Nail Growth: 30 Years of Observation

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Secular trends in growth of my thumbnail are reported. Various observations, including slowing of the rate of growth with infections, are recorded. The slowing of the rate of growth has progressed in somewhat irregular phases. This is a phenomenon that most people observe if they care to introspect themselves as they participate in the aging process. The average daily rate of growth has varied from 0.123 mm per day when I was 32 to 0.100 mm when I was 61.

"Divide your attentions equally between books and men. The strength of the student of books is to sit still—two or three hours at a stretch—eating the heart out of a subject with pencil and note-book in hand, determined to master the details and intricacies, focusing all your energies on its difficulties. Get accustomed to test all sorts of book problems and statements for yourself, and take as little as possible on trust. The Hunterian 'Do not think, but try' attitude of mind is the important one to cultivate. The question came up one day, when discussing the grooves left on the nails after fever, how long it took for the nail to grow out, from root to edge. A majority of the class had no further interest; a few looked it up in books; two men marked their nails at the root with nitrate of silver, and a few months later had positive knowledge on the subject. They showed the proper spirit. The little points that come up in your reading try to test for yourselves."
(*The Student Life: The Philosophy of Sir William Osler.* RE Verney (ed), Edinburgh, E & S Livingstone Ltd, 1957.)

"The oracle of old made it the top of wisdom to know oneself but did not fix credit to that fragment of self knowledge which enables a man to keep count of his own pulse." (Bean WB: *Aphorisms From Latham.* Iowa City, The Prairie Press, 1962.)

It is now about six years since I last rendered an account of my observations on the growth of my left thumbnail. I have accumulated information about the nail growth over the last 31 years. I began these observations the month before Pearl Harbor. The elapsed time has stretched across nearly half of my life. I was led to begin these studies because I could find no information about secular trends in nail growth and I remembered Osler's suggestion from his charming essay, "The Student Life," though I had to read his suggestion several times before it took effect.

I propose to review my own observations and discuss some of the important papers that have been written on nail growth in health and in disease and certain related phenomena.

Method

The rate of nail growth may be measured in many ways. Basically, some mark needs to be made and the time it takes the mark to move as the nail plate advances towards the free margin gives a measure of the rate of growth. The mark may be made by some indelible stain, such as nitric acid, or juice from the walnut hull, or it may be scored with a sharp small file, or little holes punched or drilled, or clippings from the nail may be measured and weighed. I have used the little file commonly employed to open small glass vials. On the first day of each month I filed a transverse groove just at the edge of the free margin of the cuticle. The end of the growing period was recorded when the mark reached the free edge of the nail, exactly 1.45 cm away. The cuticle is not manipulated except rarely shortly after the mark has been made.

At the beginning of the study, I marked all the nails of the left hand, the right thumb, and the nails of both great toes. Although there was a difference in the rate of growth, there was no variation among similar digits. Soon I confined my measurement to that of the left thumb. It was chosen because I am right-handed. The rate of toenail growth was distinctly slower than the rate of thumbnail growth. There has been no change in the distance from the edge of the cuticle to the free edge of the nail where the nail leaves its matrix. Some observers have held that one sign of aging is the shortening of the distance from the

Received for publication Nov 2, 1973; accepted Dec 3.

