolls where the depths may be 200 or 250 feet or there-

1 about<sup>d</sup> as well as in the open ocean. The shallow waters  
 2 you ~~were talking~~ <sup>mentioned</sup> were meant to be the shallows, weren't they,  
 3 at depths of 15, 20, 30 feet?

4 DONALDSON: Yes. It comes up on the shore at  
 5 night. It's carried in the surface layers and as the waves  
 6 bring it up on to shore..

7 WARREN: And the circulation of the water in the  
 8 atoll is downwind on the surface and when it reaches the  
 9 other side then there's a return <sup>of</sup> the deeper currents,  
 10 cooler water <sup>with considerable upwelling of cooler water upward</sup> and enough boiling <sup>on the upturn side.</sup> So  
 11 ~~this~~ <sup>this</sup> is the deep circulation that you mentioned.

12 DONALDSON: In part.

13 WARREN: In part it <sup>leaps</sup> out into the ocean on  
 14 the other side, too.

15 DUNHAM: How deep is an atoll?

16 DONALDSON: Most of them are 180, 200 feet. In a  
 17 living atoll this seems to be about the growth rate. They  
 18 grow into the wind, grow into the east, since the prevailing  
 19 winds are from the east. They decay on the downwind side  
 20 and the inner reef or ground more slowly. So they tend to  
 21 expand out to the deeper portions of the atoll decay or the  
 22 corals decay and make the bowl shape so characteristic because  
 23 of lack of food, lack of light.

24 CONARD: But you get a lot of coral heads, don't  
 25 you?

26 DONALDSON: Yes, we have localized ones. But  
 27 the coral heads are so spaced that they get food produce  
 28 coming in.

29 UPTON: Lauren, our coffee is here. Would you  
 30 like to break now or some time soon?

31 DONALDSON: It seems a logical place to break.

32 UPTON: Whenever you're ready.

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33 ROOT: I wanted to ask you was the species that 26

1 you mentioned of the algae, was that like the Japanese seaweed  
2 which concentrates iodine entirely? Do they have that there?

3 DONALDSON: I'm sure it exists in Japan but I  
4 don't think they eat it. I've never seen it in the markets  
5 in Japan.

6 ROOT: That heavy purple seaweed that has a strong  
7 iodine taste, does that exist down in the coral, in these  
8 atolls?

9 DONALDSON: Yes.

10 ROOT: It does? Because that is a naturally high  
11 concentrated one.

12 DONALDSON: Yes. Why I'm hesitant, there are so  
13 many algae.

14 ROOT: I was wondering whether the one you mentioned  
15 was the one?

16 DONALDSON: If I recall correctly, there are some  
17 63 species at Bikini alone. Many of them are various shades  
18 of purple and red.

19 ROOT: These would be the naturally high iodine  
20 concentrated.

21 DONALDSON: Yes, within this whole group there are  
22 those that captivate much more specifically than others and  
23 I think that it's this lack of uniformity that we have to  
24 guard against, not saying all algae do this and all fish do  
25 this and all corals do this; that all plants do such and such.  
26 And ~~th~~ is why I hesitate to do like this I put on the black-  
27 board. Land plants with a term like this, because it's self-  
28 defeating to do this sort of thing because you lose all the  
29 understanding that can be gained by looking at the variety of  
30 parameters that are available to you.

31 AYRES: You have indicated that maganese and cobalt  
32 are both taken up preferentially in sea water, which would  
33 suggest surely that they are unduly scarce. Isn't that the

1 implication you draw from that, that the requirements are  
2 greater than the supplies?

3 DONALDSON: Yes.

4 AYRES: And yet we have manganese and cobalt nodules  
5 forming somehow, which suggests a mystery.

6 DONALDSON: Yes.

7 WARREN: I think there's one thing you haven't  
8 touched on which ought to be put into the record, <sup>I think that</sup> and that  
9 ~~is~~ you said, when you finished up at Bikini, that it was very  
10 fortunate that you had made prior studies because the ~~support~~ <sup>support</sup>  
11 rate <sup>of</sup> the genetic <sup>changes</sup> cases going on in this population was  
12 much higher than had been suspected and it might have been  
13 ~~added to~~ <sup>blended in</sup> the radiation later if it had not been found <sup>earlier</sup> ~~prior~~  
14 ~~to that~~. Is that still your concept, that normally the genetic  
15 change going on in these atolls is quite high?

16 DONALDSON: Again it's a relative sort of thing.  
17 It's like saying, "What's the yardstick of comparison with  
18 the Japanese situation?" The change in the biota may not or  
19 may be great. I think we have to go back to the flora where  
20 we have fairly definite anchored things that we could look at.  
21 I would like to refer this question to Dr. Wolfe here. After  
22 all, he was the botanist-ecologist here.

23 WARREN: Well, I thought snails were particularly  
24 demonstrating this change.

25 DONALDSON: I don't know.

26 UPTON: I suggest we break now and come back to  
27 this question after coffee.

28 WARREN: All right.

29 [After coffee break]

30 BRUES: Lauren, you were talking about the concen-  
31 tration of some of these elements in particular, plants and,  
32 of course, you can tell this with these traces that are  
33 essentially cleared out of the ocean by living things? We

1 see this in fresh water situations. If you throw a little P<sup>32</sup>  
2 into a pond, it all disappears into living matter. In fact,  
3 that's probably a major limiting factor, I suppose, in how  
4 much will grow. Does this happen in the ocean or is there  
5 plenty of all the elements to go around?

6 DONALDSON: I'm sure that there are plenty of  
7 elements in the ocean, but are they available? And if you  
8 suddenly make many essential, biologically essential, avail-  
9 able, of course, they are blotted up. Maybe we can use the  
10 same illustration with that of my photograph that we pre-  
11 sented a while ago in this case were the giant column end was  
12 standing up against this one detonation of the north region  
13 at Eniwetok. The fallout of this came right across the north-  
14 western edge of the atoll. We dubbed this shot "the manure  
15 spreader" shot and this was rather popularly used in the test  
16 group, for in making the reconnaissance sweeps over the atoll  
17 there was a band inside the atoll of brilliant green, just a  
18 brilliant green. But immediately you had--you can fly from  
19 the relatively blue waters of the lagoon over this green band  
20 that persisted for several days and immediately the radiation  
21 instruments would jump several orders of magnitude. Well, it  
22 was quite obvious the thing that happened. That is, the deton-  
23 ation had burned a good deal of the calcium carbonate, just to  
24 take one element. It converted the calcium carbonate into  
25 an oxide. The oxide had dropped in the waters as hydroxide.  
26 Being soluble, it was picked up in the explosion of plant  
27 growth. But there are other elements involved in this, too.  
28 In other words, a nutritive media dropped in the sea had  
29 stimulated a very great growth, but in this were the direct  
30 materials, if you want a good sample, biased tremendously,  
31 this was the place to go get them. One could get a concen-  
32 tration of radiation tied up in this form.

33 Well, you can carry this still further in the early

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1 days of planning at Hanford the cooling ponds were--thermal  
2 coolers, as we originally designed them. You remember, Dr.  
3 Warren, when we used to sit there and hang on to our hats  
4 to keep them from going away from the pressure. But these  
5 steaming vats had tremendous algae growths around the edge,  
6 and they still do. They in turn absorbed--and there was  
7 very serious consideration given at that time of "we'll  
8 simply collect these plant growths and put them some place  
9 because they blot up the radiation very nicely."

10 EISENBUD: Lauren, iron-55 is an interesting nucleide.  
11 I wonder have you looked for iron-55 in the fish over the  
12 atoll?

13 DONALDSON: Yes.

14 EISENBUD: Have you found evidence of concentration?

15 DONALDSON: Yes. In fact, it's the No. 1.

16 EISENBUD: I would think so, yes.

17 DONALDSON: Yes.

18 DUNHAM: My recollection from a visit to Bermuda  
19 a few years ago is that one of the marine scientists there  
20 said that iron availability in the waters around there was  
21 the limiting factor in perhaps the whole food chain inasmuch  
22 as one the key algae couldn't go farther than the amount of  
23 iron available.

