Individuals with unknown or uncertain radium contents who had probable or confirmed bone sarcomas are listed in Table 10, along with the year of first exposure and the year of sarcoma diagnosis or appearance.

Head Carcinomas

Table 11 summarizes the subjects with diagnosed head carcinomas (of the paranasal sinus and mastoid air cell carcinomas) observed in the radium-exposed population, with distributions by sex and between the measured and unmeasured cases. Fewer of these malignancies occurred than bone sarcomas, 37 versus 85. Five of the 37 persons with head carcinomas also had diagnosed bone sarcomas. These numbers indicate that radium-exposed individuals developed more than twice as many bone sarcomas as head carcinomas.

Table 12 compares the head carcinomas in dial workers and in all other radium-exposed subjects.

When the time of appearance is examined, a significant difference is apparent between head carcinomas and bone sarcomas; the head carcinomas seem to appear much later. Figure 12 shows the times of appearance, in intervals of 5 years after first exposure to radium, for head carcinomas. The first head carcinoma was diagnosed 19 years after exposure to radium.

In Figure 13, the time of appearance of head carcinomas is plotted against the initial systemic intake. Here the initial systemic intake refers to the value for ^{226}Ra alone, because these malignancies are induced by radon (^{222}Rn) trapped within the air spaces in bone. Therefore, the ^{226}Ra body content is the significant parameter, because the very short half-life (55 seconds) of ^{220}Rn, formed in the decay scheme of ^{228}Ra, precludes its migration into these cavities.

When the measured cases are arranged in order of increasing initial systemic intake, the head carcinoma occurring at the lowest dose (Figure 13) is found to be number 2,024 in the list of 2,383 cases, with a calculated intake of 25.63 μCi of ^{226}Ra. As indicated below, this intake value is incorrect; the true value is larger, but how much larger is unknown.

The subject with the head carcinoma occurring at the lowest dose, Case 03-225, was given radium as radium water daily for approximately two years when he was six to eight years old. Looney et al. (1955) gave the following account of the treatment in their description of another case, the