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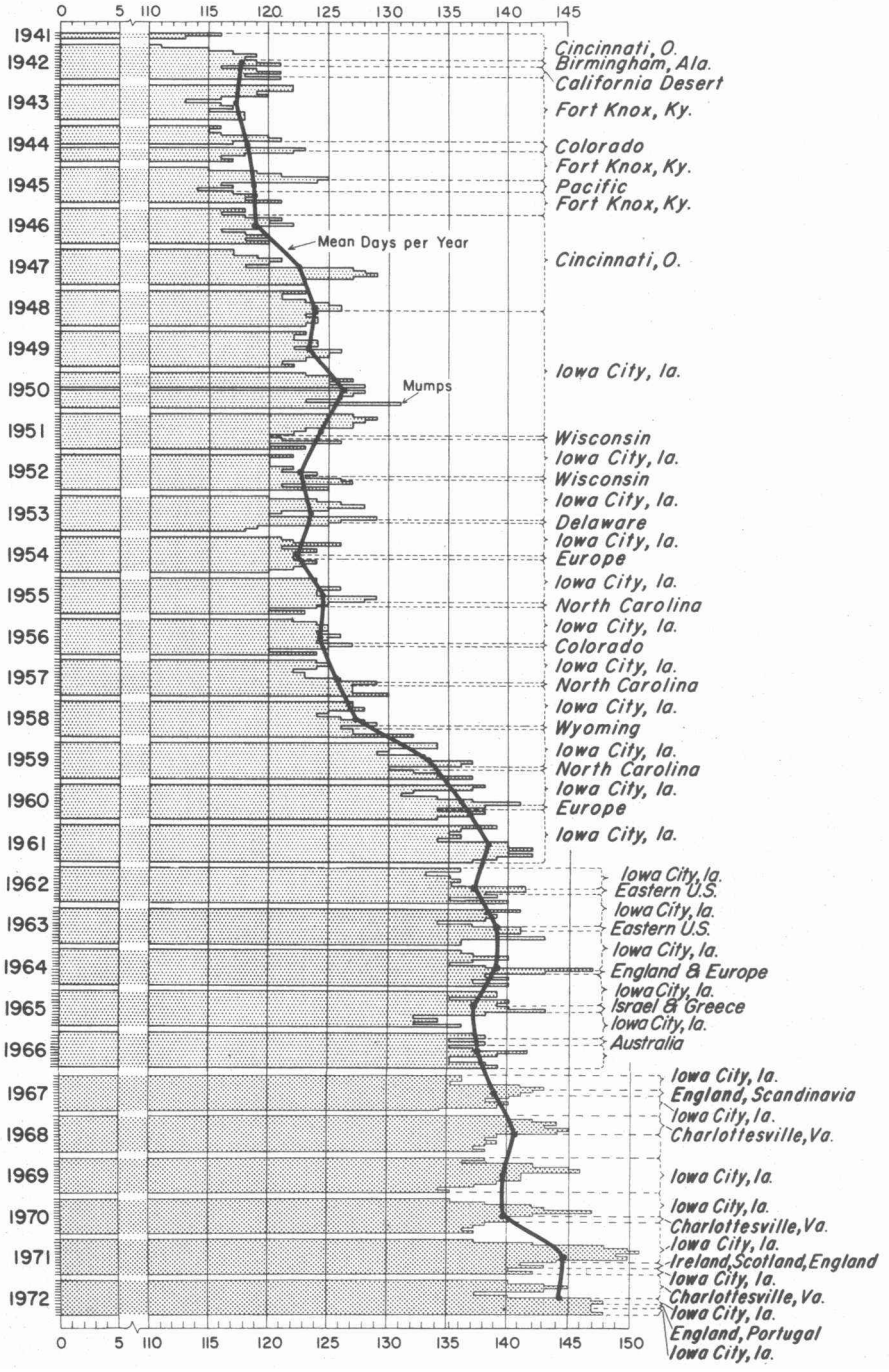

Fig 1.—Nail growth over a period of 31 years. Abscissa is total days of growth: ordinate is year and month.

cuticle to the free edge caused by recession of the juncture of matrix and free edge. This has not been true with my nails.

Early in my study I made many observations on nail clippings, both for linear growth and for weight. By measuring the distance from the free edge to the cut edge, it was found that anywhere from 25% to 50% of the nail disappeared by unnoticed attrition. This occurred from wear and at the end of the nail along the surface, particularly near the end. Most persons have observed when they cut their fingernails with straight scissors and do not file the little pointed angles that they soon wear down and the nail smooths out in a day or so of ordinary existence.

Observations and Comment

The two ways of arranging the data are in a graph (Fig 1) that records the number of days elapsing between marking the nail and the progression of the mark to the free edge, and a table with the same data (Table) in case anyone wished to make other use of the figures. The date of record is the first of each month. Things that affect growth rate may be reflected until the mark reaches the free edge. In my first paper[1] recording ten years' observations, each bar represented the number of days it took for the mark put down on the first of a particular month to reach the edge of the nail bed. Other interval reports were published in 1963 and 1968.[2,3] The first recorded the 116 days of growth from Nov 1, 1941, to Feb 24, 1942. In the most recent one, it took 148 days for the nail to grow out from Dec 1, 1972, to April 27, 1973. I wrote other papers on nails in 1959 and 1963.[4,5]

Although there is good evidence that the rate of nail growth increases when the environment is persistently warm and decreases when it is persistently cold, our central heating in the winter and working in an air-conditioned office in the summer have effectually removed such exposure to the weather as might be reflected in seasonal spurts and lags of growth. From the earliest observation onward there has been a slow and somewhat irregular decline in the rate of nail growth.