24 AYRES: You mean phosphorus was not the limiting  
25 factor?

26 DUNHAM: Iron.

27 EISENBUD: We found, in studies of our own staff in  
28 the laboratory, that some of our ladies who eat tuna fish a  
29 few times a week have blood levels of iron-55 that are about  
30 ten times higher than the rest of the staff. This led us to  
31 look at the Pacific tuna, which I think was done independently  
32 by the Hanford people, and they came to the same conclusion,  
33 that it was iron-55 from the fallout.

1 DONALDSON: Yes. Did you see cobalt?

2 EISENBUD: Cobalt-60? We haven't seen it. In fact,  
3 it isn't there. If it was there we would have seen it.

4 TAYLOR: Is there any persistent biological sign  
5 still at Bikini or Eniwetok of the testing in the aquatic part  
6 of the environment, either in the plants or in the fish? I  
7 mean if you went out there now and didn't use radiation measur-  
8 ing instruments, but simply looked at the plants and the  
9 fish and the birds, would you expect to be able to tell that  
10 there had been this very intensive exposure of the area to  
11 radiation?

12 AYRES: Without radiochemical means?

13 TAYLOR: Without radiochemical means; just by ex-  
14 amining the plants and animals?

15 DONALDSON: May I not answer, of course, but just  
16 postpone it until we have a look?

17 TAYLOR: Yes.

18 DONALDSON: Because I think it will be more obvious  
19 when we look at the film, with the co-chairman's and our  
20 host's permission, which I should like to show later on. The  
21 answer is---

22 TAYLOR: I guess the answer is yes.

23 DONALDSON: The answer is that you do not see it.

24 FREMONT-SMITH: The answer is no.

25 DONALDSON: That you do not see evidence of it.

26 FREMONT-SMITH: I'm glad you gave the answer because  
27 the time to give an answer to a question is at the time it's  
28 asked and not postpone it, although it's nice to come back to  
29 it again later and say---

30 DONALDSON: Thank you.

31 WARREN: Well, on Miller Island where the blast was---

32 DONALDSON: There's radiation, Dr. Warren. Stafford Warren

33 TAYLOR: Yes. I was thinking specifically of  
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1 aquatic life because the surface you said in places where the  
2 surface has really been completely sterilized, there has been  
3 a change, I gather, in the surface of the islands.

4 DONALDSON: Sure. There were very definite changes.

5 CONARD: There's some question as to whether some  
6 of the trees, the coconut trees and the other plants on the  
7 northern plains of Rongelap do not show some signs of genetic  
8 effects. There are some two-crowned coconut trees and this sort  
9 of thing, but it's questionable as to whether this is really  
10 a radiation effect or whether it's due to the heredity of that  
11 part of the atoll, and it hasn't been settled.

12 WOLFE: We had some guy who worked up a monograph  
13 on those coconut trees.

14 CONARD: Fosberg?

15 WOLFE: No, not Fosberg. I don't know his name.  
16 And this double crowning--he even got a coconut tree in one  
17 place with 51 of these crowns and there hadn't been detonation  
18 around that. So this could come about maybe with a butcher  
19 knife by cutting off the terminal bud; I don't know. It might  
20 have been caused by radiation, but I don't think that you can  
21 say that it was caused by radiation.

22 CONARD: Yes.

23 WARREN: Weren't there some broad stems, flat stems,  
24 in Eniwetok?

25 DONALDSON: Yes.

26 WARREN: That you were wondering about the neutron  
27 effects?

28 DONALDSON: Well, we have recorded over the years  
29 a number of variants on the normal, particularly among the  
30 plants. Whether this is induced somatic variation or whether  
31 it's inherent we don't see them now. We've gone back to the  
32 same place. They have either died, were unable to survive.  
33 Of course, we do see variations, but we at one time---

1 Dr. St. John counted as many as 23 variants on one island  
2 from the normal. But these have not been reproducible in the  
3 laboratory.

4 WOLFE: In answer to that, that flattening of the  
5 stems, that's called fasciation. And that's not an uncommon  
6 thing. You can find it in all of the vascular plants if you  
7 look long enough, and I've seen it mostly in the composites  
8 and it has nothing to do with radiation.

9 WARREN: What is it due to, do you know?

10 WOLFE: It can result from insect bite or gall or  
11 sometimes there's no obvious answer. You can't attribute it  
12 to an insect; it may be due to some damage at the stem, the  
13 growing tip where you don't get the radial development and  
14 it flattens out. I think this can be brought about. But it  
15 also occurs naturally.

16 WARREN: Would nutritional acceleration or accelera-  
17 tion from excess nutritional factors produce it?

18 WOLFE: I don't know.

19 WARREN: I've got a cucumber plant that's about 30  
20 feet long and the stems show this and I wondered if they had  
21 been exposing the seeds to neutrons to produce the new variety?  
22 It's a lemon variety which is quite unusual.

23 FREMONT-SMITH: It was just exposed to you, Staff,  
24 that was it! [Laughter]

25 BRUES: That's the California climate!

26 WOLFE: I would not say radiation could not cause  
27 it but I would also point out that it could be caused by  
28 other things.

29 WARREN: Three inches wide and about a half-inch  
30 thick in a cucumber plant is quite large.

31 WOLFE: Yes.

32 MILLER: Dr. Donaldson, what is the minimum study  
33 that would reveal in other organisms than man that the

1 radiation had taken place? What is the minimum study that  
2 will reveal the radiation experience?

3 DONALDSON: I don't know how to answer it.

4 CONARD: I was talking to a botanist and he thought  
5 it would be worth while to study some of the pollen from the  
6 coconut trees on some of the island atolls and he thought,  
7 I believe, by chromosomal aberrations and this sort of thing  
8 that he could detect persisting radiation damage, and I would  
9 think that this would be a fairly simple study that could be  
10 done.

11 MILLER: But it hasn't been.

12 CONARD: Maybe Schull might have something to add.

13 SCHULL: You know, the Indians have done something  
14 along this line in the palms associated with Carilla and they  
15 do report a higher frequency of chromosomal abnormalities in  
16 the palm trees that grow in the strip than those that grow  
17 farther away. But it seems to me that when everyone begins  
18 to talk about the genetic problem, you can approach this as  
19 an either-or situation. There are, so far as we now know, no  
20 unique yardsticks of radiation damage and therefore you ulti-  
21 mately are cast in the role of trying to show a dose depen-  
22 dence and if you can't get variability in the doses that you  
23 can recognize, then you have no means to get at the problem.

24 There's an observation here that I think is relevant  
25 to what Dr. Taylor, the question that he asked. In 1950 or  
26 1951--I think it was probably 1950--Yimashita Cosko, who  
27 is a Japanese cytogenetist at Kyoto University did a fairly  
28 extensive study in Hiroshima on the distribution of abnormal  
29 forms of cosmos which is a little garden plant and they could  
30 show a definite correlation between the frequency of aberrant  
31 forms of this plant and distance from ground zero. So that  
32 it diminished as one went outward although the very things---

33 TAYLOR: Just looking at people's gardens?

1 SCHULL: Essentially that. In Japan it grows along  
2 the roadside in many areas or did then. The very count that  
3 he was making, though, was a situation that you find these  
4 aberrant forms all over Japan but it was the frequency and its  
5 relationship to growth that is the real key, and I think that  
6 this would be typical in Bikini or Eniwetok because you prob-  
7 ably don't have enough known about the gradient in dose so  
8 that you could make any kind of strong statement to show that  
9 the frequency is varying as the dose is varying.

10 CONARD: You would have quite a gradient on Rongelap,  
11 2300 on the north island as compared to 265 on the southern  
12 islands. That's quite a gradient.

13 UPTON: But in point of fact no measurements of this  
14 kind have been made to date?

15 CONARD: So far as I know, they haven't.

16 EISENBUD: These are not high doses compared to what  
17 can be obtained in these areas of natural radioactivity. For  
18 example, in Brazil the ambient levels from external radiation  
19 are about 3 mrv per hour downwards to normal levels, and this  
20 is about 12 r per year. So that in 100 years you have 1200  
21 rads. Presumably some of those forms have been there much  
22 longer. And then if you superimpose on that the dose from  
23 the internal, which is, incidentally, very hard to calculate  
24 because they are alpha-betas and the location and relation of  
25 the genetic material hasn't been worked out yet, the internal  
26 dose is presumably much higher so that I think that there are  
27 probably situations in nature where this kind of a situation  
28 could be obtained if one wanted to.

