tying them submerged in the Ohio, Little Miami, Mohawk, and Clinch rivers for periods of 2 to 7 days, after which the contents showed high concentrations of several radionuclides, including cerium, cobalt, cesium, iodine, zirconium, ruthenium, zinc, and strontium. The presence of most of these radionuclides was not apparent from an analysis of the usual 1-liter volume of water. Packages of preserved tea, spinach, ion-exchange resin, and dead *Pithophora* showed less selectivity in uptake than live algae. In the dead group highest uptake occurred in dead *Pithophora*. Where aquatic environments are unfavorable for metabolism of live algae, these packaged materials could be used.

An advantage of sampling with such concentrators, particularly in the analysis of gamma-emitting radionuclides (all those listed above, except strontium), is that the contents of the polyethylene bag may be placed in a suitable container and counted directly without elaborate preparation of the sample, and sample preparation is made easier for strontium quantitation.

The chemical similarity of K to Cs and Ca to Sr may account, in part, for the ability of algae to concentrate all of them. However, these organisms assimilate only K and Ca. They do not substitute Cs for K or Sr for Ca. Therefore, the presence of nutrient levels of K and Ca are necessary for metabolism, which may permit the algae to accumulate huge amounts of nonmetabolic Cs and Sr. High levels of Ca and K, however, do reduce the accumulation of Sr and Cs (*3*). This has been repeatedly demonstrated in laboratory experiments. This reduction, however, is only apparent in live cells and has not been demonstrated in nonliving organic materials. For this reason preserved tea leaves, which are not as efficient as live *Pithophora* for concentrating Cs and Sr, may be better for quantitating fission products in natural bodies of water because this kind of uptake is not influenced, respectively, by natural levels of K and Ca. For example, at 25°C, preserved tea leaves were found to reach a peak equilibrium in 3 days and to concentrate Sr^{85} about 130 times and Cs^{137} about 80 times from water containing 3 or 30 parts of K or Ca, or both, per million, at several trace levels of these radionuclides. Experimental errors in the logs of counts were found to be approximately constant for this and some other organic material over the wide range of concentrations of these radionuclides, which might be similar to what could be expected from natural aquatic habitats.

Live *Pithophora* for quantitating is impractical, however, because moderate levels of K reduce the uptake of Cs and high levels of Ca reduce the uptake of both Sr and Cs. Both K and Ca concentrations vary widely in natural aquatic habitats; however, the uptake varies with the concentration of these competing ions; this fact may permit some generalizations.

For concentrating, live algae have a marked advantage over ion-exchange resins and dead materials, because they not only adsorb but concentrate ions such as Cs and Sr by active (living) transport into solutions with high concentrations within the cells. Resins can only absorb.

In the laboratory live *Pithophora* has concentrated Cs^{137} and Sr^{85} over 20,000 times. The efficiency of *Pithophora* as a biological indicator and concentrator under river conditions is shown by the gamma scan obtained with *Pithophora* (Fig. 1) compared to an indigenous filamentous alga (*Cladophora*) taken from the Mohawk River. With the exception of cerium, *Pithophora* shows the higher concentrations of these nuclides taken up by the two media and also demonstrates the presence of other radionuclides, notably cobalt. For further comparison, samples of fish and water taken at the same sampling location are included. Similar data, obtained with other organic concentrators immersed in the Clinch River at the mouth of White Oak Creek below the Oak Ridge National Laboratory, are shown in Fig. 2.

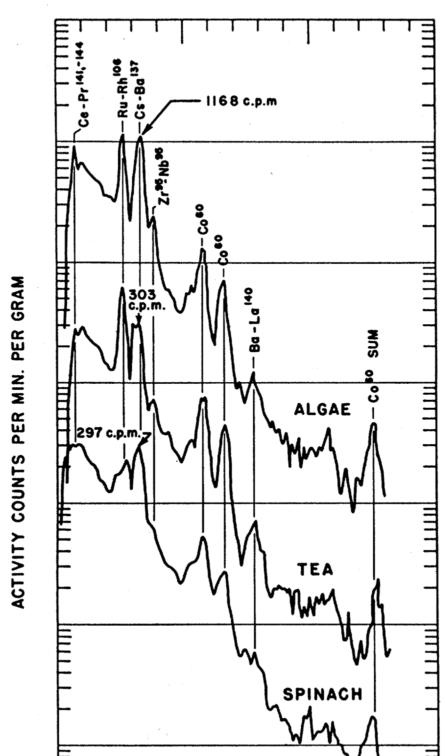

Fig. 2. Uptake of radionuclides in the Clinch River at the mouth of White Oak Creek near Oak Ridge National Laboratory, during 24 hours at 0°C in February 1960 by live *Pithophora*, preserved tea, and spinach packaged in perforated polyethylene bags. Uptake of these gamma-emitting nuclides by live *Pithophora* at this station at 20°C in June 1959 was generally higher by a factor of 10, while Cs^{137} was higher by a factor of 100, in laboratory trials.

