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Benjamin Banneker's Original Handwritten Document: Observations and Study of the Cicada

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Synopsis

Benjamin Banneker, farmer, mathematician, astronomer, and scientist, is known for his mathematical puzzles, ephemeris calculations, almanacs, his wooden clock, land surveying work, and famous letter on human rights. However, as a naturalist, his scientific and systematic observations of the cicadas are less known. In this paper we publicize Banneker's naturalistic study of the seventeen-year periodic cycle of the cicada and make available the original handwritten document of his observations. We also introduce the audience of this journal to an intriguing natural problem involving prime numbers.

Benjamin Banneker was born in Baltimore County, Maryland, to Robert and Mary Bannaky on November 9, 1731 (his family name changed slightly during his lifetime). Banneker died quietly in his Maryland cabin on October 9, 1806, after taking a leisurely walk with a friend. As he was being buried on October 11th, family and friends were astonished and saddened to see Banneker's cabin burning. Someone had set the cabin afire. It burned to the ground with valuable documents and artifacts inside. Only a small number of papers were saved. Friends had secured a few of his other written works and documents in their home [6]. In this paper, we share a rare document on Banneker's study of the cicada. We also introduce the audience of this journal to an intriguing natural problem involving prime numbers.

Figure 1: Benjamin Banneker, used with the courtesy of the Maryland Historical Society.

Banneker was a farmer, self-taught mathematician, astronomer, and scientist. He could have acquired his scientific mind and curiosity for the mysterious from his ancestral past, as he was born into a family of Africans whose ancestors were called the Dogon. The Dogon are known for their interest in the “dog star,” Sirius, and for their philosophy of theology and cosmology which is supported by a sophisticated numerical system [1, 6]. Banneker was a brilliant man and became a distinguished figure in history and academia. He is recognized for his famous letter to Thomas Jefferson on human rights, his wooden clock, his mathematical puzzles, ephemeris calculations, almanacs, and land surveying of the Federal Territory which was later called the city of Washington, now Washington DC [6]. Readers of this journal may be interested in reading more on Banneker’s mathematical puzzles and works; for this we refer them to [1, 14, 15, 19].

However, as a naturalist, Banneker’s observations of the cicadas (locusts) are much less known, taught, and publicized. Therefore, in this paper we hope to help publicize Banneker’s scientific documentations and study of the periodic cycle of the cicada, and to also make available the actual handwritten document of his study of the cicadas. Though mention of Banneker’s observations tends to be limited in much of the relevant literature, his accomplishments are noted in the works of Bedini [1] and Cerami [6].

Benjamin Banneker became fascinated with the mysteries and the magic of nature and science at a young age. In particular an insect the seventeen-year-old Banneker called the locust grabbed his interest. To him the locusts seemed to sing as well as dance. These locusts were in fact the seventeen-year cicada (see Figure 2). Banneker's curiosity was piqued, so he decided to study the cicada scientifically. Banneker studied and observed these locusts for fifty-one years. The following 1800 journal entry contains Banneker's scientific and mathematical thoughts about the life and behavior of the cicada. This observation was made on his farm in Maryland:

I like to forgot to inform, that if their lives are Short they are merry, they begin to Sing or make a noise from the first they come out of Earth till they die, the hindermost part rots off, and it does not appear to be any pain to them for they still continue on Singing till they die [See the bottom paragraph of Figure 3.]

He noticed and heard a slew of strange insects (cicadas). The sound was deafening and continuous. The insects were too numerous to get rid of, so he began an intense study of their behavior. They seemed to love each other as much as Banneker enjoyed studying them, for the cicadas' purpose of rising to the surface of Earth is to mate [21, 25]. The young farmer was curious enough to conduct a scientific and naturalistic observation of the cicada over several years. An interesting way to do this was to study not only the behavior of the cicadas, but also the life cycles. Are they here to stay? Will they be back? If so, when? Thus, as indicated in his Astronomical Journal below, it is obvious that he had a vast and cosmic interest in the re-emerging seventeen-year cycle of the cicada.

Figure 2: Cicada drawing (2004) by: Nkwanta Kinlaw Barber.

