WAS THERE A PRE-BIBLICAL 9-ARY NUMBER SYSTEM?

Olga Kosheleva
Ph.D. (Phys.-Math.), Associate Professor, e-mail: olgak@utep.edu
Vladik Kreinovich
Ph.D. (Phys.-Math.), Professor, e-mail: vladik@utep.edu

University of Texas at El Paso, El Paso, Texas 79968, USA

Abstract. In the Biblical Hebrew, in general, numbers were represented in decimal form. For example, a representation of 123 consists of three symbols that represent 100, 20, and 3. However, there are exceptions to this rule: for two numbers, 15 and 16, representation involve number 9, not number 10: 15 is represented as $9 + 6$, and 16 as $9 + 7$. Maybe this means that in the past, people used a 9-ary number system? In this paper, we explain why this hypothesis makes sense, how it explains that this system disappeared, and how we can use this hypothesis to further "spice up" the teaching of different number systems.

Keywords: 9-ary system, seven plus minus two law, ternary number system, Biblical mathematics, teaching number systems.

1. How Numbers Are Represented in the Bible: A Brief Reminder

In the Biblical Hebrew, numbers were represented by combinations of letters:

- aleph (א), the first letter of the alphabet, had the value 1,

- beth (ב), the second letter, had the value 2, etc.,

- . . .

- until we reach the tenth letter, which has the value 10.

Consequent letters have values 20, 30, . . . , 90, then 100, 200, 300, etc.

2. Exceptions

In general, this system was decimal. For example, to form a number

$$123 = 100 + 20 + 3,$$

we needed to write down letters corresponding to 100, 20, and 3.

There were, however, two exceptions – numbers 15 and 16 were represented in an unusual way:

- 15 was represented as $9 + 6$ and

- 16 was represented as $9 + 7$.

3.   Traditional Explanation of the Above Two Exceptions

Traditionally, there is a theological explanation for this:

- Letters corresponding to a more standard representation $10 + 5$ or $10 + 6$ also form the name of God.

- Thus, using such a decimal representation would have contradicted the commandment not to use God's name in vain.

4.   Possible Mathematical Explanation

However, maybe there is a mathematical explanation for these exceptions? Just like:

- the fact that in modern French and Spanish, there are special words for 20, words which are different from the usual words for multiples of ten, indicates that their ancestors use base-20 system,

- maybe the ancient Hebrews used base-9 number system?

5.   This Explanation Makes Psychological Sense

Base-9 system actually makes sense: indeed, in psychology, there is a famous "seven plus minus two law", according to which we can simultaneously keep in mind between 5 and 9 items – the actual number depends on the individual; see, e.g., [4, 5].

- From this viewpoint, it makes sense to have a base-5 system: since everyone can keep 5 different items in their mind. Such a system was indeed used, e.g., by the Mayans; see, e.g., [1–3].

- Base-9 numbers also make sense: they correspond to number for which some people can still keep that many items in their mind.

Here:

- while base-5 numbers can be viewed as universal – for everybody,

- base-9 numbers can be viewed as special numbers for those who can master them, for the skilled elite.

6.   This May Explain Why 9-Ary System Was Forgotten

9-ary numbers are as elitist as we can have – 10 items are already impossible to remember. This elite character of the base-9 numbers may be the reason why this system – provided that it was actually used – was largely forgotten and only traces of it remain.

7.   Base-9 Numbers Make Sense Computationally

Base-9 numbers are, in effect, ternary (base-3) numbers if we combine every pair of consecutive ternary digits into a single 9-ary digit, just like:

- we combine a triple of binary digits into an octal number, and

- we combine a quadruple of binary digits into a hex (base-16) number.

This is interesting, because ternary numbers are actually provably the most adequate for computations; see, e.g., [2]. Because of this, in the past, there were even computers that used ternary numbers, not the usually binary digits 0 and 1 [2].

8.   What Can We Do With This Suggestion?

From the viewpoint of history of science, what we are doing is a speculation. We have to wait for a more serious evidence for this suggestion to be taken seriously by historians.

However, speculation or not, nothing prevents us from using this suggestion when teaching students different number bases:

- just like the Mayan reference helps to spice up this material,

- the Biblical hypothesis may need to further increase in interest, especially in Christian and Jewish religious schools, where the Biblical references will definitely resonate with the students.

Acknowledgments

References

1. Boyer C.B. and Merzbach U.C. History of Mathematics. Wiley, Hoboken, New Jersey, 2011.

2. Knuth D.E. The Art of Computer Programming. Vol. 2: Seminumerical Algorithms. Addison-Wesley, Boston, Massachusetts, 1980.

3. Kosheleva O. and Villaverde K. How Interval and Fuzzy Techniques Can Improve Data. Springer, Cham, Switzerland, 2018.
4. Miller G.A. The magical number seven, plus or minus two: Some limits on our capacity for processing information. Psychological Review, 1956, V. 63, no. 2, pp. 81–97.
5. Reed S.K. Cognition: Theories and Application. Wadsworth Cengage Learning, Belmont, California, 2010.

СУЩЕСТВОВАЛА ЛИ ДОБИБЛЕЙСКАЯ 9-РИЧНАЯ СИСТЕМА СЧИСЛЕНИЯ?

О. Кошелева
к.ф.-м.н., доцент, e-mail: olgak@utep.edu
В. Крейнович
к.ф.-м.н., профессор, e-mail: vladik@utep.edu

Техасский университет в Эль Пасо, США

Аннотация. В древнееврейском языке числа в общем были представлены в десятичной форме. Например, представление числа 123 состоит из трёх символов, которые представляют 100, 20 и 3. Однако, из этого правила есть исключения: для двух чисел, 15 и 16, представление включает в себя число 9, а не 10 - 15 представляется как $9 + 6$, а 16 как $9 + 7$. Может быть, это означает, что в прошлом люди использовали 9-ричную систему счисления? В этой статье мы объясняем, почему эта гипотеза имеет смысл, как объясняется исчезновение этой системы и как мы можем использовать эту гипотезу, чтобы в дальнейшем «оживить» изучение различных систем счисления.

Ключевые слова: 9-ричная система, закон «семь плюс минус два», троичная система счисления, библейская математика, изучение систем счисления.