29 FREMONT-SMITH: Dr. Taylor, you just wanted to say  
30 something.

31 TAYLOR: It just occurred to me that there's a mass  
32 of data sitting there at Rongelap waiting to be gathered and  
33 looked at.

1           FREMONT-SMITH: We'll have to plant some cosmos  
2           in there.

3           TAYLOR: No. Just observe what's there. As long as  
4           the dose levels are reasonably well known, and I'm not sure  
5           from the conversation whether they are really well known or  
6           not. Do people agree that the dose levels at Rongelap have  
7           been normal within a factor of, say, one and a half, the total  
8           dose?

9           CONARD: I would think so, judging from the dose  
10          calculations and the hematological responses of the people,  
11          that we're not too far off.

12          AYRES: With a position of 50 per cent you ought to  
13          be all right.

14          TAYLOR: That's the trick.

15          ROOT: I would think that there would be a consider-  
16          able difference in the Rongelap material, too, than the Brazil  
17          because that would be cumulative and you would have no control  
18          from ground zero before they were exposed, whereas here you  
19          would have the sudden exposure to whatever it was, 2300 rad  
20          and would have your before-and-after picture. So I would  
21          think this would be terribly important material to have.

22          EISENBUD: One problem that's cropped up in Brazil  
23          which hasn't been solved that might be pertinent here is the  
24          fact that it's hard to tell where these chromosomals come  
25          from. You take a sample of a plant and it's easy to calculate  
26          the somatic dose because presumably the plant has been there  
27          for its life. But what the dose is at the gene type of that  
28          plant is very hard to calculate because it goes back presum-  
29          ably many thousands of years and maybe this plant came from  
30          a seed which was dropped by a bird two months ago and picked  
31          up ten miles away. And I suppose to some extent this would  
32          be true in Rongelap where your coconuts tend to drift around.  
33          I don't know what the mean distance transversed by a cosmos

1 pollen is, but this would even have to be considered in  
2 Hiroshima. In Hiroshima it certainly must be a large dis-  
3 tance in relation to the radiation gradient in Hiroshima over  
4 a ten-year period.

5 WARREN: Looking at aerial photographs of this  
6 Brazil site, though, you don't see any change in the foliage  
7 when you come over the rolling country up to the edge of this.

8 EISENBUD: There are differences in the radio-  
9 activity part due to the fact that there are also chemical  
10 changes associated with the mountains which in turn give rise  
11 to the fact that it's radioactive and these chemical changes  
12 presumably are important. This is another factor that has to  
13 be considered.

14 WARREN: Yes, it is.

15 EISENBUD: Yes.

16 WARREN: Is that a volcanic cone or this---

17 EISENBUD: It's a volcanic cone with an alkaline  
18 intrusion in the center. The alkaline intrusion is where the  
19 main radioactivity gets about, a couple of kilometers across,  
20 about 300 meters high above three---

21 WOLFE: Is it active?

22 EISENBUD: It was many, many thousands of years ago  
23 but not in historic times. This was a major volcanic eruption.  
24 The cone is about 50 kilometers in diameter and within the  
25 center of it is an alkaline intrusion which is just a knob  
26 which brought up a lot of rare earth minerals associated with  
27 thorium, and this is a few kilometers across and this is where  
28 the work is going on.

29 WOLFE: I haven't seen it.

30 WARREN: I've only read it. You don't run sheep on  
31 this because there's no grass or enough foliage?

32 EISENBERG: No, that's not so. In fact, the cows  
33 graze on it and it's part of a grazing land and there's enough

1 grass on it.

2 WARREN: Very interesting.

3 DONALDSON: We've purposely omitted one of the prime  
4 areas of interest in the over-all environment and Bob has some  
5 data on the whole-body burden of the Rongelap people that we  
6 might bring in now, with your permission.

7 CONARD: Well, yesterday I mentioned that after  
8 about six months, a year or two, the body burdens of the  
9 Rongelap people dropped down to barely detectable levels and  
10 by the time they were moving back to Rongelap he couldn't tell  
11 the difference between the comparison of unexposed people and  
12 the exposed people, the level of body burden. As soon as they  
13 got back to Rongelap, however, there was a rather sudden and  
14 marked increase in their body burden because of the residual  
15 contamination on the Island. This came about primarily through  
16 eating pandanus, which had some strontium-90 and cesium-137  
17 and, strangely enough, from eating fish, the zinc-65 in the  
18 fish, as Lauren pointed out, got in the people since fish is  
19 one of their mainstays in their diet and we then were able  
20 to get a whole-body counter out to Rongelap. The first one  
21 was a big monster that weighed about 21 tons and that was a  
22 real endeavor to get that thing out on Rongelap Island, but  
23 we did. We finally gave that to the Navy and had to get  
24 another one. So we wound up by using a shatter shield type,  
25 more portable type of whole-body counter consisting of lead  
26 brick.

27 The first slide will give you an idea of what that  
28 looks like.

29 UPTON: Were the fish levels higher in the Rongelap  
30 area than in the area to which the natives had been evacuated?

31 DONALDSON: Yes. There was no fallout down at  
32 Majuro.

33 CONARD: They were in a relatively clean area.

1 They were down at Majuro, 400 miles to the south.

2 UPTON: The fish then continued to be more active  
3 in the Rongelap area over the passage of years.

4 CONARD: Right. That was a three-year period up  
5 until their return.

6 UPTON: Yes.

7 CONARD: And the fish were still quite active with  
8 zinc-65.

9 UPTON: These are marine fish?

10 CONARD: Yes.

11 DONALDSON: There's no fresh water.

12 UPTON: The lagoon is a marine lagoon.

13 CONARD: Yes. It's salt water.

14 FREMONT-SMITH: These are fish that stay in the  
15 lagoon. They were not going in and out of the ocean.

16 DONALDSON: Both. Both populations exist there.  
17 The residual fish that live in the lagoon are there but there's  
18 also tuna fish that are used.

19 FREMONT-SMITH: Which were the ones that were pri-  
20 marily responsible for the increased body burden, do you know?

21 CONARD: I really don't. They ate all kinds of  
22 fish.

23 FREMONT-SMITH: I mean do you presume that the ocean  
24 fish in that area still carried the heavy?

25 CONARD: Lauren, it was maybe lagoon fish, wasn't it?

26 DONALDSON: The ocean fish are essentially carnivores  
27 and the lagoon fish are herbivores and you immediately fraction-  
28 ate on this basis alone, that is, the food chain is different.

29 FREMONT-SMITH: Yes.

30 DONALDSON: And as you go up the thing looks again  
31 as if you dilute it.

32 FREMONT-SMITH: So it was the herbivore that was  
33 responsible obviously.

1 DONALDSON: The herbivore are obviously the best  
2 concentraters.

3 CONARD: The next slide I think shows a spectograph  
4 of what you get from the whole-body count, showing the com-  
5 parison of 1957 and 1959. In March, 1957, shortly after they  
6 had come back showing an increase, the first peak being  
7 cesium-137 and the second peak is zinc-65. We carried out  
8 these whole-body counts over the years since they've been  
9 back on the Island and I can now review very briefly what's  
10 happened in the way of the body burden of these isotopes.

11 The next slide, please. This is a histogram that  
12 shows the changes over the years. The first 1954 data there  
13 shows the higher levels, of course, connected with the initial  
14 contamination and then up until 1957 their body burdens re-  
15 duce practically to zero and then you see on their return to  
16 Rongelap the increase in cesium and zinc and strontium-90,  
17 of course, also began to appear, and this had to be detected  
18 not by whole-body counting but by urinalyses, radiochemical  
19 analyses of the urine.

20 The levels reached a peak about 1961 or so and be-  
21 yond that time they have seemed to be at equilibrium with the  
22 environmental levels of the isotope. Cesium, for instance,  
23 peaked at about a little less than one microcurie of body  
24 burden, which is not high, but it represents about 300 times  
25 the level of those of us in the medical team that were counted.  
26 Since that time it seems to have remained fairly constant.  
27 In other words, they are taking in just about as much as they  
28 are putting out.

29 In regard to the zinc, it reached a peak at about the  
30 same time that the cesium did but suddenly within one year's  
31 time it dropped to about 1/10 the previous year's value, and  
32 I wonder, Lauren, do you have any comment on that as to why  
33 we had this sudden drop in zinc-65 in the people? Was

1 something happening to the fish then that caused this sudden  
2 change?