The first great Locust-year that I can remember was 1749th
 I was then about seventeen years of age when thousands of ^{them} came
 was creeping up the trees and bushes, I then imagined they came
 to eat and destroy the fruit ~~of~~ ^{of the} Earth, and would occasion a
 famine in the land, I therefore began to kill and destroy them but
 I soon saw that my labour was in vain, therefore gave over my pretension
 Again in the year 1766 which ^{is} seventeen years after their ^{first} appearance
 to me, they made a second, and appeared to me to be full as numerous as
 as the first. I then being about thirty four years of age I had more sen-
 sible than to endeavour to destroy them, knowing that they was not so pecu-
 cious to the fruit of the Earth as I did imagine they would be
 Again in the year 1783 which ^{is} seventeen years since their ^{last} second
 appearance to me they made their third and they may be expected again
 in the year 1800 which is seventeen since their third appearance to me
 so that if I may venture to express it, their periodical return is ^{se-} ^{venteen}
 seventeen years, but they like the comets make but a short stay with us
 The female has a sting in her ^{tail} as sharp and hard as a thorn with which
 she perforates the bances of the trees and in them holes lays eggs, that
 branch soon dies and fall, then the egg by ^{some} occult ~~operation~~ ^{cause} cause immor-
 a great death into the earth and there continues for the space
 of seventeen years as aforesaid
 I like to forget to inform that if their lives are short ^{as} ^{they} ^{are} ^{short}
 they are merry, they begin to sing or make a noise from
 the first they come out of Earth till they die, the ^{undermost} part rots off
 and it does not appear to be any pain to them for they still continue
 on singing till they die

Figure 3: Page from Benjamin Banneker's June 1800 Astronomical Journal (MS 2700 - Maryland Historical Society, Baltimore, Maryland).

Below is the exact printed record of the handwritten Banneker document in Figure 3. The last paragraph was quoted earlier.

The first great Locust year that I can Remember was 1749. I was then about Seventeen years of age when thousands of them came and was creeping up the trees and bushes, I then imagined they came to eat and destroy the fruit of the Earth, and would occasion a famine in the land. I therefore began to kill and destroy them, but soon saw that my labor was in vain, therefore gave over my pretension. Again in the year 1766, which is Seventeen years after the first appearance, they made a Second, and appeared to me to be full as numerous as the first. I then, being about thirty-four years of age had more sense than to endeavor to destroy them, knowing they were not so pernicious to the fruit of the Earth as I did imagine they would be. Again in the year 1783 which was Seventeen years since their second appearance to me, they made their third; and they may be expected again in the year 1800, which is Seventeen years since their third appearance to me. So that if I may venture So to express it, their periodical return is Seventeen years, but they, like the Comets, make but a short stay with us—The female has a Sting in her tail as sharp and hard as a thorn, with which she perforates the branches of the trees, and in them holes lays eggs. The branch soon dies and fall, then the egg by some Occult cause immerges a great depth into the earth and there continues for the Space of Seventeen years as aforesaid.

Banneker studied the cicada as long as he could because—as he recorded in his *Astronomical Journal* of scientific observations—these insects spend a very short while above ground each time they surface. Banneker recorded that his first experience with the cicada was in 1749 when he was seventeen years of age. In 1766, seventeen years later at age thirty-four, he observed their noisy presence again. And then again at age fifty-one (1783). And yet again at age sixty-eight (1800). Benjamin Banneker examined, scientifically observed, and documented the recurrence and behavior of the cicada through four seventeen-year cicada life cycles. Note that he wrote: “So that I may venture So to express it, their periodic return is Seventeen years, but they, like the Comets, make but a short stay with us. . .” This points to Banneker’s scientific understanding and his early documentation of the cicada life cycle.

According to his own documentation, Banneker studied the behavior of the cicada, as well as their interaction with the environment. Throughout history, several observers and writers have noted the appearance of cicadas [9, 17, 22, 25]. As we mentioned earlier, our research found that Banneker is hardly ever mentioned in the literature and history of scientific or mathematical information on the cicada. However, when he is noted, some write that Banneker was first to document the noisy recurrence of the seventeen-year cicada [19]. More accurately, documentation shows that Benjamin Banneker did observe the cicadas as early as 1749, but did not actually document the information until 1800. The cicadas' presence was first recorded as early as 1633 [11, 22], 1634 [17], and 1666 [13]. Later in 1775, Thomas Jefferson wrote in his Garden Book that locusts (cicadas) appeared at Monticello in Charlottesville, Virginia [3, 11]. He also noted that cicadas have seventeen-year cycles [3]. Banneker's *Astronomical Journal* referencing the cicada [1, 6] as well as other more recent [19] writings provide evidence that Benjamin Banneker is among the first American scientists to document and record chronological information of the seventeen-year cycle of the periodic *Magicicada*—*Brood X*, also known as the *Tibicina Septendecim cicada* [17].