The bulk of the information obtained, at least in the initial phases of evaluation, is qualitative, indicating the identity of the specific nuclides accumulated. Laboratory study indicates that quantification may be possible, because the concentration ratio for each medium at these trace levels, regardless of the nuclide, varies directly with the concentration of the nuclide in the water at the same temperature. Perhaps these concentrators may be useful in locating release of radioactive materials from waste containers disposed at sea.

Concurrent laboratory studies are in process in conjuction with field studies to identify, collect, and grow, under controlled conditions, selected biological concentrators.

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References

1. L. G. Williams and H. D. Swanson, *Science* **127**, 187 (1958).
2. L. R. Donaldson, A. H. Seymour, E. E. Held, N. O. Hines, F. J. Lowman, P. R. Olson, A. D. Wilander, "Survey of radioactivity in the sea near Bikini and Eniwetok atolls, June 11–24, 1956." Applied Fisheries Lab., Univ. of Washington, Seattle, 1956.
3. L. G. Williams, *Limnol. Oceanogr.* **5**, 301 (1960).

23 June 1960

Parental Body Build and Developmental Progress in the Offspring

Abstract. Children selected for study according to the body build of their parents were found to differ in rate of growth and in timing of osseous development. Boys and girls with large-chested parents were taller and heavier during the growing period and were more advanced in skeletal development than offspring of narrow-chested parents.

A relationship between "mesomorphic" body build and accelerated sexual maturation in boys has been reported by a number of workers (*1*). However, these findings are open to question because of the subjective nature and poor reliability of ratings on physique during childhood (*2*) and because greater

Table 1. Average comparative skeletal development of LL and SS boys and girls during infancy and childhood.

Variable	Sex	LL	SS	t
No. hand-wrist centers at 1.5 yr	M	7.8	6.3	1.73
No. hand-wrist centers at 1.5 yr	F	18.6	15.2	2.55
No. hand-wrist centers at 3.0 yr	M	22.1	18.4	4.20
No. hand-wrist centers at 3.0 yr	F	24.4	23.5	2.64
Hand-wrist completion (age)	M	6.7	7.7	2.05
Hand-wrist completion (age)	F	7.3	8.0	2.18
Bone age at 11.0 yr	M	11.9	10.1	5.29
Bone age at 11.0 yr	F	10.0	11.1	0.21

muscularity is a normal correlate of physiological advancement during the growing period.

In a preliminary investigation, subjects were selected according to parental mating combinations. The parents were categorized, by sex, according to their bony-chest diameters as measured on posteroanterior teleoroentgenograms, as "large" (above the mean) and "small" (below the mean). Children of the LL (large × large) and SS (small × small) mating combinations were then considered. In all, there were 20 LL parental mating combinations, with 56 offspring, and 15 SS mating combinations, with 31 offspring, in the study; however, the sample size was smaller in the adolescent period.

In replicate tests, the adult bony-chest diameter exhibited excellent short-term reliability ($r = 0.98$ to 0.99) and good 5-year reliability ($r > 0.90$) as an index of physical development. The bony-chest measurement has been shown to correlate well with the fat-free mass, or "lean body weight" (*3*), and is only slightly correlated with stature ($r = 0.2$). It is therefore a useful measure both of the lean body weight and of physique.

Offspring of the LL parental mating combination were compared with offspring of the SS combination for length and weight throughout the growing period, according to data, for individuals, from the Fels Longitudinal files. As shown in Fig. 1, LL boys surpassed SS boys in both length and weight from birth through 17 years, length being significantly greater from 5 through 13 years and weight from 1 through 17 years. The same tendency was observed for the girls, though the absolute differences were smaller, and significant only from 5 through 7 years for length and 5 through 9 years and at 17 years for weight. The 56 LL children of both sexes were longer and heavier than the 31 SS children throughout the growing period.