3 DONALDSON: When did they get rice?

4 CONARD: They had been eating rice pretty much all  
5 along.

6 DONALDSON: Their food habits can change rather  
7 drastically and greatly.

8 DUNHAM: There wasn't a difference in your counter  
9 at that point?

10 FREMONT-SMITH: Don't suggest that!

11 EISENBUD: What is the half-life of zinc-65? I  
12 should know, but I don't remember.

13 DONALDSON: 2.6 years isn't it? Something of that  
14 order of magnitude.

15 CONARD: But that wouldn't account for a sudden  
16 change?

17 DONALDSON: If I remember the data correctly--and  
18 I would have to look it up. I have it here, but essentially  
19 there has been no drastic change in any incidence in the  
20 usually expected declines that have gone on. Maybe if they  
21 have changed their habits not only in eating fish but in  
22 eating birds; if they've had expeditions to the north island  
23 and come back with lots of birds, that would increase it.

24 FREMONT-SMITH: Did you do any cultures of white  
25 cells on these people?

26 CONARD: For chromosomal aberrations. At ten years  
27 we had quite a few cultures, about 40 cultures.

28 FREMONT-SMITH: Did they show anything out of the  
29 usual?

30 CONARD: They showed persisting aberration, low  
31 levels of aberration.

32 FREMONT-SMITH: More than other people would have?

33 CONARD: More than the control. They were compared

1 with the controlled unexposed population.

2 EISENBUD: I think it should be emphasized that  
3 those doses that you are showing on the board, when trans-  
4 lated into dose units, are just a couple of hundred milli-  
5 grams.

6 CONARD: I was going to get around to that in a  
7 minute.

8 EISENBUD: Sorry, I didn't mean to anticipate.

9 CONARD: Then another isotope that was found was  
10 cobalt-60 to some extent, which is about 1/10 the single  
11 level. We haven't seen any iron-55 in the people but we  
12 haven't done---

13 EISENBUD: Any what? Have you looked for it?

14 CONARD: Not specifically, no, but we haven't had  
15 whole-body counts now in a couple of years.

16 EISENBUD: You can't do it with whole-body counting.  
17 It decays by internal conversion and gives you an electron---

18 CONARD: Maybe we'll pick it up in the urine.

19 EISENBUD: No. Sample blood. Maybe you have some  
20 in your laboratory. What you do is separate out the iron-55  
21 and look at it with a thin crystal.

22 DONALDSON: Yes.

23 EISENBUD: It should be very interesting in that  
24 group to see what the iron-55 level is. Iron-55 is an inter-  
25 esting isotope. It's been neglected up till now because the  
26 emission is a 6 Kev. electron which has a range of only one  
27 micron in tissue and it's been generally ignored. But iron  
28 goes to very small volumes of tissue. Specifically it tends  
29 to concentrate in these little globules and you get a very  
30 high dose there because essentially all of the range of the  
31 iron-55 electron is comparable with the diameter of the  
32 globule.

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33 MILLET: May I ask if the unexposed population

1 showed chromosomal changes, too?

2 CONARD: They showed some peculiar chromosomal  
3 changes that we haven't been able yet to understand, chromo-  
4 somal breakages. They show about as many breakages of chromo-  
5 some as to the exposed people. But I was referring to the more  
6 specific radiation-induced types of aberrations such as di-  
7 centrics and ring forms that occurred.

8 AYRES: May I ask about the zinc. How is that  
9 taken up and where is it stored in the body? Is that taken  
10 up as zinc or is it surrogate to something else?

11 CONARD: I really don't know. I know it gets into  
12 the body and is fairly well distributed, as I recall it.

13 LANGHAM: It's concentrates in the epithelial  
14 tissues. The hair is very high, the skin is high.

15 CONARD: The prostate I believe is very fairly  
16 high.

17 LANGHAM: The prostate and pancreas. There is zinc  
18 exudated. The skin and the hair, if you calculate the total  
19 amount in the body, the majority of it would be percentagewise  
20 in the skin.

21 BRUES: It looked to me as if the cesium levels were  
22 remaining rather constant in these people. I think that's  
23 remarkable. It turns over with a half-time of three months  
24 or so in man. So they must be in essentially a closed environ-  
25 ment without cesium drifting or blowing out of it.

26 CONARD: That's so. And I think, as Lauren pointed  
27 out, the fact that this material is sticking in the upper  
28 layer of the soil and not being dispersed, being diluted in  
29 soil, so to speak, means that for a long time probably we'll  
30 have levels that can be detectable.

31 WARREN: It's interesting that the tropical rains  
32 don't leach it downwards. ~~It's interesting that the tropical~~  
33 ~~rains which they have~~ *the tropical rains should* would produce quite a bit of water to

1 leach this down into the soil. Is it complex and fixed?

2 DONALDSON: It doesn't leach to any degree. It  
3 stays pretty well fixed.

4 WOLFE: It's accumulated in the algae in that  
5 upper layer, isn't it? That is as that radioautograph shows.

6 DONALDSON: Yes.

7 WOLFE: And the algae are only in about the upper  
8 end. Below that it's apparently too dark.

9 CASARETT: Maybe we can ask the same question about  
10 man as we just did about other organisms. What mineral  
11 studies could be done to show that they had this radiation  
12 exposure, and so far it seems that the cesium-137 would re-  
13 veal the exposure. Cytogenetic studies do. The thyroid  
14 studies do in two ways by nodules or ablation and the beta  
15 burns, the scar are depigmentation, or the nevi. Does this  
16 give some clues as to what may be looked for in animals or  
17 plants? For example, where are these radioactive isotopes  
18 concentrated in the tissue of birds or plants? The cyto-  
19 genetics has already been mentioned.

20 Does this give some clues from man who can be studied  
21 in greater detail as to where you might look in other organ-  
22 isms?

23 CONARD: This is going backwards, isn't? We're  
24 usually trying to extrapolate from animals to man and now  
25 we're going backwards.

26 CASARETT: You can do it both ways.

27 CONARD: I suppose there would be some correlation  
28 here. It would depend on the animal. We hadn't thought  
29 about it.

30 TAYLOR: Is there any animal study that correlates  
31 with the observation of malformations of human children that  
32 were in the fetal state two or three months or so when the  
33 irradiation took place? Is there any animal counterpart of

1 that that's been seen in any of the bomb test irradiation?

2 MILLER: Not in the wild state but in the labora-  
3 tory animal certainly.

4 TAYLOR: How about fish, for example? When the fish  
5 are irradiated when they are developing eggs, do the eggs  
6 lose their fertility like that?

7 DONALDSON: You can go the whole gamut. The chronic  
8 exposure over long periods of time and pick a level, a half-  
9 hour per day for 100 days of total exposure at 50 roentgens  
10 and follow them through several generations, and instead of  
11 finding a damaging effect you find a stimulating effect.  
12 Double the dose, and the same sort of thing happens. Or double  
13 it again and I'll give you the answer in part tomorrow. I'll  
14 be a midwife tomorrow while you're enjoying yourselves here.  
15 But we'll have several hundred fish coming back from the sea  
16 that have had this experience.

17 FREMONT-SMITH: These are salmon?

18 DONALDSON: Yes.

19 FREMONT-SMITH: I thought there might be somebody  
20 that would know it.

21 DONALDSON: They're the only ones that actually  
22 come home to us from the sea.

23 FREMONT-SMITH: They are bigger and better as a  
24 result of the radiation?

25 DONALDSON: Yes.

26 DUNHAM: Are they all or are they selected? You  
27 still are losing 90 or 99 per cent of them.

28 DONALDSON: Yes. The survival is better---

29 DUNHAM: It's the ones that come back that are  
30 bigger and better.

31 FREMONT-SMITH: Do you lose 90 or 99 per cent? Is  
32 that right?

33 DONALDSON: Actually the normal expected mortality

1 in the sea of salmon is in excess of 90 per cent and these  
2 go through about that same experience plus or minus half a  
3 per cent. We have controls going along, but the survival are  
4 the irradiated up to--we have the information back at 1.5 r  
5 per day for 100 days during the embryonic period as their  
6 survival, coming back from the sea, is greater than a like  
7 control group. We use siblings in either case.