As I recorded in my first paper, infection, in my particular case a belated attack of the mumps, was associated with a very sharp slowing, practically a cessation of growth during the period when I had fever. In the third paper, I recorded two periods when influenza-like cold, with severe upper respiratory infection, was associated with similar but not quite as much slowing. Since my original observations, extensive studies, par-

ticularly by Hamilton et al[6] have demonstrated repeatedly in children with the ordinary childhood diseases that there is a sharp decline in the rate of nail growth.

During certain intermediate phases of the study, I took weekly photographs of the nail. One is shown in Fig 2. Detailed measurements of the growth for short periods could be examined in minute detail. In an effort to get precision in the photography, a small wooden frame was devised into which the thumb could fit snugly. The camera was fixed on a rack so that focal distance and other variables were kept constant. A small bit of transparent film which was marked in millimeters was held in position against a nail to facilitate measuring.

No variation in rate of nail growth related to geographical location, physical activity, or season was found. A good many trips to Europe, one to the Middle East, and one to Australia, with change in climate and environment, were not associated with any alteration in growth rate. Throughout the 31 years nearly every day I have engaged in some form of brisk physical activity: tennis in the spring, summer, and fall, and then squash in the winter from 1955 to 1972, when indoor tennis courts in Iowa City made it possible to play that game the year around, with only occasional periods of squash, such as the winter months and the two six-month periods in Charlottesville.

Other Observations

I very rarely get little white spots on the nails. One that occurred several years ago in the left thumbnail moved precisely the same rate as the marked groove until it got about a month away from the free edge; then the white mark diminished in size and it almost disappeared by the time it reached the free edge of the nail.

I have hammered my thumb once, producing a small hematoma. This too moved along with the nail and diminished substantially in size as it approached the free margin. Other recognized minor bumps and injuries have led to a few splinter hemorrhages. Sometimes these have appeared without any observed or recollected trauma. The subungual accumulation of blood, as well as splinter hemorrhages, moved out at the same rate the nail grew.

My left thumbnail has a longitudinal streak, where the color is slightly darker and the surface of the nail slightly furrowed. This part, which is thinner than the rest of the nail, when a portion is cut and the two ends are pressed together the thin part bends acutely.

Other Writings

I have followed at times systematically, at times erratically, medical writings for references to nail growth and have studied many of the papers. The earliest record I can find is one by S. Weir Mitchell,[7] published in 1871, with the provocative title "On the Growth of Nails as a Prognostic Indication in Cerebral Paralysis." Not only did he note transverse serrations, but he observed that the nails of the paralyzed hand in a 56-year-old women under his care for a stroke grew more slowly than those of the unaffected hand. This led him to stain with nitric acid the nails of two men with hemiplegia he saw soon after the acute episode. In each, the nails of the paralyzed hand failed to grow during the early days. Growth returned at its usual rate, abruptly in one after 12 days, and in the other after 21 days. On the basis of his observations of skin temperature and peripheral nerve function, he concluded that a central trophic influence rather than local ischemia was responsible. On a finger or hand immobilized in a splint, the nails grow more slowly than their normally functioning mate; this suggests that activity with its promotion of an increased blood supply may be the actual cause.

