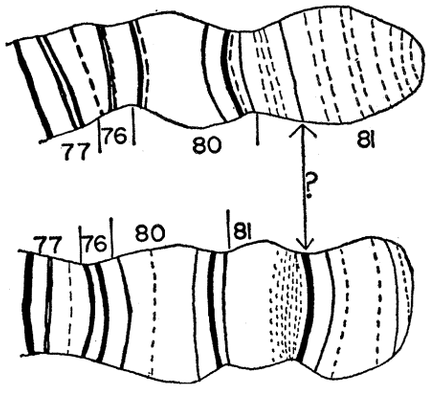

Fig. 1. Distal ends of unaltered (top) and altered (bottom) third chromosomes bearing the CH gene arrangements. The numbers refer to homologous sections (*5*). The arrow connects two bands which are presumed to be homologous. Immediately to the right of this band on the altered chromosome is the new or accentuated band of section 81.

found in the salivary gland preparations of a few individuals, all of which carried the Chiricahua (CH) gene arrangement in homozygous condition. The new chromosome was extracted from the population (W-11) by single-pair matings and progeny tests. A stock was formed in which all the third chromosomes were of the altered variety.

A striking feature of the altered chromosomal banding pattern is the introduction of a new or accentuated second heavy band near the middle of section 81. This is usually accompanied by a constriction in the chromosome at that point. This constriction causes the formation of an extra, intermediary bulge between the new (or accentuated) band of section 81 and the distal end of section 80. The appearance of the chromosome is unaffected by temperatures between 15° and 25°C. Measurements with an ocular micrometer of the length and width of sections 80 and 81 of 25 normal and 25 altered CH chromosomes showed that there is no

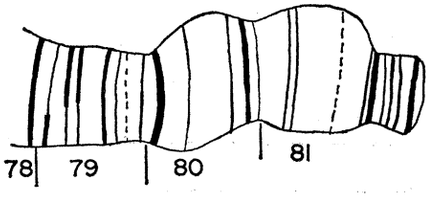

Fig. 2. Distal end of third chromosome with second new banding pattern. This chromosome has the AR gene arrangement.

significant difference between the chromosomal types in either length or width of these sections. Comparison of slides identically stained with the Feulgen reagent revealed no detectable difference in total staining.

The F_2 generation from the crosses of the altered stock with normal CH gave 72 normal and 26 altered karyotypes, suggesting a 3:1 ratio. A backcross of F_1 individuals to the altered stock gave 17 altered and 16 normal individuals, suggesting a 1:1 ratio. Crosses of the altered stock to individuals with normal chromosomes of the gene arrangements Chiricahua (CH) or Arrowhead (AR) gave all normal F_1 progeny (18 individuals). These breeding data strongly suggest the control of the chromosomal abnormality by a genetic unit that behaves as a single recessive gene which we call "salivary" (sal). This gene is probably located on the third chromosome, as shown by its failure to produce an altered chromosome in other than CH homokaryotypes in the population in which it was discovered. Since this gene has no known specific effects other than changing the chromosomal banding pattern, linkage tests cannot easily be made.

A single individual, in the same population from which sal was derived, was found to have another unique banding pattern in section 81 (Fig. 2). This pattern was observed in many cells of this gland, and occurred in an individual homozygous for the AR arrangement. The cause of this second abnormality is unknown, as it was not possible to obtain a stock of flies carrying this other abnormal chromosome. The absence of detectable structural heterozygotes in the population implies, as in the case of sal, that here again a chromosomal rearrangement is probably not involved.

To our knowledge, sal is the first gene found in *Drosophila* which causes a morphological change in a chromosome, other than the break caused by SD (*2*). Certain chromosomal rearrangements in *Chironomus* are however known to also cause changes in banding (*3*). In fact, to our knowledge, sal is the first gene known in any organism to produce a specific, single kind of viable chromosomal change. Experiments are now in progress testing the relative fitness of individuals carrying the altered CH as compared with those carrying the normal CH chromosome.

Until now a complex sequence of chromosomal rearrangements, such as is known to have occurred within *Drosophila pseudoobscura*, has been the only known mechanism for alteration of chromosome morphology. The discovery of sal suggests another mechanism, namely the establishment of genes that affect the chromosomal banding pattern itself. By the substitution of a single gene (sal), a banding pattern is produced which cannot be accurately homologized in every respect with that of the unaltered chromosome. Such a phenomenon could in part account for the evolutionary development of interspecific differences in chromosomal morphology (*4*).

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5 June 1962

Determination of the Tropospheric Residence Time of Lead-210

Abstract. The ratios of bismuth-210 to lead-210 in rain samples were used to calculate tropospheric residence time for lead-210. The value of about 6 days thus obtained agrees closely with the average interval between two rainfalls.

In the past few years much work has been done on determining the mean residence time of matter in the troposphere and stratosphere. Tracers produced by nuclear bomb explosions have commonly been used in these studies. During the 1958–60 nuclear bomb test suspension period, while artificial radioactivity decayed to a low level, it was possible to measure natural radioactivity for such a study.