8 FREMONT-SMITH: So that is really as if you had  
9 benefited the fish by radiation.

10 DONALDSON: Yes.

11 UPTON: How about the hatchery?

12 DONALDSON: Better. Fairly significant.

13 EISENBUD: Do the salmon say the university is  
14 always here? [Laughter]

15 DONALDSON: They don't make mistakes! I wish I  
16 had students as smart as those fish.

17 WARREN: I think <sup>that</sup> this ~~is a~~ <sup>which</sup> point that Lauren has  
18 found ~~that~~ is of great significance in this whole story of  
19 radiation exposure and yet it's been sort of ignored.

20 FREMONT-SMITH: It's against the dogma.

21 WARREN: It's against the dogma.

22 FREMONT-SMITH: Not just ignored. It's submerged,  
23 it's suppressed.

24 WARREN: I've examined this with great interest for  
25 years since he first had this finding.

26 DONALDSON: Let's get the record straight. I'm  
27 still under---

28 WARREN: He's still exploring.

29 DONALDSON: ...under the initial directive that I  
30 received it must be done over many years and it must be done  
31 in the complete environment. In other words, the fish must  
32 be exposed during the time that they would be, say, comparable  
33 with the Hanford Works and you must follow them out where

1 they must compete in the open environment and you must in  
2 some way get your hands on them again so that all systems  
3 have to be operative. In other words, you must not simply  
4 say because, well, they didn't die in the first 90 days or  
5 20 days or the first year or something, that there's no im-  
6 portance to it. So in doing this I have very naively told  
7 Dr. Warren, let's see, 24 years ago, that, yes, we can do  
8 this. Well, I didn't realize that it would take me 24 years  
9 to get an answer, but that's about where we are now.

10 FREMONT-SMITH: You're going to telephone tomorrow  
11 afternoon and tell us what the answer is?

12 DONALDSON: One step of the answer.

13 FREMONT-SMITH: But go ahead, Staff. You were goin  
14 to comment.

15 WARREN: I think this is very significant and I  
16 think a great deal of credit is owed to the AEC Division of  
17 Medicine and Biology for continuing to support this work over  
18 the years, 20-odd years, with such a small yield in return o  
19 a few percentage of fish, that this has been maintained over  
20 the years and you're now in what, 26 <sup>this</sup> generations, which  
21 ought to be of interest to the geneticists here - from some o  
22 the original exposures in 1943 or 4.

23 DONALDSON: Those are with trout in 1943.

24 WARREN: Those were with trout.

25 DONALDSON: Yes.

26 WARREN: But here has been the longest, to my  
27 knowledge, the longest single set of observations on one or  
28 more species of fish that have been exposed to relatively  
29 small amounts of radiation, and I think this ought to be co-  
30 tinued as long as it's necessary to get the final answers;  
31 I agree with Lauren. He's got some initial answers which  
32 look very spectacular and interesting and he's properly m-  
33 in not claiming too much too early. But I think this is

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1 as important as following the Nagasaki situation, where the  
2 dosages are not so well controlled.

3           FREMONT-SMITH: May I make a comment also on this,  
4 because it would seem to me that nature has taken advantage  
5 of all of the physical properties of nature and used them  
6 to an advantage. On the other hand, it has been sort of  
7 assumed that radiation was always bad and that any radiation  
8 was going to be harmful. Now it seems to me there's some  
9 evidence to believe that there was a higher radiation in the  
10 past than there is today and that therefore it's entirely  
11 possible that there is an optimum radiation for some species  
12 or maybe for many species and that we shouldn't assume that  
13 every radiation is bad. It seems to me that Lauren's temporary  
14 answer supports this position, that it may be that salmon,  
15 maybe other fish, and maybe other species are benefited by  
16 an appropriate radiation and just wanted to make that hazardous  
17 statement. I know it's contrary to official position but I'm  
18 contrary to official position.

19           WARREN: I've been looking into this, as you know,  
20 with some interest of late and I'm not willing to say that  
21 radiation is universally harmful because we have a continuous  
22 background of naturally occurring radiation and cosmic  
23 radiation, and the former could have been considerably higher  
24 in the past, but I don't think I'm in any position to go any  
25 further in that discussion. But I point to Lauren's experiment  
26 as being significant in this direction.

27           FREMONT-SMITH: Yes.

28           DONALDSON: I cringed just a little bit, Dr. Warren,  
29 when you talked about small in numbers, because I've made the  
30 grandiose statement that this is probably the biggest numeri-  
31 cal experiment that's been carried on radiation studies with  
32 vertebrate animals, not with Drosophila or something like  
33 that we normally use in excess of 100,000 exposed and 100,000

1 controls, making 200,000 animals in each experiment. Then  
2 we have to carry another population along. So we always have  
3 reserve stocks. So even---

4 WARREN: The salmon gives a percentage of return,  
5 as you indicated.

6 DONALDSON: Yes. Even if we get a 1 per cent return,  
7 we have somewhere between--never less than 2, but 2 to 5 or as  
8 many as 6000 salmon coming back in the University pond that  
9 is just slightly larger than this room. When you have that  
10 great number of these adult beasts, the average weight last  
11 fall was 8.6 pounds, coming to a tiny place like this in a  
12 two-week interval, you have a tremendous mass of at least  
13 physical material, but you also have a fantastic number of  
14 measurements to make. So you're stick problems get astronomical.  
15 This population would produce at least 5 million offspring  
16 each year. So with 5 million offspring to evaluate and follow  
17 through step by step all through their incubation period,  
18 determine the number of anomalies, determine the rates of  
19 growth, individual variations between lots of some thousand or  
20 1200 lots, you need more than a computer, you need a bunch  
21 of trained monkeys, as we saw in the film.

22 FREMONT-SMITH: How large a staff do they provide  
23 for you to help you with this?

24 DONALDSON: This was a question that was asked me  
25 last week by a group of Russian geneticists.

26 FREMONT-SMITH: I'm asking it now.

27 DONALDSON: Ask John.

28 FREMONT-SMITH: Let's get it on the record. How  
29 large a staff? They've been supporting it for 24 years, but  
30 how large a staff do you have?

31 WOLFE: It depends upon the season of the year. When  
32 those fish are coming back, he's got 25 or 30 guys out there  
33 catching them out of the pond and going through all these

1 ablations that they go through.

2 AYRES: What do you do after?

3 WOLFE: During the off-season I don't know how many  
4 people there are.

5 FREMONT-SMITH: What I'm trying to bring out, does  
6 he have enough staff to do the job?

7 WOLFE: Nobody ever has enough staff.

8 FREMONT-SMITH: Okay, I just wanted to bring it  
9 out. He hasn't got enough staff.

10 DONALDSON: This is one of the tricks that one learns  
11 being a schoolteacher, Doctor Fremont-Smith. The fish usually  
12 come between August and September. The school doesn't start  
13 until the 25th day of September. So the return runs the 25th  
14 day of September. This year it was the 26th, but it's close  
15 enough. Then I have the 25 or 50 students who can help me.

16 WARREN: He orders the fish to return on that date!

17 [Laughter]

18 FREMONT-SMITH: I think you ought to go the Univer-  
19 sity to start on that.

20 DONALDSON: The fish normally go to the sea during  
21 July, maybe as late as August, but that's inconvenient because  
22 school lets out in June. So let's have them go the sea the  
23 first day of May and we'll speed them up and get them out the  
24 first day of May. Then the students have time to prepare for  
25 their examinations and everything goes along nicely.

26 WARREN: It was very cute of him to turn nature to  
27 his time schedule.

28 FREMONT-SMITH: Forgive my remarks. I just wanted  
29 to get it on the record. Maybe he could have a little more  
30 help.

31 EISENBUD: What is the radiation pattern? I don't  
32 know if you gave that. If you did give it, I missed it. What  
33 dose to you give them over what period of time?

1 DONALDSON: The dose has been increasing year by  
2 year. We started out at .5 r per day; went to 1 r per day,  
3 then to 2, now 2.5, and this year we're going up to 5 r per  
4 day.

5 EISENBUD: For how many days does this go on?

6 DONALDSON: Approximately 100 days. During the  
7 entire incubation period. This is one advantage of this sort  
8 of experiment. You have a built-in food supply and you can  
9 put them in a chamber and expose them to your cobalt-60  
10 source, expose them for this 100 days. At the end of 100  
11 days they are ready to start to feed and then you start to  
12 take them out. But at the end of that 100 days they're going  
13 through their entire embryological field. They're fully formed.

