Again, the submature or mature main valleys, profile 2′, of the present cycle, presumably excavated beneath the wide-open old valleys of the earlier cycle, have not as yet encroached greatly upon the ore-bearing part of the inter-valley highlands, profile 6. The encroachment and removal will be greater and greater as the main valleys of the present cycle are widened, profile 3′, (the recent submergence is not indicated here) and as branch valleys are extended headward into the highland by retrogressive erosion. Still later, profile 4′, the highland surfaces of the earlier cycle and their residual laterite cover will be completely worn away; but finally, when old age is again approaching, profiles 5′ and 6′, new deposits will again be formed by rock disintegration and ore concentration on the subdued and lowering inter-valley hills of the future, just as happened in the past.

The superficial laterite ores of the serpentine highlands in New Caledonia therefore seem to be local as to area of development and intermittent as to time of origin and duration of occurrence. The same relations presumably obtain in a general way regarding the limonite and bauxite deposits of our Appalachian valleys.

[1] *Report, Ontario Bureau Mines*, No. 26, part 1, 1917.

[2] Richesses minérales de la Nouvelle Calédonie, *Ann. des Mines*, 1903–04.

A COMPARISON OF GROWTH CHANGES IN THE NERVOUS SYSTEM OF THE RAT WITH CORRESPONDING CHANGES IN THE NERVOUS SYSTEM OF MAN

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For a number of years the albino rat has been used for the study of growth changes which occur in the brain between birth and maturity.

As occasion offered, the results obtained from the rat have been compared with those from man, in order to determine how far the rat might be used for the study of the corresponding problems in man.

As all of these studies were in the field of growth, and as growth is a function of age, it became necessary in order to make the cross reference, to determine the equivalent ages of the rat and man.

Two observations were available for this determination.

1. The rat doubles its birth weight in 6 days, while man takes 180 days—giving a ratio of 1 to 30 days. From this it would appear that the rat was living 30 times as fast as man.

2. Again, a rat of 3 years is very old—so that I have ventured to compare a rat of this age with a man of 90 years. Once more the rat appears to be living 30 times as fast as man.

For working purposes we assumed that 1 day in the life of the rat was equivalent to 30 days in the life of man, and that the equivalent ages in these two animals were represented by equal fractions of the span of life.

One adjustment is necessary however in dealing with the data for the nervous system. The brain of the rat at birth is less mature than that of man at birth, and it is not until the rat is 5 days old that the brain is in the same phase as that of man at birth.

In making any comparison therefore the data for the rat at 5 days of age are arranged to coincide with the data for man at birth. Using the foregoing methods, four comparisons have been made between the growing nervous system of the rat and that of man.

The first chart is for the growth in the weight of the entire brain of the rat from birth to maturity, compared with that of man. When the human brain

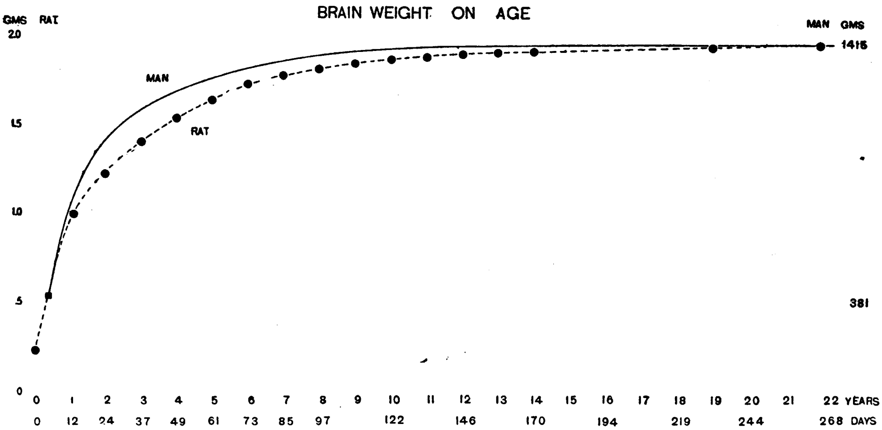

CHART 1

Showing the increase in the brain weight of the albino rat on age (broken line and dots) and compared with this the increase in the brain weight of man at the equivalent ages (solid line). The values for equivalent ages are on the same ordinate.

weights are reduced, and the comparison is made in the way described, the two graphs run well together. Thus, at equivalent ages, the brain in these two forms has undergone nearly the same degree of enlargement.

Chart 2 shows the percentage of water in the rat's brain at different ages. The graph indicates a rapid, followed by a slow loss of water, with advancing age. I have found only four corresponding records for man, namely at birth, 2 years, 9.5 years and 25 years, and these are entered by the heavy black dots at the equivalent ages on the graphs for the rat. The coincidence is good.

It has been determined that this loss of water is due to the progressive accumulation of myelin in the nervous system (Donaldson, '16) and the inference is therefore justified that the formation of myelin is progressing in a like manner in the two forms—only it progresses 30 times as fast in the rat.

