PINEAPPLES AND FIBONACCI NUMBERS

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In the book, Fibonacci and Lucas Numbers, by V. E. Hoggatt, Jr., there is a paragraph mentioning the spiral curves on pineapples which makes reference to Mathematical Diversions by Hunter and Madachy (Princeton, N. J., published by D. Van Nostrand Co., Inc., in 1963). Thus, parastichies on pineapples were known, then, sometime prior to 1963.

The author first became aware of the spiral curves and the agreement with Fibonacci numbers about 1951 upon reading an article in a magazine put out by the American Association for the Advancement of Science which pertained to Fibonacci Numbers. At that time, the author was working for the Maiu Pineapple Company, Kahului, Maui, Hawaii, and after reading this article, started checking pineapples. The vast majority of pineapples checked had 8 - 13 - 21 rows of fruitlets (eyes). A few runts were 5 - 8 - 13.

Since a pineapple with more fruitlets for a given size would likely have a finer texture and would be better for eating, the author was interested in finding a pineapple with 13 - 21 - 34 rows. No such pineapples were ever found, however.

Giving evidence to the fact that numbers of spiral rows on pineapples were studied even earlier, the Experiment Station of the Association of Hawaiian Pineapple Canners published an article on such a study as early as 1933. The article by M. B. Linford was published in the Pineapple Quarterly, Vol. III, No. 4, December 1933, pp. 185-195. It was entitled "Fruit Quality Studies II, Eye Number and Eye Weight," and mentioned the number of rows of fruitlets on pineapples as basically 8 - 13 spirals, ranging from 5 - 8 - 13 - 21 for the several types of spirals. The article did not, however, draw any connection between these numbers and the Fibonacci Numbers.

Following is a quotation from a section of this article which had the heading, "A Method of Estimating Eye Numbers."

> "A Cayenne pineapple fruit of usable size consists of from 100 to 200 fruitlets. This makes counting eyes in any large numbers of fruits both tedious and expensive. Where great precision is required there is no short cut, and when counts are made of very young inflorescences long before flowering the use of a low-power microscope is essential.

"For use where such precision is not required, however, the regular arrangement of eyes (fruitlets) suggested a method of estimating which is much more rapid. As may be seen in Figure 1, the fruitlets are aligned in two series of spirals, one rising to the right, the other to the left. One series of spirals is steep and is found, in Cayenne and at least some other varieties, to be composed of 13 separate rows of eyes. The other series, less steep, is composed of 8 longer spirals. Various irregularities occur, but in examining many individual fruits over a period of two years, no specimen has yet been found in which the basic pattern was other than 8 and 13 spirals. It follows from this uniformity that a count of eyes in one spiral, multiplied by the number of similar spirals should yield a figure close to the actual number of eyes. Errors are introduced by two factors: Some spirals have more eyes than others of the same fruit. In Figure 1b some spirals contain 11 eyes, some contain 12. Chance will determine which spiral is counted. Then as shown in Figure 2, irregularities may result in there being more or less than the regular number of spirals through part of the length of the fruit. By actual test, it has been determined that smaller errors result from counting the longer spiral and multiplying by 8, than from counting the short spiral and multiplying by 13. For this reason, the standard procedure adopted is to count the long spiral. On some fruits, this ascends to the right of the observer, on some to the left. After a little practice, it is recognized readily as the less steep of the two spirals which bound the four sides of an eye, considering the eye as a square standing on one corner. In case of doubt, it is safest to verify the number of spirals before counting eyes.

"Confusion may arise with extraordinarily small or large fruits from the fact that two other series of spirals may sometimes be recognized. These include steep, nearly vertical spirals, of which there are 21, and very flat spirals of which there are only 5. Thus the numbers of spirals of the several types are 5, 8, 13 and 21. The number of eyes counted in any spiral must be multiplied by the number of similar spirals.

"In other plant parts where spiral patterns occur, chance alone usually determines whether the spiral winds to the right or to the left. This was tested for pineapples by recording direction of spirals along with eye number for a large number of fruits during seasin 1932. Results are shown in Table 1. If chance determines we should expect to find equal numbers of right and left patterns. Actually among 9,008 fruits, right spirals were found 49.4 percent of the time, left spirals 50.6. Only one of the lots shown in this table deviated markedly from the expectation, and the 24 separate plots in that group showed no agreement among themselves; some had more left spirals and some more right. Chance alone seems to determine the direction of these spirals in the pineapple."