14 BRUES: There's some evidence appearing now that the  
15 earth's magnetic field flops over every so often which lets  
16 in little meteorites and cosmic radiation. I believe the last  
17 time that this was supposed to have happened coincides more or  
18 less with the time when man first appeared on earth. That is  
19 rather speculative, of course.

20 FREMONT-SMITH: Do the salmon get bigger at the  
21 same time, too! [Laughter] Go ahead. I didn't mean to  
22 interrupt you.

23 BRUES: No. This is the whole story.

24 WARREN: He has indicated that there are periods of  
25 bursts of irradiation which do affect this at different times  
26 due to the shift. Lauren ought to also tell you that he has  
27 men study all of the abnormalities that can be produced in  
28 these fish with irradiation and there's a certain mortality  
29 from this, depending upon the dose rate. You get all of the  
30 abnormalities that have been ascribed to this other species  
31 and the large lethals are included in this list. But at this  
32 dose rate your abnormalities and your lethal effects are pretty  
33 low, aren't they?

1 DONALDSON: There's no significant difference in  
2 the number of anomalies between the irradiated and exposed  
3 at the levels as far as we have gone.

4 FREMONT-SMITH: No increase?

5 DONALDSON: No significant increase one way or the  
6 other.

7 TAYLOR: What is the LD-50 dose for a salmon?

8 DONALDSON: An acute dose is between 450 and 500 r.

9 TAYLOR: You're giving them about 500 r, aren't you?

10 DONALDSON: Chronic exposure.

11 WARREN: Daily.

12 DONALDSON: We'll give 500 r this year.

13 AYRES: That's a time when cell reproduction is  
14 rather rapid, though.

15 DONALDSON: That's right.

16 WARREN: At their rate of maximum growth and change.  
17 Presumably this should be the most sensitive period, shouldn't  
18 it?

19 FREMONT-SMITH: The most vulnerable period.

20 AYRES: On the other hand, recovery can be more  
21 rapid.

22 TAYLOR: Why don't they all die, is what I'm asking?

23 LANGHAM: It's the dose range. There's a lot of  
24 difference in giving a dose in five minutes and over a hundred  
25 days.

26 TAYLOR: Is it a factor of 2?

27 DUNHAM: Your monkeys all had lethal doses, as you  
28 showed yesterday.

29 LANGHAM: Yes. And the prompt lethal dose of the  
30 monkeys is about 550 r.

31 FREMONT-SMITH: Please, gentlemen, don't have a  
32 private conversation because it makes it impossible. Stafford Warren  
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33 UPTON: I think a similar experiment has been in 52

1 the mouse. I think I seem to recall that Russell could  
2 detect defects in mice exposed to dose levels of 25 r in the  
3 embryonic period whereas if they administered something like  
4 7 r a day continuously given over a 24-hour period without  
5 embryogenesis, they observed no effects, due presumably to the  
6 lower dose rate.

7 DONALDSON: I think if there's an real unusual thing  
8 about this experiment we seem to have drifted into, is that  
9 the total response has to be functional, that is, they must  
10 memorize their migratory pattern out to the sea, and memorize  
11 their migratory pattern coming back, and this requires an  
12 extremely astute sequence of mental gymnastics. They must  
13 compete in a very competitive environment in the sea. They  
14 must survive and reproduce and continue on.

15 Well now, what are the effects of 20th or the 30th  
16 generation? Well, I'm never going to live long enough to know  
17 because it takes us about four years to do an experiment, one  
18 cycle and the subsequent cycles, but we are in the F-3 of some  
19 of the groups now and we'll continue to grind along as long  
20 as our energies hold out.

21 FREMONT-SMITH: Do you want to tell us briefly that  
22 fascinating story about the olfaction and how they do find  
23 their way?

24 DONALDSON: I keep watching the clock.

25 FREMONT-SMITH: It's so exciting I think we ought  
26 to just get a flavor of it.

27 DONALDSON: This is the work of Dr. Gorbman. Dr.  
28 Gorbman is the same chap that worked on the iodine uptake.  
29 He has been doing memory pattern responses by taking the  
30 salmon at the return and immobilizing them, lifting the skull  
31 case off, putting probes in the olfactory lobes and then  
32 dropping water on the olfactory nerves step by step down the  
33 environment.

1.                   FREMONT-SMITH: Down the river.

2                   DONALDSON: Yes, down the river or up the river or  
3 some other place or tap water and getting the input directly  
4 in measuring their memory response for this particular environ-  
5 ment or stimulus.

6                   FREMONT-SMITH: The electrical activity to the en-  
7 vironmental water.

8                   DONALDSON: Yes.

9                   AYRES: Is it an encephalogram technique?

10                  DONALDSON: Yes.

11                  FREMONT-SMITH: What happens?

12                  DONALDSON: It's sensitive to such infinitesimally  
13 small amounts. Then you can take it down and distill the  
14 water on and on, and they are even so sensitive that you can  
15 move up above for 100 yards on up the watershed where they  
16 haven't experienced it and there's no response.

17                  TAYLOR: What happens if he takes them out of the  
18 water and gives them upstream water and downstream water and  
19 some mixed stream water?

20                  DONALDSON: This can be done.

21                  FREMONT-SMITH: It makes them very angry!

22                  AYRES: It confuses the hell out of them! [Laughter]

23                  DONALDSON: May we come back to the subject at hand  
24 for the moment and before leaving this environmental area  
25 that we've been talking about in the mid-Pacific, I think it's  
26 germane that we include a word or two about the change in re-  
27 lationships with Japan since 1954 and how these environmental  
28 problems were handled on a bit different basis.

29                  In the 1958 series, we obtained permission from the  
30 Division of Biology and Medicine, Dr. Wolfe and Dr. Dunham,  
31 to do a sort of undercover operation. This undercover opera-  
32 tion was to contact one of our good friends in Japan, one of  
33 the leaders in the SHUNKOTSU Maru expedition that caused so

1 much problem in the 1954 era. One of the chaps agreed to  
2 collect and evaluate sample of tuna fish that were caught  
3 by the Japanese fleet. He collected some 2000 samples, sent  
4 us half of the samples; he kept half of the samples and then  
5 we made our evaluations, they made theirs and we compared them.  
6 But he couldn't get his published in Japan, but that didn't  
7 necessarily matter. There were available these data in Japan.  
8 But since they were not the sort of exciting things that would  
9 make a good news story, they are part of the scientific record  
10 but are not a part of the popular record.

11 In 1964, during the high altitude tests at Christmas  
12 Island, this program was again repeated and Dr. Carl Botter  
13 again collected the samples and sent them to us. But under  
14 some very real pressures on the part of the hysteria-minded  
15 group in Japan there was floated an expedition to evaluate the  
16 radiation hazard by a group of reliable scientists. The ship  
17 was equipped and sent out and we were advised and we met them  
18 in Honolulu in June of 1964 and had long conversations with  
19 them as to what we had found in the Pacific and, most important  
20 I think, for this record at least, we more or less held their  
21 hand during this operation, because, to say it very frankly,  
22 they did not expect to return home. They were perfectly will-  
23 ing to give their life to the cause, many of them. This was  
24 particularly true---

25 FREMONT-SMITH: They expected to be killed by the  
26 blast?

27 DONALDSON: They expected to be, at least at the very  
28 minimum, extremely affected by radiation fallout.

29 EISENBUD: What year was this?

30 DONALDSON: 1962. It seems fantastic again or in-  
31 credible, to use a much used word, but they had the most  
32 elaborate air-conditioning system I've ever seen. Every port-  
33 hole was plugged. They had long filters installed. The ship

1 was equipped so that it could be operated entirely without  
2 anyone being on deck; almost a periscopic peekhole and they  
3 wanted from us assurance that they could go into the area and  
4 possibly survive, but how would they best orient it. "Well,  
5 we just came back from down there. We've been traveling  
6 around."

7 "Where were you?"

8 "Right at this point; that point, that point."

9 "But your health is good."

10 "Sure our health is good. Why shouldn't it be?"

11 Well, the ship left Honolulu; they made their  
12 stations, they went home and we arranged again through the  
13 Division of Biology and Medicine and the Commission sent Dr.  
14 Gordon Dunning over to chair the meetings where we brought  
15 all these data together, their data, our data, and we pooled  
16 our resources. We did a correlation study even eventually  
17 and found that we had significantly the same--it was signifi-  
18 cant--I've forgotten the exact degree, but at least it was  
19 significant that the results that they had and our results were  
20 in agreement.