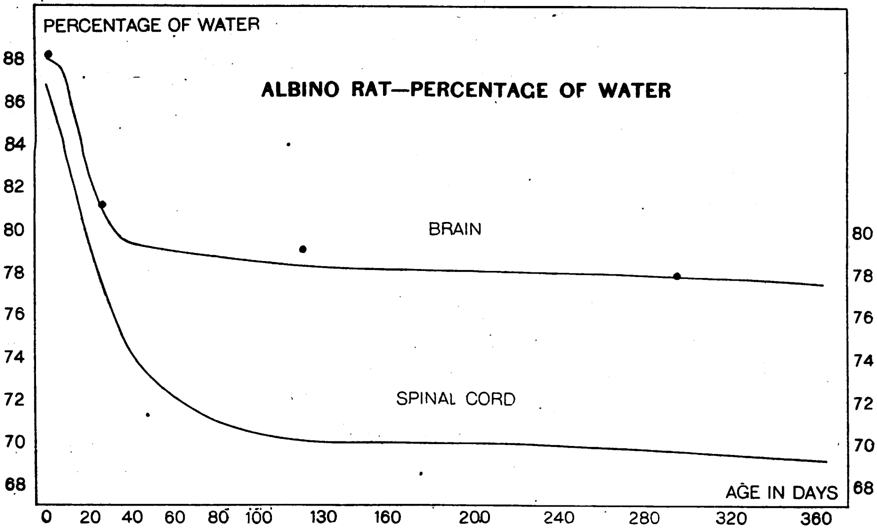

CHART 2

Showing on the upper graph the percentage of water in the brain of the albino rat from birth to 365 days. The four heavy dots represent the observation for man entered at equivalent ages. The graph for the percentage of water in the spinal cord is not discussed.

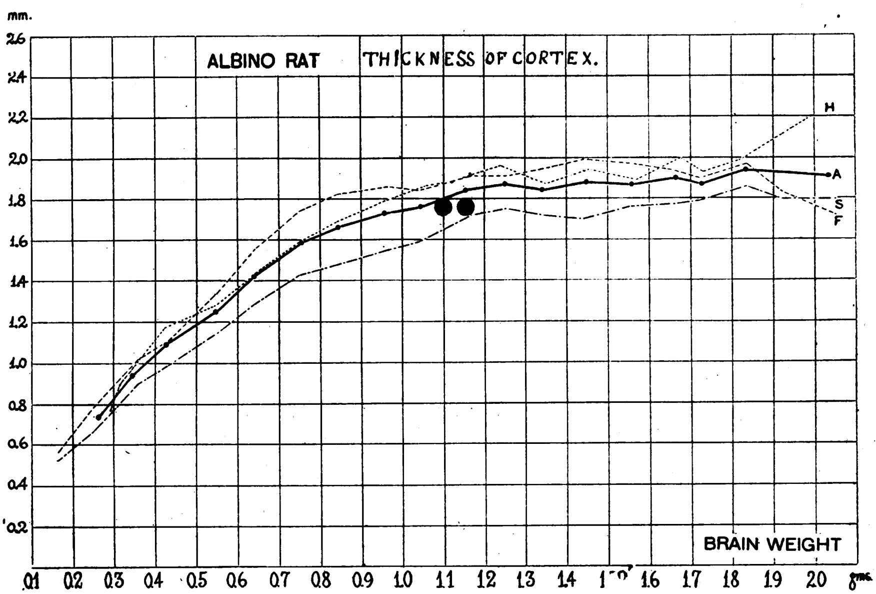

CHART 3

From Sugita '17, chart 9. Giving in millimeters the corrected thickness of the cerebral cortex of the albino rat; *H*, in the horizontal section; *S*, in the sagittal section; *F*, in the frontal section; *A*, the heavy line, represents the average of all of the measurements. The two heavy dots represent two incidental values for the human cortex—after reduction—entered at the equivalent ages.

The third instance is the maturing of the cerebellum, represented by the completion of the Purkinje cells and the disappearance of the external granule layer. In the rat these events occur between birth and 20 days of age, Addison '11. Like events occur in the human cerebellum and are completed in man at nearly the equivalent age. When the cerebellum has so far matured, locomotor control is attained in both forms, and thus this series of histological adjustments and locomotor control are accomplished at nearly equivalent ages in both the rat and man.

Finally, Dr. Sugita ('17) has just completed a study of the growth in thickness of the cerebral cortex of the rat, and the graph A in chart 3 shows that the mature thickness is nearly attained at the age of 20 days. There are at present no systematic studies on this point for man, but two incidental observations, entered as heavy dots, agree with the inference that at 15 months, the equivalent age, a like degree of completeness is reached by the human cerebral cortex, and therefore that only slight growth in the thickness of the human cortex is to be expected after this age.

There are therefore five prime events in the growth history of the nervous system of the rat, namely: (1) increase in total weight; (2) decrease in the percentage of water; (3) accumulation of myelin; (4) maturing of the cerebellum; (5) the attainment of the mature thickness of the cerebral cortex, all of which takes place at ages equivalent, or nearly equivalent, to those at which they occur in man.

It appears then that by the use of equivalent ages we have a satisfactory method for making a cross reference between the rat and man, and because the growth changes are similar in both forms, the rat may be used for further studies on the growth of the nervous system with the assurance that the results so obtained can be carried over to man.

Addison, William H. F., *Wistar Inst., Philadelphia, J. Comp. Neur.*, **21**, 1911 (459–481).
Donaldson, H. H., *Ibid.*, **26**, (1916), (443–451); these PROCEEDINGS, **2**, 1916, (350–356).
Sugita, Naoki, *J. Comp. Neur.*, **28**, 1917, (511–591).

VARIATION AND HEREDITY DURING THE VEGETATIVE REPRODUCTION OF ARCELLA DENTATA

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The conclusions of several investigators, that the genotype is constant in organisms that are multiplying by fission, have recently been put in question by the work of Middleton (1915) on *Stylonychia* and by Jennings[2] (1916) on *Difflugia*. Middleton obtained two lines of *Stylonychia* from a single specimen