In 1899, Blake[8] reviewed the problem of nail growth in a little book, entitled *On Study of the Hand for Indication of Local and General Disease.* He was aware of Beau's observation that nails of the hand grow about 1 mm per week (*Arch Gen Med* 2:447,

Number of Days for Scored Mark at First of Each Listed Month to Reach Free Edge*

Years	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Average
1967	136	136	135	141	143	142	141	140	138	140	139	134	138.7
1968	140	142	144	143	145	144	139	138	139	138	137	138	140.5
1969	138	136	142	145	146	141	141	141	139	137	134	135	139.5
1970	135	138	142	143	147	142	140	140	138	137	136	137	139.5
1971	137	142	148	150	151	149	150	144	141	143	140	142	144.7
1972	140	143	145	143	137	140	147	148	147	147	147	148	144.3
Average	137.6	139.5	142.6	144.1	144.8	143	143	141.8	140.3	140.3	138.8	139	

* Table includes averages by year and averages for the various months. The length of the nail transversed was originally and has remained 145 mm. Anyone who is curious can convert the days into rates of growth. Others may content themselves with the comforting view expressed in the afterthought. Subsequent to the submission of this paper for publication, figures for 1973 and part of 1974 became available. They are as follows: 1973—January, 143; February, 144; March, 146; April, 144; May, 144; June, 144; July, 145; August, 145; September, 150; October, 150; November 150; December, 151; 1974—January, 146; February, 146; March, 149.

1846). Thus, according to Beau's observations, the nail would take about 105 days to grow from its first visible appearance under the cuticle until it reached the free edge. He said that Dufour gave the time as ranging from 121 to 138 days. Blake made many observations but they were somewhat hit or miss and have not all been borne out by other observations. He did notice that the rate of nail growth was normal in hysterical paralysis but greatly slowed in the paralyzed side in hemiplegia. He did not find the correlation between age and rate of growth that has been uniformly found by other observers. He noticed a considerable variation from person to person but not much in the same person.

Bier,[9] in his book on hyperemia, recorded observations made towards the end of the last century. He said, "without doubt both active and passive hyperemia lead to rapid growth of the covering epithelial structures. Thus, it is known that in summer when the skin is supplied with a greater quantity of blood than in winter, hair and nails grow faster. Besides there are numerous observations which prove that the same occurs in all chronic hyperemias." He referred many times to the increased growth of nails with hyperemia. The converse of this is well recognized when ischemia slows nail growth in the extremities, particularly on the feet. Hair frequently disappears on the dorsum of the toes. The rate of growth of all affected nails diminishes notably.

Schick[10] made 250 observations on the rate at which the "physiological nail line" of the newborn child moves to the free end of the nail. He records the data but there was so much individual variation that it was difficult to generalize from his facts.

Head and Sherren[11] independently observed that nail growth is retarded on the fingers of the paralyzed side and they indeed observed that similar slowing occurs when enforced immobilization is produced by fixing the limb or finger in a splint or cast.

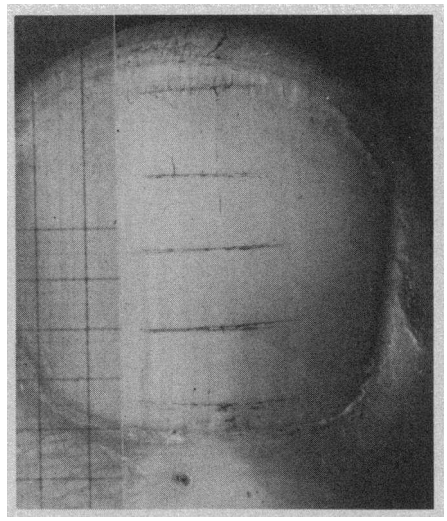

Fig 2.—Wax crayon has been used to make the filed marks clearer. Small tattoo mark is proximal to the free edge of cuticle.

LeGros Clark and Buxton,[12] who conducted their studies of nail growth on children in local Oxford schools, as well as undergraduates in the university, found no differences in the rate of growth of the nails of the right or left hand regardless of handedness, sex, or in relation to the age of the groups studied. Nail biters had a rapid growth, approximately 20% faster than that of nonbiters, as if to keep supplying the extravagant demands. LeGros Clark[13] noted a significant and consistent tendency for the nails to grow faster in warm weather in all the groups they studied. The growth rate of nails in poorly nourished children was distinctly slower than those who had good nutrition.

In comparison to the early days, more than 30 years ago, when it took my nail somewhere around 110 to 115 days to grow from starting point to free margin, the last six years show a variation between 137 and 145 days, continuing again the downward drift. These introspections and observations of mine call to mind the long contemplation and recording of the growth, the coming and going of an individual hair and its root that were recorded by Pinkus,[14] more than 25 years ago. During a six-year period, Pinkus took note of and recorded the events as 14 different hairs grew out from one root. Each lived out its brief span and disappeared. The first one was in situ when he began his observations and the 14th one was still in a healthy growing state when he grew tired and brought his study to a conclusion. He made careful observations of the period when no growth was occurring, the period when no hair was present, and the periods of active growth.