There are three distinct species of cicadas in the Eastern United States; they all spend most of their life cycle underground in nymphal stages. Above ground as adults they live for only a few days. These cicadas have almost perfectly synchronized thirteen or seventeen-year periodic emergences. Not all types and species of cicadas are as synchronized, so it is unlikely that the different species of cicadas will cross, or ever get a chance to cross-mate. Furthermore the female cicadas only respond to the sound, or “love” song, of the males of her specific species. In striking synchronicity, mature nymphs periodically emerge above ground where many of adult cicadas mate, deposit their eggs, and then die within a few days. The cycle is then repeated every thirteen or seventeen years [21, 25, 26].

The cicadas seem to understand the prime numbers 13 and 17 innately. But of course we can ask about just how this happens to come about. Indeed several mathematical models relating to the prime numbers 13 and 17 have been developed, well after Banneker's lifetime, in order to explain why periodical cicadas may have evolved prime number cycles [2, 7, 10, 13, 18, 26].¹

¹“An insect population is said to be *periodical* if the life cycle has a fixed length of k years ($k > 1$) and if the adults do not appear every year but only every k th year” [4].

One thing that many mathematical population theorists find interesting is that the periods 13 and 17 of the periodical cicada problem are prime numbers [26]. There are two major hypotheses to explain this prime periodicity. The first involves an evolutionary strategy to avoid parasites. If the life cycle appears in prime numbers, it is highly unlikely that the parasites would match it [5]. The second hypothesis is “that prime periodicities are selected to avoid co-emergence and hybridization with periodical cicadas with different periods” [12].” The cited mathematical models have been constructed to investigate these hypotheses and thus are predator-prey models. This type of deterministic discrete population model studies the dynamics of the interactions between predator and prey. The cicada behaviors of predator satiation, parasitism, and competition between the nymphs under the ground have been studied using the model where various model parameters related to cicada environments and survival are examined. Besides these, other mathematical models have been developed to investigate the periodical cicada problem, such as a real-numbered base deterministic discrete model [24], a simulation base deterministic discrete model [27], a numerical model as a prime number generator [8, 16], and a model involving cellular automaton [5]. Even with all of these investigations, the full mechanism underlying the periodic cycles and the prime number conundrum are still not well understood. The prime number aspect of the question is naturally what most intrigues mathematicians [23, 26]. Based on our understanding of Banneker’s cicada observations and his well-known fascination with mathematics, we believe that he too would have been intrigued by these modern-day mathematical models, as well as the ongoing prime number conundrum of the cicada.

The Benjamin Banneker Historical Park and Museum, housed a few feet from his historical homestead, was again overrun by the pesky and loved periodic *Magicicada*—*Brood X* upon the authors’ visit there in May 2004. This area, in what is now named Oella (in Baltimore County, Maryland; see Figure 4 on the next page), is where Banneker was born and raised [6]. It is also where Banneker made notes of and observed the behavior of the cicada. These seventeen-year cicadas were flying everywhere, singing their song, dancing like ballerinas in love, and mating. When the authors visited Banneker’s homestead again in late June 2004, the cicadas were still present but naturally dying out. This was also during the twelfth seventeen-year cicada cycle since Banneker’s last recorded observation that brought him and his curiosity of the cicada back to life in a special way.

Returning to the Banneker homestead in February 2013, the authors realized, as Banneker likely did at some point during his studies, that the cicadas are now at the half-way point of their periodic cycle. A different brood (*Brood II*) should emerge in 2013, while the cicadas that Banneker researched, observed, and documented will return in 2021.

