vey in 1955–57, made in about 20 states, the syndromes here described were encountered side by side in the field in three states: in Georgia in 1955 and in California and New Jersey (*7*) in 1957. In Georgia the Porto Rico variety and several seedlings were observed to be infected with feathery mottle. In California, feathery mottle was found on Red Velvet, a pigmented selection from Porto Rico. In New Jersey the affected variety was Georgia Red. In all cases in other states the "yellow dwarf" symptom description of common use in California was found to be generally applicable.

Incidentally, two similar sweetpotato disease syndromes caused by viruses are known in other countries. The Russian sweetpotato P.I. 105945 exhibits both syndromes. Sweetpotato root material from Israel exhibited both the cork and the feathery mottle syndromes and, when indexed, was apparently identical with the United States material.

Sheffield (*8*) reported that at least two viruses, designated A and B, attack sweetpotatoes in East Africa. Virus A, found only in one locality, caused a relatively mild disease and was transmitted by *Myzus persicae*. Virus B was widespread throughout East Africa and was transmitted by a white fly (*Bemisia tabaci* Genn.). There are a number of strains of virus B, the mildest of which may cause no symptoms in some sweetpotato varieties, whereas the others cause extremely severe diseases. Infection with virus A did not protect a plant from infection by virus B, but infection with a mild strain of virus B protected against infection by a severe strain of virus B. Neither virus was transmitted mechanically to healthy sweetpotatoes. Sheffield conjectured that virus A might be the same as one of the sweetpotato viruses in the United States but considered virus B to be distinguished from them by its insect vector, the white fly. However, we do have an as yet unidentified insect vector for the feathery mottle American counterpart, to judge by the spread of this disease in nature.

In an earlier report Sheffield (*9*) noted that in some cases there was no obvious stunting by virus B, "the symptoms being confined to mottling, or one runner only may be affected or one branch only of one runner. It is probable that the stunted forms are primary infections (i.e., they arose from infected vines), the milder forms being secondary (or new) infections."

The appearance of similar current-season symptoms at Beltsville, Maryland, in 1957 in the syndrome caused by our feathery mottle virus confirms her finding on virus B. It would appear that differences in the climate or environment of the continents and the effect of these differences on the agents of dissemination might account for the apparent discrepancies in the disease syndromes caused by similar viruses, but the possibility of specific differences exists. The latter view is supported in the recent report by Sheffield (*3*), who describes the transmission of sweetpotato virus to other hosts (several species of *Ipomoea* and of the family Solanaceae) by mechanical inoculation, by graft, and by means of white flies.

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Thorium Content of Ocean Water

Two samples of ocean water from the Pacific, one collected at the surface, near the coast, outside San Diego Bay in the summer of 1956, and the other taken at a depth of 3500 m from longitude 124° 41.0′ W, latitude 33° 54.5′ N on 25 March 1957, have been analyzed for total thorium alpha activity.

Each sample was approximately 25 liters in volume. Three hundred milliliters of concentrated HCl, 25 ml of $0.18M$ $Fe(NO_3)_3$ solution, and approximately 5000 count/min of Th^{234} beta tracer were added to each sample at the time of collection. The samples (in polyethylene containers) were stored for several weeks before they were analyzed.

The method of analysis was as follows. To carry the thorium, ferric hydroxide was precipitated by adding slight excess of ammonium hydroxide to the sample solution. The hydroxide precipitate was dissolved in dilute hydrochloric acid. Nitric acid and perchloric acid were added to the solution, which was then evaporated to fumes of perchloric acid. Addition of hydrofluoric acid and repeated fuming served to remove silica. The final solution was diluted to decrease the concentration of perchloric acid to $3N$ and was then transferred to a 4- by 100-mm Dowex-50 resin column to separate the thorium from carrier and extraneous ions (*1*). The thorium on the column was washed repeatedly with $3N$ hydrochloric acid. It was then eluted from the column with $0.5M$ oxalic acid. This eluant was treated with nitric acid and perchloric acid, heated to fumes of perchloric acid three times, diluted, and again transferred to the resin column. After washing with $3N$ hydrochloric acid, the carrier free thorium was eluted with $0.5M$ oxalic acid, and the eluant was collected on a tantalum plate. The plate was taken to dryness under a heat lamp, flamed, and counted for alpha and beta activity. The beta count served to determine the fraction of added Th^{234} which was recovered. From the observed alpha activity the total thorium alpha activity in the sample was calculated assuming complete exchange of thorium with the Th^{234} tracer.

