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# Masters of Math, From Old Babylon

By EDWARD ROTHSTEIN

If the cost of digging a trench is 9 gin, and the trench has a length of 5 ninda and is one-half ninda deep, and if a worker's daily load of earth costs 10 gin to move, and his daily wages are 6 se of silver, then how wide is the canal?

Or, a better question: if you were a tutor of Babylonian scribes some 4,000 years ago, holding a clay tablet on which this problem was incised with cuneiform indentations — the very tablet that can now be seen with 12 others from that Middle Eastern civilization at the Institute for the Study of the Ancient World — what could you take for granted, and what would you need to explain to your students? In what way did you think about measures of time and space? How did you calculate? Did you believe numbers had an abstract existence, each with its own properties?

And how would you have figured out the width of that canal (which, the tablet tells us, is one-and-a-half ninda)?

Spend some time at this modest yet thoroughly intriguing exhibition, "Before Pythagoras: The Culture of Old Babylonian Mathematics," and you begin to realize that the answers can be far more cryptic than these tablets were before great scholars like Otto E. Neugebauer began to decipher them during the first half of the 20th century.

The institute, part of New York University, has gathered together a remarkable selection of Old Babylonian tablets from the collections of three universities — Columbia, Yale and the University of Pennsylvania — that cover a wide mathematical range. Made between 1900 and 1700 B.C., they include student exercises, word problems and calculation tables, as well as more abstract demonstrations. Under the curatorship of Alexander Jones, a professor at N.Y.U., and Christine Proust, a historian of mathematics, the tablets are used to give a quick survey of Babylonian mathematical enterprise, while also paying tribute to Neugebauer, the Austrian-born scholar who spent the last half of his career teaching at Brown University and almost single-handedly created a new discipline of study through his analysis of these neglected sources.

Only about 950 mathematically oriented tablets survived two millenniums of Babylonian history, and since their discovery, debate has raged over what they show us about that lost world. Every major history of Western mathematics written during the last 70 years has at least started to take Babylonians into account. Generally, their systems have been seen as precursors to the theoretical flowering of Greek mathematics, out of which our own mathematical approaches have grown.

But Neugebauer, and then his many students and rivals, also showed how sophisticated Babylonian mathematics was and how many similarities existed to later Western systems — if, that is, you counted using 60 fingers (as we often seem to, thanks to the Babylonians, when dealing with seconds and minutes and, in part, even when measuring angles).

Examining the surviving tablets, including one multiplication table on display here, scholars decoded the bird's feet of Babylonian numerals, showing that the Babylonians, like us, used the same symbol to represent different numerical values. (The same digit for us has a different value if it is in the 1's column, the 10's column, or the 100's column; the Babylonians could use the same sign, depending on context, to represent a 1 or a 60 or a 3,600.)

The most famous tablets here — one showing a square with two diagonals, and another, known as Plimpton 322, containing a table of numerical symbols — suggest that the Babylonians knew at least some of the consequences of the theorem that now bears the name of the Greek mathematician Pythagoras, who lived some 1,500 years after these works were chiseled.

But did the Babylonians conceive of it as a "theorem" — a timeless truth subject to proof based on accepted principles? Or was it thought of as a property of areas of land that were mapped out by surveyors? Or, as one scholar recently wrote, was Plimpton 322 "a teacher's catalog of parameters" for calculation? Or something else completely?

Aside from the fact that the analysis of these tablets is relatively recent, one of the problems is that much of their context is hypothetical, because of the almost haphazard way in which early modern explorers pulled these artifacts out of the layered rubble of ancient mounds of detritus. In a fascinating 2008 book, "Mathematics in Ancient Iraq: A Social History" (Princeton), Eleanor Robson even suggests that many tablets like these of the second millennium B.C. "were essentially ephemera, created to aid and demonstrate recall, destined almost immediately for the recycling bin."

But as Ms. Robson also points out, these tablets' word problems about digging and construction, their use in teaching record keeping and calculation, and their implicit affirmation of the importance of scribes and teachers, also reveal a highly organized, bureaucratic society, an "ordered urban state, with god, king and scribe at its center."

At the exhibition itself, it would have helped if some of the translations and interpretations of the tablets provided in an accompanying brochure had been made available directly on the labels themselves, so you could both look at the artifact and see how to interpret it.

It might have helped, too, if the show suggested the kinds of debates that have arisen about the status of Babylonian mathematics, which, in many ways, parallel larger debates about Western and non-Western cultures. In this case those debates become all the more charged because of the geographical region involved.

While once, for example, Babylonian mathematics was clearly seen as a precursor to the Greeks and to Western systems, there is an impulse now to see it as a historical victim of Western cultural perspectives. That is partly how Ms. Robson portrays it, even (unconvincingly) evoking Edward Said's book "Orientalism"; a hint of that sentiment may even be one of the subtle draws of this exhibition.

But for an outsider surveying these objects and the history, the response is at once awe at the ancient minds that created such powerful systems for understanding and ordering experience, and still more amazement at the mathematical world that later developed and went so much further: explicitly turning individual examples into theorems, earthly practices into abstract principles and outlining new methods for understanding that are still being applied.

*This is the trench solution as it appears on the Babylonian tablet. The translation, by Alexander Jones, a curator of the "Before Pythagoras" exhibition, is in the show's brochure:*

"Solution: Multiply the length and the depth, and you get 30. Take the reciprocal of the workload, multiply by 30 and you will get 3. Multiply the wages by 3, and you will get 6. Take the reciprocal of 6, and multiply it by 9, the total cost in silver, and you will get its width. One and a half ninda is the width. Such is the procedure."

(A reciprocal in Babylonian arithmetic is in relation to 60, so the reciprocal of 10 is 6.)

*"Before Pythagoras: The Culture of Old Babylonian Mathematics" is on view through Dec. 17 at the Institute for the Study of the Ancient World, New York University, 15 East 84th Street, Manhattan; nyu.edu/isaw.*