Lovell[15] could not find any speeding up of the rate of growth in clubbing of the fingers. Ronchese,[16] who has done so much to illuminate occupational nail and hand changes and diseases of the nail, has not specifically studied nail growth.

Hamilton et al[6] studied nearly 300 Japanese men and boys and the same number of women and girls and compared them with similar studies in 1,000 white subjects. They found unequivocal evidence for the reduction of the rate of growth of nails and hair with aging. This seems to represent a general biological truth as indicated by decreased rate of regeneration of the liver and other tissues growing in vitro. At the time when the adolescent spurt of growth is occurring, nails grow more rapidly and wounds heal faster. They also were able to demonstrate certain familial tendencies to have rapid growth or slow growth of nails. White and Japanese subjects did not differ in any substantial way. In both instances, male subjects tended to have a faster rate of growth. Starvation is associated with conspicuous slowdown in growth rate. Starvation, lactation, and the use of antimitotic drugs all slow the rate of growth of nails or claws.

Babcock[17] cited Robert Boyle's studies that go back to 1684, and commented upon Halban and Spitzer's observation that the rate of fingernail growth increases between a fourth and a third during pregnancy. He also cited Basler's observation that the rate of growth of the fingernail slowed at night. Babcock devised a number of fancy methods of measuring nail growth including making a deep scratch in the nail and filling it

with bismuth, amalgam, and taking roentgenograms. He found that this gave him the same results as ordinary photography that is much simpler.

Observations in the outdoors and in people living much out-of-doors where they are exposed to wind, sun, rain, snow, cold, and heat were reported by Geoghegan et al[18] who studied 49 sailors in the British navy in the temperate waters around Britain and on an Arctic cruise. They found that the mean daily nail growth in the Arctic environment was 0.114 mm per day, whereas in the temperate region it was 0.1194 per day.

The fact that the process of aging is associated with slowing of nail growth, without any alteration in the differentiation of its cells, suggests that progressive differentiation is not a requisite for at least one of the characteristic alterations that occurs with aging. Sibinga[19] studied the nail growth rate in many infections and made observations after death. The slowing of growth that I had observed during an attack of mumps is characteristic of infections generally. Sibinga brought what he thought was some support for the alleged growth of hair and nails after death. All evidence from a study of cells indicates that mitosis, begun before death, may be completed. No new mitotic activity begins. Thus, linear growth in the sense of the production of new cells and the pushing forward of the nail plate cannot occur after death. Such "growth" is apparent and not real. It results from the drying and shrinking of surface tissues after death. The cuticle retreats back from the nail plate and the nail appears therefore to have grown forward but there is no change at the free margin. The apparent growth results from the retreat of the cuticle, that is, the bench mark for the start has receded, the amount of exposed nail is increased. There has been no growth. In similar manner, apparent growth of beard occurs when the skin shrinks down.

Hale and Burch,[20] reviewing arteriovenous anastomoses and glomus bodies, emphasized the role in temperature regulation of such structures.

Morton[21] has introduced a special visual assessment of nail growth by drilling small holes in the nail and following their movement.