In each of the samples analyzed, additional thorium was obtained from the first eluant and hydrochloric acid washings by taking these through further perchloric acid fumings and resin-column treatments. These second fractions of thorium which were separated from the surface water and deep ocean samples are designated below as S-2 and D-2, respectively.

Samples were counted on an alpha proportional counter at 51-percent geometry. The observed activities, corrected for yield, geometry, background, and reagent blank, are listed in Table 1.

The half-life values of Th^{232}, Th^{230}, Th^{228}, and Th^{227} (the only thorium alpha emitters which occur naturally) are 1.39×10^{10} years, 80,000 years, 1.90 years, and 18.6 days, respectively. Using these values, we calculate the following upper limits of concentration of thorium isotopes in the deep ocean sample (*2*): Th^{232}, less than 5×10^{-11} g/ml; Th^{230}, less than 3×10^{-16} g/ml; Th^{228}, less than 7×10^{-21} g/ml; Th^{227}, less than 2×10^{-22} g/ml.

Some information concerning the approximate isotopic composition of the thorium which was isolated from our surface water sample was obtained by observing the change in its alpha activity with time. The data for sample S-2 are shown in Table 2. The growth of alpha activity during the first 20 days

Table 1. Thorium alpha activity in Pacific Ocean water.

Sample	Th^{234} tracer recovered (%)	Th alpha activity (disintegration/hr liter)
	Surface	
Fraction S-1	10	9 (±2)
Fraction S-2	40	9.6 (±0.5)
	Deep ocean	
Fraction D-1	28	0.3 ±0.3
Fraction D-2	45	0.4 ±0.4

Table 2. Alpha activity in thorium isolated from surface water, sample S-2.

Elapsed time after chemical processing (day)	Total alpha activity in sample (disintegration/hr liter)	
	Observed	Calcd.
0	9.6 (±0.5)	
3	13.5 (±1.0)	13.5
4	15.2 (±0.9)	14.6
7	16.6 (±0.6)	16.7
18	18.5 (±0.6)	19.0
21	19.1 (±0.6)	
35	18.7 (±0.6)	18.3
73	16.7 (±0.6)	16.0
161	14.8 (±0.6)	14.3
221	13.7 (±0.5)	13.7
363	12.8 (±0.5)	

indicates the presence of Th^{227} or Th^{228}, or both.

The fact that the activity at 73 days is higher than the initial activity shows that Th^{228} is present. If we represent the initial activities (in disintegrations per hour per liter of water) of the individual nuclides by $A_{\mathrm{Th}^{232}}$, $A_{\mathrm{Th}^{228}}$, and so forth, we may write for the total initial alpha activity

$$9.6 = A_{\mathrm{Th}^{232}} + A_{\mathrm{Th}^{230}} + A_{\mathrm{Th}^{228}} + A_{\mathrm{Th}^{227}}.$$

At 363 days over 99.99 percent of Th^{227} and daughters will have decayed. Allowing for Th^{228} and daughter activity growth and decay during the 363-day interval (*3*) and assuming 100 percent Rn^{220} retention, we write for the total alpha activity at 363 days

$$12.8 = A_{\mathrm{Th}^{232}} + A_{\mathrm{Th}^{230}} + 3.5\ A_{\mathrm{Th}^{228}}.$$

At 21 days the activity of Th^{228} and its daughters will be 4.84 times the initial Th^{228} activity (*3*). The activity of Th^{227} and its daughters will be 2.31 $A_{\mathrm{Th}^{227}}$. Hence we write for the activity at 21 days

$$19.1 = A_{\mathrm{Th}^{232}} + A_{\mathrm{Th}^{230}} + 4.8\ A_{\mathrm{Th}^{228}} + 2.3\ A_{\mathrm{Th}^{227}}.$$

Solving the above equations, we find:

$A_{\mathrm{Th}^{227}} = 1.6$ disintegration/hr liter
$A_{\mathrm{Th}^{228}} = 1.9$ disintegration/hr liter
$A_{\mathrm{Th}^{232}} + A_{\mathrm{Th}^{230}} = 6.1$ disintegration/hr liter

Calculated total alpha activities at various times for a sample which initially had this composition are shown in Table 2 alongside the observed activities in the S-2 surface sample. The calculated and observed values are in good agreement.