21 FREMONT-SMITH: Were they awfully surprised to come  
22 back alive?

23 DONALDSON: They were tremendously pleased, I guess,  
24 to live.

25 DUNHAM: You said they were very sophisticated,  
26 knowledgeable scientists.

27 DONALDSON: They were very sophisticated, knowledge-  
28 able scientists. I qualify this to say that it was the seamen  
29 on the ship plus these chaps. But the precautions that they  
30 had and the facilities that they had were so completely out  
31 of keeping with anything that we had available to us or that  
32 we had ever seen actually.

33 EISENBUD: How close in did they go?

1 DONALDSON: The exclusion area was 200 miles. So  
2 they were close.

3 EISENBUD: The Shunkotsu Maru came that close in  
4 1954 and they didn't seem to be too concerned about it although it  
5 was interesting, you may have noticed in The Saturday Evening  
6 Post picture that shows me on the deck of the ship, that I was  
7 the only one that didn't have a mask and the Japanese accused  
8 me of being a little too cavalier about radioactivity. They  
9 thought I really ought to take care of myself.

10 DUNHAM: You were grandstanding! [Laughter]

11 EISENBUD: There was nothing I could do about it. I  
12 didn't bring any along and they didn't have any for me.

13 DONALDSON: I'm about at the punch line of my story,  
14 I hope. But at the conclusion of the meetings there was to be  
15 a press announcement and the place swarmed with newspaper  
16 people; it just literally swarmed. They had television  
17 cameras, newspaper photographers. The place just buzzed. The  
18 prepared statement was handed to the newspaper people saying  
19 that we were in complete agreement and that the levels of  
20 radiation were such-and-such and such-and-such. And you should  
21 have seen the expression on these men. "But there are not  
22 great amounts," they would say. "No. These are the findings  
23 of the joint report." And we searched the papers the next day  
24 and about an inch and a half appeared and I don't think any  
25 of the footage was used on television.

26 BRUES: Lauren, should we set up the projector. You  
27 wanted to show a picture before lunch.

28 DONALDSON: Yes.

29 CONARD: I had one final statement I wanted to  
30 make. In regard to the Rongelap body burden situation, it  
31 turns out that none of these isotopes exceeded 5 to 10 per  
32 cent of the MPC in the people. The children had slightly  
33 higher values for the strontium-90, to 20 per cent in some

1 cases. But it was estimated that the total body dose from  
2 all of these internally deposited isotopes only amounted to  
3 several hundred milliroentgens per year and, as you know, our  
4 MPC levels are based on peacetime limits and are very con-  
5 servative with a safety factor of about 10 which is usually  
6 cranked in. So in the aftermath of a nuclear war it would  
7 seem to me that this Marshallese experience does tend to in-  
8 dicate that one can live in a contaminated area without too  
9 much radiation hazard.

10 FREMONT-SMITH: With that degree of contamination.

11 CONARD: Yes. But even extrapolating back to larger  
12 amounts, judging by the smaller dosage they received, it would  
13 seem that it would be a minimal hazard.

14 ROOT: You mean if you hadn't moved them off at  
15 all it would have been a minimal hazard?

16 CONARD: I would say that it probably would. I don't  
17 think that I want to stick my neck out that far because I  
18 really haven't calibrated what the total dose would be if they  
19 had remained on the Island continuously, but certainly it's  
20 not anywhere near in the range of the acute immediate hazard.

21 ROOT: You mean that's a good shelter hypothesis  
22 then if you can get them all under shelter while the actual  
23 fallout was taking place? They could emerge the next day  
24 without perhaps danger?

25 CONARD: I wouldn't say the next day.

26 AYRES: That's a standard self-defense notion that  
27 you shelter for a couple of weeks and during that time the  
28 drops by a factor of 100 and then you're probably all right.

29 ROOT: Yes.

30 CONARD: Most of the radiiodine by that time has  
31 decayed.

32 EISENBUD: I would like this off the record.

33 [Off the record]

1                   FREMONT-SMITH: Back on the record.

2                   EISENBUD: Things had quieted down in the summer of  
3 1954 and then I guess we forgot to mention yesterday that the  
4 Russians started a test in September and the fallout levels  
5 to Japan were actually heavier in September than they had been  
6 during the period when we were testing the previous spring.  
7 But things had quieted down any way, which lead many of us to  
8 believe that the commotion in Japan in that time was at least  
9 in part motivated by Communist propagandists.

10                   Well, one of the things that happened in the early  
11 fall, particularly I think motivated in part by the Russian  
12 test, was that the Japanese decided that they didn't get the  
13 most out of the visits that some of us had made the previous  
14 spring and they wanted to have a radiobiology conference and  
15 they invited the Atomic Energy Conference to send a group over,  
16 and about a dozen of us went over in November of 1964 and sat  
17 with our counterparts in Japan and had two weeks of very worth  
18 while discussion with them.

19                   Interestingly and apropos of the remarks I made  
20 yesterday about the schism in Japanese medicine there, there  
21 were no Japanese physicians in their delegation and we were  
22 discreetly asked not to include any in ours so that they  
23 wouldn't have to pick or choose between Tsuzuki and his oppon-  
24 ents. So the conference included geneticists, physicists, and  
25 biologists of various kinds but we never did get to see the  
26 physicians afterwards, of course. This is very interesting.

27                   But out of that conference we saw some Japanese data  
28 in which their SHUNKOTSU MARU expedition, I think--was it in  
29 May of 1954--I think it was right in the middle of the test,  
30 wasn't it, Lauren?

31                   DONALDSON: Yes.

32                   EISENBUD: Do you remember the date of the SHUNKOTSU  
33 MARU expedition?

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1 DONALDSON: May 24th they left.

2 EISENBUD: They sailed into the equatorial current  
3 just west of Bikini and took profile measurements which indi-  
4 cated that about 200,000 curies a day was drifting out of the  
5 lagoon into the equatorial current. This is while the other  
6 tests were going on. This information was given to me in a  
7 little packet which wasn't discussed very much and I read it  
8 on the way back and I got interested in it and as a result of  
9 that and the fact that it was a simple extrapolation to show  
10 that this device would go into the Kuroshiro Current in the  
11 Philippines and then head north to the Japanese coast, it  
12 seemed prudent to get out and get some measurements, and this  
13 was done through an operation control which was carried on  
14 jointly between the Coast Guard and Dr. Donaldson's laboratory  
15 and ours and that took place at I believe in March, about a  
16 year after the 1954 event.

17 DONALDSON: 1955.

18 EISENBUD: And gave some very good data on the  
19 distribution of radioactivity in the Western Pacific as a  
20 result of that test.

21 FREMONT-SMITH: Was it appreciable?

22 EISENBUD: Yes. The radioactivity was detected  
23 everywhere that the expedition went. It started from--well,  
24 essentially from the Marshall Islands and proceeded west to  
25 Guam and then north in the Kuroshiro Current to Japan, where  
26 they put in and exchanged data with the Japanese and then as  
27 I recall, Lauren, you correct me--I'm just reconstructing  
28 this--they came back in the Alaska Current and went down the  
29 West Coast of the United States and completed a cruise of some  
30 three and a half or four months during which time they actual-  
31 ly followed the current all the way around.

32 FREMONT-SMITH: Were the fish getting this and ac-  
33 cumulating it?

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1 EISENBUD: Yes, but very, very small amounts. Also  
2 we obviously said it was high enough to be interesting but  
3 low enough so that we didn't really have to worry about it.

4 BRUES: Do you want to say anything before the pic-  
5 ture is turned on, Lauren?

6 DONALDSON: No.

7 BRUES: Let it be turned on then. Lunch will be had  
8 in ten minutes instead of 25 minutes and we can continue with  
9 our discussion if anyone has anything to discuss until twelve  
10 o'clock, and we'll show the picture later in the day. Every-  
11 one run out of talk?

12 DOBSON: I would like to ask Lauren Donaldson a  
13 question. Perhaps it's not too well phrased, and perhaps the  
14 question is too large. But extrapolating from the experiences  
15 that you've had over the years with your ecological studies,  
16 what kind of situation would you visualize, let's say, in the  
17 western part or region, the Washington region of the United  
18 States if a sizable number of nuclear devices were exploded?  
19 I'm thinking of the aquatic animals, the river systems, the  
20 terrestrial, and so forth. It's a fuzzy question. I don't  
21 mean an overwhelming number, but choose your number.