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References

- [1] S. A. Bedini, *The Life of Benjamin Banneker: The First African-American Man of Science*, 2nd Edition, Revised and Expanded, Maryland Historical Society, Baltimore, 1999.
- [2] H. Behncke, "Periodical cicadas," *Journal of Mathematical Biology*, Volume **40** (2000) pages 413–431.
- [3] E. M. Betts, *Thomas Jefferson's Garden Book (1766-1824): With relevant extracts from his other writings*, The American Philosophical Society, Philadelphia, 1944.
- [4] M. G. Bulmer, "Periodical insects," *The American Naturalist*, Volume **111** (1977), pages 1009–1117.
- [5] P. R. A. Campos, V. M. de Oliveira, R. Giro, and D. S. Galvao, "Emergence of prime numbers as a result of evolutionary strategy," *Physical Review Letters*, Volume **93** Number 3 (2004), pages 098107-1–098107-4.
- [6] C. A. Cerami, *Benjamin Banneker: Surveyor, Astronomer, Publisher, Patriot*, John Wiley and Sons, New York, 2002.
- [7] E. Goles, O. Schulz, and M. Markus, "Prime number selection of cycles in a predator-prey model," *Complexity*, Volume **6** (2001), pages 33–38.
- [8] E. Goles, O. Schulz, and M. Markus, "A biological generator of prime numbers," *Nonlinear Phenomena in Complex Systems*, Volume **3** (2000), pages 208–213.
- [9] S. P. Hildreth, "Notices and observations on the American cicada, or locust," *American Journal of Science*, Volume **18** (1830), pages 47–50.
- [10] F. C. Hoppensteadt and J. B. Keller, "Synchronization of periodical cicada emergences," *Science*, Volume **194** (1976), pages 335–337.
- [11] C. Jones, "A history lesson," *Cincinnati Enquirer*, May 5, 2004. Available online at http://www.enquirer.com/editions/2004/05/05/loc_cicadagr06.html, accessed on January 9, 2014.

- [12] R. Kon, “Permanence induced by life-cycle resonances: The periodical cicada problem,” *Journal of Biological Dynamics*, Volume **6** (2012), pages 855–890.
- [13] N. Lehmann-Ziebarth, P. P. Heideman, R. A. Shapiro, S. L. Stoddart, C. C. L. Hsiao, G. R. Stephenson, P. A. Milewski, and A. R. Ives, “Evolution of periodicity in periodical cicadas,” *Ecology*, Volume **86** (2005), pages 3200–3211.
- [14] B. Lumpkin, “From Egypt to Benjamin Banneker: African origins of false position solutions,” in *Vita Mathematica: Historical Research and Integration with Teaching*, R Calinger, ed., MAA Notes #40, Mathematical Association of America, Washington DC, 1996, pages 279–289.
- [15] J. F. Mahoney, “Benjamin Banneker and the law of sines,” *Mathematics Teacher*, Volume **98** Number 6 (February 2005), pages 390–393.
- [16] M. Markus and E. Goles, “Cicadas showing up after a prime number of years,” *The Mathematical Intelligencer*, Volume **24** Issue 2 (Spring 2002), pages 30–32.
- [17] C. L. Marlett, “The periodical cicada,” *U.S. Department of Agriculture, Bureau of Entomology Bulletin*, Volume **71** (1923), pages 1–183.
- [18] R. M. May, “Periodical cicadas,” *Nature*, Volume **277** (1979), pages 347–349.
- [19] C. Milloy, “Time to Create Some Buzz for Banneker,” *Washington Post*, April 14, 2004, page B-01.
- [20] T. F. Mulcrone, “Benjamin Banneker, pioneer Negro mathematician,” *The Mathematics Teacher*, Volume **54** Number 1 (January 1961), pages 32–37.
- [21] T. M. Powledge, “The 17-year itch: Brood X reappears, with clues to cicada behavior,” *Scientific American*, Volume **290** (2004), pages 32–33.
- [22] C. V. Riley, “The periodical cicada: An account of cicada septendecim and its tredecim race, with a chronology of all broods known,” *U.S. Department of Agriculture, Division of Entomology Bulletin*, 2nd ed., Volume **8** (1885), pages 1–46.

- [23] M. Stroh, "Mathematicians Explore Cicada's Mysterious Link with Primes," *Baltimore Sun*, May 10, 2004.
- [24] Y. Tanaka, J. Yoshimura, C. Simon, J. R. Cooley, and K. Tainaka, "Allee effect in the selection for prime-numbered cycles in periodical cicadas," *Proceedings of the National Academy of Sciences of the United States of America*, Volume **106** (2009), pages 8975–8979.
- [25] The University Of Michigan Museum of Zoology Insect Division, "Cicada Pages Index," website at http://insects.ummz.lsa.umich.edu/fauna/michigan_cicadas, accessed on January 10, 2014.
- [26] G. F. Webb, "The prime number periodical cicada problem," *Discrete and Continuous Dynamical Systems*, Series B, Volume **1** (2001), pages 387–399.
- [27] J. Yoshimura, T. Hayashi, Y. Tanaka, K. Tainaka, and C. Simon, "Selection for prime-number intervals in a numerical model of periodical cicada evolution," *Evolution*, Volume **63** (2009), pages 288–294.