Further comparison was made for developmental status as measured by the number of hand-wrist ossification centers present at 1.5 and 3.0 years, the age of completion of the 28 bony nuclei of the hand and wrist (*4*) and for bone age at 11.0 years in both sexes, according to the Greulich-Pyle standards (*5*). As with length and weight, the LL children tended to be advanced over the SS children. More bony centers were present in the LL boys and girls at 1.5 and 3.0 years, and the full count of 28 centers was attained earlier in the LL children (Table 1).

A check on motor skills during early childhood showed LL children to be advanced over the SS offspring in Gesell scores at 0.5, 1.0, and 1.5 years (*6*), in Merrill-Palmer scores at 1.5 and 2.0 years (*7*), and in early Stanford-Binet quotients.

Clearly, parental body build, specifically the phenotypic mating combinations LL and SS, is associated with differences in the rate of growth and speed of maturation of the offspring. Children of broad-chested parents grow faster and are developmentally advanced during the growing period. Apparently, differences in adult physique are attained through different paths of development, suggesting that genes for body build also influence the rate of maturation (*8*).

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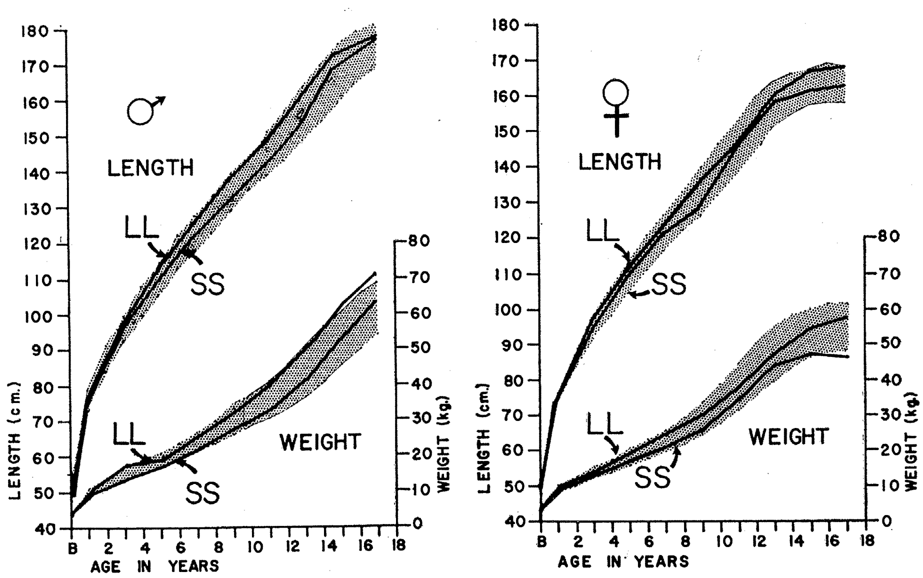

Fig. 1. Comparative growth of children of LL and SS parental mating phenotypes shown against the ± 1 σ limits (shaded areas) for the Fels Institute population. LL boys and girls tend to be longer during the growing period and heavier throughout.

References and Notes

1. W. H. Sheldon, S. S. Stevens, W. B. Tucker, *The Varieties of Human Physique* (Harper, New York, 1940); R. M. Acheson and C. W. Dupertuis, *Human Biol.* **29**, 167 (1957); E. E. Hunt, G. Cocke, J. R. Gallagher, *Human Biol.* **30**, 73 (1958).
2. R. W. Parnell, *Behaviour and Physique* (Arnold, London, 1958); E. E. Hunt and W. H. Barton, *Am. J. Phys. Anthropol.* **17**, 27 (1959).
3. A. R. Behnke, *Human Biol.* **31**, 297 (1959).
4. Radiographic determinations were made by Christabel G. Rohmann.
5. W. W. Greulich and S. I. Pyle, *Radiographic Atlas of Skeletal Development of the Hand and Wrist* (Stanford Univ. Press, Stanford, Calif., ed. 2, 1959). Radiographic determinations were made by A. H. Lewis.
6. A. Gesell, *The Mental Growth of the Pre-School Child* (Macmillan, New York, 1925). All behavioral test determinations were made by Virginia L. Nelson.
7. R. Stutsman, *Mental Measurement of Pre-School Children* (World Book Co., Yonkers, N.Y., 1931). Dr. Jerome Kagan arranged analysis of the longitudinal behavior records.
8. Data analysis was supported in part by grants M-1260 and A-3816 from the National Institutes of Health.

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Machine Retrieval of Pharmacological Data

The retrieval of pharmacological data from the literature has been reported by several workers in the field of science information. G. Congdon Wood (*1*) has devised a detailed code for storing, retrieving, and correlating chemical-biological data. Admittedly, the methodology of abstracting and filing