Radon isotopes, decay products of thorium and uranium in the earth's crust, escape from the crust into the

atmosphere, where chains of nongaseous daughter products are formed. Radon daughters in the thorium and U^{235} chains decay to stable lead quickly, and those in the U^{238} chain decay to radioactive Pb^{210}. The activity ratios of Po^{210} to Pb^{210} and the ratios of Bi^{210} to Pb^{210} in rains can be used to calculate tropospheric residence times. The decay scheme is

$$Pb^{210} \xrightarrow[T_{1/2} = 21.4 \text{ years}]{\beta^-} Bi^{210} \xrightarrow[T_{1/2} = 5 \text{ days}]{\beta^-}$$

$$Po^{210} \xrightarrow[T_{1/2} = 138.4 \text{ days}]{\alpha} Pb^{206} \text{ stable}$$

Kuroda (*1*) used Sr^{89}, Sr^{90}, and Ba^{140} in 1957–1958 rains to calculate a tropospheric mean residence time of from 7 to 10 days. Von Buttlar and Libby (*2*) calculated the mean residence time for tritium in the troposphere to be about 3 days. Burton and Stewart (*3*) used the Po^{210}/Pb^{210} ratio in six rains in 1956 to calculate a mean residence time for the total atmosphere of 29 days, and for the tropospheric mean residence time, 22 days. Lehmann and Sittkus (*4*) reported values of 33 days and 14 days from Po^{210}/Pb^{210} ratios in 1957 rain and air samples respectively.

We felt that the 138-day half-life of Po^{210} might be too long for the accurate measurement of tropospheric residence time, and used 5-day Bi^{210} along with Pb^{210}.

The Pb^{210} was isolated by the addition of inactive lead carrier to rain samples and precipitation as sulfide, sulfate, and chromate several times. (When considerable quantities of Ba^{140} from recent bomb tests are present, extraction of lead into dithizone at *p*H 9.5 is necessary also.)

The Bi^{210} with added inactive bismuth carrier was successively precipitated as oxychloride, dimethylglyoximate (*5*), and phosphate. Bismuth activity, resulting from the decay of Pb^{210} between the time of rainfall and the time that analysis was begun (less than 2 days), was calculated and subtracted from the bismuth activity measured.

The gas-flow CE-14 Tracerlab counter used in this work employed an aluminized Mylar window 0.9 mg/cm² thick and had a low background of 1.0 count/min.

Table 1. Lead activities and Bi^{210}/Pb^{210} ratios with corresponding mean tropospheric residence times.

Rainfall		Pb^{210} ($\mu\mu$c/lit.)	Observed Bi^{210}/Pb^{210} ratio	Tropospheric residence time (day)
Date (1961)	Amount (mm)			
2 Feb.	4	7.9 ± 0.2	0.52	7.8
5 Feb.	4	4.6 ± 0.1	0.25	2.4
22 Feb.	3	1.1 ± 0.1	0.41	5.0
27 Feb.	6	1.3 ± 0.2	0.65	13.3
20 Mar.	10	2.2 ± 0.1	0.25	2.4
28 Mar.	2	5.8 ± 0.2	0.28	2.8
11 Apr.	27	1.5 ± 0.1	0.78	25.6
Average			0.45	5.9
7 June	18	5.0 ± 0.2	0.36	4.1
13 June	36	2.6 ± 0.3	0.37	4.2
13 Aug.	123	3.8 ± 0.1	0.41	5.0
15 Aug.	7	4.3 ± 0.4	0.49	6.9
23 Aug.	3	7.1 ± 0.1	0.76	22.7
Average			0.48	6.6

Table 1 shows the lead activities and Bi^{210}/Pb^{210} ratios with corresponding mean tropospheric residence times, in 12 samples of rain collected at Fayetteville, Arkansas. It was assumed that the Pb^{210} originated mostly from the troposphere. The uncertainties in the ratios and residence times are less than 20 percent. The Pb^{210} activities are in good agreement with those reported by Rama *et al.* (*6*) for three 1960 rains on the west coast, and with those reported by Burton (*3*) and Lehmann (*4*).

By introduction of a fallout constant k_T, the equilibrium for Pb^{210} and Bi^{210} present in the atmosphere can be described by

$$(\lambda N)_{Pb^{210}} = (k_T + \lambda_{Bi^{210}}) N_{Bi^{210}}$$

where λ represents the decay constant and N the number of atoms of the indicated species. This equation may be rearranged to

$$k_T = \left[\frac{(\lambda N)_{Pb^{210}}}{(\lambda N)_{Bi^{210}}} - 1 \right] \lambda_{Bi^{210}}$$

If experimentally obtained Pb^{210}/Bi^{210} activity ratios are used to solve for k_T, it is indicated that the tropospheric residence time of Pb^{210} ($1/k_T$) is of the order of 1 week, although individual values fluctuated, and values greater than 20 days were occasionally observed.

The mean residence time calculation is very sensitive to errors in either polonium or bismuth determinations. In considering the disparity between residence times reported by other authors and by us, this must be taken into account, as well as nonuniformity of air masses, and the fact that Arkansas gets land rains while other authors collected rains from the oceans.

The mean interval between two rainfalls in this region has been calculated for 34 months, November 1958 through August 1961. There were 171 precipitations in 1029 days, with the average interval between two rainfalls being 6.0 days. The mean tropospheric residence time of Pb^{210} shown in Table 1 (5.9 days and 6.6 days) is in excellent agreement with the mean interval of 6 days between two successive rainfalls in this area.

This illustrates that fine particulate matter, such as Pb^{210} formed by the disintegration of radon in the atmosphere, is efficiently captured by raindrops and removed from the atmosphere (*7*).

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7. We express our appreciation to Professor P. K. Kuroda for his helpful guidance in this research. The work was performed under the auspices of the Atomic Energy Commission.

18 May 1962