Taking the uranium content (*4*) of ocean water as 3.0×10^{-6} g/liter ($A_{\mathrm{U}^{238}} = 130$ disintegration/hr liter), we see that in both samples the Th^{230} content is far below the amount required for secular equilibrium with the U^{238} present. In the surface water we find 5 percent or less of the equilibrium quantity of Th^{230}; in the deep sample less than 1 percent of the equilibrium amount.

The equilibrium Th^{227} activity corresponding to a uranium content of 3.0×10^{-6} g/liter is 6 disintegration/hr liter. A comparison with the experimental values listed above shows that the Th^{227} concentration in both the deep water and surface water samples is also below its equilibrium concentration with respect to U^{235}, indicating that not only Th^{230} but apparently also Pa^{231} or Ac^{227}, or both, are precipitated with the sediments.

Using the value 1.3×10^{-13} g/liter for the radium (*5*) content of deep ocean water, we calculate $A_{\mathrm{Ra}^{226}} = 17$ disintegration/hr liter. Hence, for the deep sample,

$$A_{\mathrm{Th}^{230}}/A_{\mathrm{Ra}^{226}} < 0.05$$

The radium content of the water is far in excess of the amount which can be supported by the Th^{230} which is present. Koczy, Picciotto, Poulaert, and Wilgain (*2*) report a similar situation in their Skagerak and Gullmerfjord samples. They suggest that the excess radium may arise from redissolution of radium originating from Th^{230} in the sediments (*6*).

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Relationship between Rate of Photosynthesis and Growth of Juvenile Red Salmon

Bare Lake, a 120-acre unstratified lake on Kodiak Island, Alaska, was fertilized annually during the period 1950–56 with inorganic nitrate and phosphate fertilizers. The total amount of fertilizer added each year was calculated to increase the concentration of phosphate phosphorus and nitrate nitrogen by approximately 0.05 and 0.25 mg/liter, respectively.

The purpose of fertilization was to determine whether this process will bring about an increase in the food supply of red salmon (*Oncorhynchus nerka*) during their lake residence, and thereby increase their growth and survival rate prior to their migration to sea, which may occur during the beginning of their second, third, or fourth year of age. Studies have demonstrated that fertilization during the years 1950–53 increased the rate of photosynthesis of the phytoplankton and increased phytoplankton production (*1*).

Phytoplankton are utilized by a variety of benthic insect larvae and zooplankton upon which the fish have been observed to feed. That these organisms have increased in production is strongly suggested by the fact that growth of young red salmon has increased since 1950 (Fig. 1*a*). The seaward-migrating red salmon, generally referred to as smolts, received no benefit from this fertilization in 1950, for they migrated prior to the July application and the juveniles during their first growing season probably received very little benefit by 27 August, the date their growth was calculated.

To obtain information about the size of red salmon smolts prior to 1950, measurements of scale radii were taken of smolt scales for the years 1950–53 and of the fresh-water zone scales from adult salmon that returned to the lake from the smolt migrations of 1947 through 1953. A significant correlation was found between the scale radii and fork length of smolts, and it was found that the fresh-water zone scale radii of adult red salmon were equal to or greater than scale radii measurements from samples of the smolts producing the adults. Since the scale radii of adult red salmon returning from the smolt migrations of 1947–49 were slightly smaller than those returning from the smolt migration of 1950, this is good evidence that the smolts of those years were no larger than those of 1950.

Thus, it appears that fertilization has brought about an increment in fish growth that has to date been rather progressive over the years. It is important to note that during the period no increase in growth of red salmon occurred