22 DONALDSON: One could approach this with 180 degree  
23 differences either way. If one wanted to choose for the moment,  
24 say for the sake of argument, we would have to go back to our  
25 original comment that in water you are dealing with a three-  
26 dimensional aspect. You deal immediately with fractionate of  
27 nucleides. Then you have selective concentration of nucleides  
28 and they are selectively picked out by different sections of the  
29 biota. In vertebrates as a group being different almost than  
30 vertebrates, you have the food chain series. Which stage of  
31 the food chain is one interested in fish, the herbivores being  
32 more specific than the carnivores? So to make a blank state-  
33 ment there would not be an effect, there would be an effect,

1 would be almost ridiculous. The qualifications would have  
2 to be so numerous that I think one could almost without  
3 question say that a device in the area over a city or away  
4 from the immediate contact with the water, there would not be  
5 much concern. A few minutes, a few hours, at most, and it  
6 would be of little concern. It would be an academic problem,  
7 some of the ones we've been talking about today. On the other  
8 hand, if it were in a harbor and under the water or in the  
9 water, this would introduce a whole new series of parameters  
10 because of entrapment of materials and the immediate avail-  
11 ability of both fission products and nonfission products and  
12 induced radiation to living things.

13 CONARD: Did you say that over land it would not be  
14 of consequence?

15 DONALDSON: It would be of little consequence.

16 CONARD: I don't see why you wouldn't have a big fallout  
17 problem with the fireball if it was close enough to the sur-  
18 face to draw up and incinerate tremendous quantities of earth  
19 into the cloud.

20 DONALDSON: I'm assuming that.

21 ROOT: A high burst, you see.

22 DONALDSON: I'm assuming a high burst in contact.

23 DUNHAM: I would like Dr. Wolfe to comment on this  
24 question because I think I know what Warren is driving at and  
25 that is that the earth is so different on the atoll than that  
26 of the State of Washington in terms of radiosensitivity with  
27 the tremendous amount of pine forests that maybe there would  
28 be a difference.

29 WOLFE: I would think in the coniferous forests of  
30 the Northwest that there would be widespread damage in the  
31 areas of heavy fallout, damage to the extent that the forests  
32 might be totally killed in areas. I don't know whether I'm  
33 talking to your question or not. This is one important thing

1 that we know of differential sensitivity, that conifers are  
2 more sensitive and it would take a lot less radiation to kill  
3 the forests in the Northwest than it would to take them out  
4 in the Appalachians. In the Appalachians I think maybe fire  
5 would be the sole killer except in the pine regions to the  
6 southeast and along the coast. In the Northwest you have both  
7 radiation and fire and in the coniferous forests most of them  
8 can be rather disastrous in areas of high radiation. I know  
9 that there have been those who speak lightly as fire as a  
10 factor in nuclear war, but I noticed in this last fire, the  
11 fires in the Northwest, that you had available manpower and  
12 you couldn't do anything about them until they had run their  
13 course. In a time of nuclear war you won't have any manpower  
14 and you won't have any equipment. So I think fire and radi-  
15 ation would cause considerable damage in the Northwest over  
16 the land.

17 DONALDSON: This is the sort of fractionation of  
18 a question I imagine one would expect from basically an aquatic  
19 biologist as contrasted to a terrestrial ecologist. Immediate-  
20 ly my interpretation was "Well, the only things that are im-  
21 portant in this world are those that are associated directly  
22 with the water, water mass, this being the ocean. Then, back  
23 to some of it, say, we had yesterday: What would you do if the  
24 area was contaminated? The same thing that we were doing at  
25 Rongelap in the early days. We would run on, sure, grab a  
26 sample, and then get out and stand in the water up to our necks  
27 until someone came to pick us up. Sometimes that was a long  
28 time, quite a wait, but this is just to emphasize the difference  
29 between the two environments, that is, where you have a point  
30 source as a three-dimensional. There isn't any reason to assume  
31 that per area originally there wasn't just such fallout on  
32 Rongelap lagoon as there was on the land area. But if you  
33 spread it, plus the shielding, you have just different problems.

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1 You're dealing in another media.

2 ROOT: Do I understand that you are referring to  
3 particulate fallout matter in the water which goes into the  
4 food chain and Dr. Wolfe is referring to radiation? So that  
5 high burst, your high burst would not be so effective on the  
6 water but you're referring directly to radiation and not the  
7 fallout, aren't you?

8 WOLFE: I'm talking about the radiation that gets  
9 there, whether it's from fallout or any other source.

10 ROOT: Yes. I mean you would get it in a high  
11 burst whereas you would not get it on the water. A high burst  
12 wouldn't be so damaging because there wouldn't be anything to  
13 come down.

14 WOLFE: I don't think it would. But this illustrates  
15 a question that has been put to the Division by the Joint  
16 Committee. They want to know since we're conducting radiation  
17 studies at Oak Ridge and Brockhaven, why do we have to do them  
18 at the test site, for example? And the problem I think is  
19 answered in part here with the Rongelap study, that neither  
20 Oak Ridge nor Brockhaven or Argonne or anybody else could have  
21 predicted accurately or could have discovered the thyroid  
22 difficulties that Bob Conard has reported on. And you've got  
23 to go where the action is.

24 ROOT: Sure.

25 WOLFE: And I don't know how I can put it in language  
26 to you, but I don't know whether we could put it on paper for  
27 the Joint Committee, Chuck. We miss your fine hand there.

28 DUNHAM: The Atomic Bomb Casualty Commission is  
29 always being sniped at in top quarters that I think we go  
30 where the action was--I'll change your word immediately--it's  
31 awfully good.

32 WOLFE: We've got a different environment; it in-  
33 volves different biota and different meteorology and different

1 climates and different relationships altogether. That just is  
2 the way ecology is. It involves geography.

3 TAYLOR: Aren't there two very significant differences  
4 at least between the exposures at Bikini and Hiroshima and  
5 what you do at Oak Ridge and at Brookhaven? That is the close-  
6 in dose rate phenomena...are not producible on a large scale.  
7 You can't irradiate a group of trees in a very short time.

8 WOLFE: We do have a cesium source in a forest at  
9 Brookhaven.

10 TAYLOR: Yes, but some of the irradiations are in  
11 milliseconds, as I understand it. The dose rate phenomena---

12 UPTON: One can tend to simulate this with a fast  
13 reactor.

14 TAYLOR: Are these ecological studies?

15 UPTON: Yes. From the tower.

16 TAYLOR: Then let me mention what may not be a dif-  
17 ficulty. Some of the significant effects, at least in the  
18 Marshall Islands were due to fallout, literally to fallout,  
19 to material falling on the community that is being irradiated  
20 and that has at least two effects that are different from what  
21 you get with a gamma source. One is chemistry is involved,  
22 biochemistry, and the other is there are things like beta  
23 burns which are not produced with a cesium source.

24 Now, in connection with this last thing I have  
25 heard many people say that deciduous forests are relatively  
26 radiation resistant. Is it really clear that they are also  
27 resistant to beta and alpha activity distributed on the sur-  
28 face of the soil trickling down through the trees, particularly  
29 in the wintertime, because the state of ecological complexity  
30 right near the surface is considerable and it would appear to  
31 me that you don't produce a lot of effects by irradiating to  
32 very high dose levels the first few millimeters of the soil.

33 WOLFE: You just kill everything at very high levels.

1 TAYLOR: Yes. The question is will that kill the  
2 trees?

3 WOLFE: Deciduous trees?

4 TAYLOR: Yes.

5 WOLFE: No.

6 TAYLOR: You say all of the transfer between bac-  
7 teria and fungi and nematodes and all these things that go  
8 on in the upper foot are not effected by the fires?

9 WOLFE: I would doubt it.

10 BRIES: I'm going to adjourn the meeting for lunch  
11 now since the management has offered to have it early for us.

12 We will convene then at one-thirty instead of one  
13 forty-five. I will ask you and Dr. Langham to get together  
14 and decide which is the most appropriate time to show the  
15 film, assuming we can get it turned around.

16 We stand adjourned.

17 [Adjourned at twelve o'clock noon.]

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