Van Utrecht-Cock[22] and van Utrecht[23] in Holland have made detailed studies of the wave-like periodicity and thickening and growth of the baleen plate of the fin whale and of the blue whale. They can thereby estimate the creature's age, and the time of the female's ovulation, changes in pregnancy, and changes that may occur during the migration from one pole to another with the intervening periods in tropical waters. It appears that ovulation, at least in some whales, is determined by the amount of daylight to which they are exposed as they swim the seven seas. Differences found in the baleen plate of the male and female fin whales indicate that the sexual cycle has much influence on the growth cycle. In the day-by-day existence of migrating fin whales, the length of day naturally varies, not only with the season but with where they happen to be. The length of daylight, water temperature, and other factors obviously may be involved. It has been postulated that the sexual cycle of the female fin whales is related to the length of daylight and the ovulatory cycle begins to appear when the length of day increases. Whales that roam from pole to pole have two periods of increase in the length of day during the course of each year and spring with migration to a high latitude and in fall when they migrate to a low latitude. Their travelog is clearly marked out in the baleen plates that the Dutch observers have found to be an extraordinarily useful measure of life history, including ovulation, previous pregnancies, and such private concerns of this kind of whale. Thus, the growth of deciduous tissue in whales and in many other mammals gives us a natural chronograph to record secular trends. In some tissues, nature makes its own mark on the moving record. It is comforting, thus, to have Melville's predictions borne out. In *Moby Dick*, Melville remarks that "In the central blinds of bone, as they stand in their natural order, there are certain curious marks, curves, hollows, and ridges, whereby some whale men calculate the creature's age, as the age of an oak by its circular rings. Though the certainty of this criterion is far from demonstrable, yet it has the savour of analogical probability."

Wheeler,[24] who studied the hoof growth of sheep as a possible index of nutrition in grazing animals, used a marking device very much like my simple method of scoring the nail. He concluded, initially, that hoof growth was an accurate and readily observed phenomenon that was a useful supplementary index of the nutritional state of grazing animals if the biological background could be standardized or was unknown.

More recently, Wheeler et al[25] have compared the effect of ambient temperature, foot temperature, and daylight on the hoof growth in sheep. They found that the relationship of temperature to growth is a complex one. Basically, things that increase the local temperature will increase the rate of growth. Total body temperature, as well as the temperature of the part of the foot where the hoof grows, is intimately related to shearing or the state of wool and degree of insulation. Thus, nutrition becomes but one of several factors that are important in the rate of growth of sheep's hoofs.

My observations have differed in some respects from those reported by others. The lack of seasonal variation I ascribe to the fact that our protected hothouse and air-conditioned existence effectively lifts us out of the external physical environment so that the effects of heat and cold were not detected. I have not observed seasonal changes at all and varying degrees of physical activity seem to have made no difference. During World War II, work in deserts and tropical regions and in a laboratory hot room with considerable exposure to large heat loads for eight or nine

hours daily over many months at a time or in the desert and tropical environment, I found no change. I conclude that our achievement of a virtually homothermic environment has nullified any temperature effect on nail growth.

The very gradual slowing down of nail growth that was observed during the first decade of the studies was followed by a sharper decline in rate that occurred in the period from 1957 to 1961. It was associated with no identifiable cause or change in activity in professional or physical activity. Another but slighter decline in growth rate has occurred in the last several years. There does not seem to be anything to account for it but the inexorable process of aging. In the pattern, as one follows it from month to month, there have been a number of unaccountable spurts or lags. I could find no relationship to varying physical activity, geographical location, season, travel, or anything else. The objective evidence of slowing in nail growth has occurred at periods when, though I was conscious of the passage of time and the almost imperceptible encroachments and diminishments of old age, I was aware of no subjective change. To be sure, there was a general slowing down and an evident but not alarming decrease in productive activity.

This mark of the slowing down of nail growth was borne in on me much more powerfully than any evidence of general slowing down, though this may indicate that perceptive capacity was slowing down. Or was I avoiding the implications of old age. If so, it was unconscious. The subtle graying of the hair, the slower pace of running, walking, or climbing stairs, the encroachment of presbyopia, to which I surrendered by getting bifocals at the age of 55, compare with the stark and finite memento in the diminuendo of nail growth.

Conclusions

Five more years of nail growth have not added any new findings as the rate stabilized from age 53 through 57.

Growth of deciduous tissues gives us a natural kymograph to record secular trends, and in some instances makes the mark on the moving record.

Afterthought

I herewith paraphrase Kemp Bennett Kolb's[26] mortal "New Unit of Length."

Just as the astronomers have on a cosmic scale a unit of length related to the time something special travels at its own speed, physics has long awaited a corresponding unit in the microcosmos. The proposed unit is the NAIL-SECOND: the distance a standard nail, my nail, grows in one second. Conveniently, there are nearly 10^{24} nail seconds in one light year, placing the new unit in the virus particle range and beyond.

To complete the definition my standard nail is defined as growing on a standard thumb at a rate of one nail-second (100 Ångstroms exactly) per second.

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