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Rock Art Tallies: Mathematics on Stone in Western North America

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Synopsis

Western North America abounds with rock art sites. From Alberta to New Mexico and from Minnesota to California one can find the enigmatic rock paintings and rock carvings left by the pre-Columbian inhabitants. The images left behind on the rocks of the American plains and deserts are those of humanoids and animals, arrows and spears, and a variety of geometric shapes and abstract designs. Also included, in great numbers, are sequences of repeated shapes and marks that scholars have termed “tallies.” The tallies are presumed to be an ancient accounting of something or some things. This article examines rock art tallies as instances of ancient mathematical thought.

Western North America abounds with rock art sites. From Alberta to New Mexico and from Minnesota to California one can find the enigmatic rock paintings and rock carvings left by the pre-Columbian inhabitants [4, 5, 6, 8, 9, 11, 13, 16, 19, 20, 22]. The images left behind on the rocks of the American plains and deserts are those of humanoids and animals, arrows and spears, and a variety of geometric shapes and abstract designs. Also included, in great numbers, are sequences of repeated shapes and marks that scholars have termed “tallies.” The tallies are presumed to be an ancient accounting of something or some things. They are also a record of mathematical thought.

Lakoff and Núñez [10] tell us that two of the fundamental cognitive capacities needed to be able to count on our fingers are the grouping capacity and the pairing capacity. We need to be able to group discrete elements either physically or mentally. We need to be able to pair individual fingers with individual objects. These two mental capacities are among the most funda-

mental human mathematical capacities. Humans also have the additional capacity to pair objects with abstract marks. In this case, the activities of grouping and pairing may be manifested in the archaeological record. This record takes the form of tally marks carved in stone. A tally mark is a symbol that represents one or more objects, entities, or concepts. A tally mark can represent a man, a bear, a day, a month, a prayer, or just about anything that can be enumerated.

This essay offers an introduction to North American rock art tallies from a mathematical point of view. My goals are to widen awareness of the tally corpus among mathematics teachers and to inspire research into the structure and meaning of tally texts.

Let us begin with the partial panel of pictographs from western Montana shown in Figure 1. Here we see a collection of strokes surrounding a stick figure. Strokes are the most well known tally mark. Most of us have used tallies to keep track of something. Children use tallies to keep score in games. Prisoners (in cartoons) use tallies to keep track of their days behind bars. Tallies are among the earliest means of accounting [1]. It is safe to assume that the ancient carvers of rock art were also using tallies to record or count.



Figure 1: Tallies in western Montana (drawn by the author after [8, page 41]).¹

¹I drew most figures in this essay (all except Figures 3 and 5) by hand, inspired by figures and photographs in rock art books. I have long been interested in the study of mathematical ideas in the ethnographic and archaeological record. My interest in ancient mathematical ideas led me to earning a master's degree in anthropology and acquiring a nice collection of materials on pictographs and petroglyphs. I hope that the drawings I selected for this essay give the reader a taste of the vast record of tallies in stone.

When we look at the tallies on a petroglyph or pictograph panel, we are confident that the strokes and the spaces between the strokes had some meaning to the artist. But what was that meaning?

With some exceptions, what the rock tallies are tallying cannot be determined. As a result, most rock art researchers have focused on non-tally rock art (see [23] for an overview of rock art research and [2] for a critique of the current state of rock art research). From the perspective of the history of mathematics and ethnomathematics we find tallies interesting in their own right because they are a record of mathematical thought. Looking at Figure 1, we see (reading left to right) groups of 2, 6, and 1 strokes followed by (reading top to bottom) 5, 8 and 6 strokes. The total number of strokes is 28. Could they be some reference to a lunar cycle? Or, as one of my students suggested, is this a record of arithmetic ($2 + 6 = 8$, $5 + 1 = 6$)?

A second popular and pervasive tally mark is the painted or carved dot. An example of a carved dot site from British Columbia is shown in Figure 2. The open circles may or may not be part of the tally. In this carving the dots are in groups of 5, 12, 14, 2, and 2. What could they be counting?

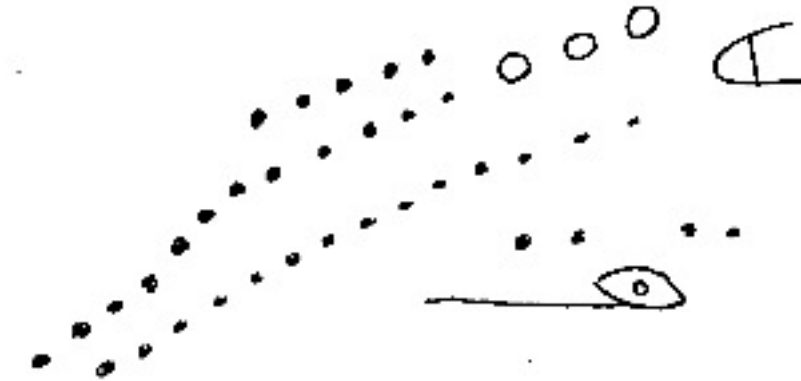


Figure 2: Dot tallies at Douglas Channel, British Columbia (drawn by the author after a photograph by Ray Hill [6, page 184]).

Tallies may be composed of symbols other than strokes or dots. There are many of these in North American rock art. Table 1 offers twenty examples. Some of the symbols are certainly suggestive of actual objects or cultural artifacts. They may be representational, iconic, or purely abstract symbols.





















	Tally Mark	Location	Reference
1		Atherton Canyon, MT	Sundstrom 1990:294
2		Atherton Canyon, MT	Sundstrom 1990:294
3		Robison Rockshelter, MT	Sundstrom 1990:294
4		Robison Rockshelter, MT	Sundstrom 1990:294
5		Signal Mountain, MT	Sundstrom 1990:295
6		South Comanche Creek, MT	Sundstrom 1990:295
7		Signal Mountain, MT	Sundstrom 1990:295
8		Red Canyon, WY	Francis & Loendorf 2002:182
9		Bighorn Site 2, WY	Sundstrom 1990:296
10		Craven Canyon, SD	Sundstrom 1990:202
11		Craven Canyon, SD	Sundstrom 1990:202
12		Custer, SD	Sundstrom 1990:202
13		Edgemont, SD	Sundstrom 1990:203
14		Castle Gardens, WY	Francis & Loendorf 2002:150
15		Crossfield Coulee, Alberta	Keyser & Klassen 2001:279
16		Crossfield Coulee, Alberta	Keyser & Klassen 2001:279
17		Hidden Valley, CO	Schaafsma 1980:129
18		Grand Gulch, UT	Schaafsma 1980:53
19		Yavapai Co., AZ	Malotki 2007:120
20		Gila Co., AZ	Malotki 2007:121

Table 1: Examples of tally symbols in North American rock art.

Tallies represent a count of something. If there are more than one of the thing counted, then the tally mark is repeated. At its most basic, there is a one-to-one correspondence between the collection of tally marks and the collection of objects being tallied. Obviously, we cannot be certain that a set of repeated marks is in fact a tally without the confirmation of the maker of the marks, but in many cases the likelihood of the repeated collection being anything other than a tally is low. Consider the rock record found on the cliffs lining the Cheyenne River in the Southern Black Hills (Figure 3). One hundred nineteen repetitions of the symbol that looks like a humanoid are incised on the rock. Clearly, this is a count of something. Indeed, researchers agree that the panel depicts a Sioux or Cheyenne coup count from their wars with the U.S. Cavalry [22, 9]. There are actually two tallies here. The humanoid symbol tallies people and the b-shaped symbol tallies rifles.

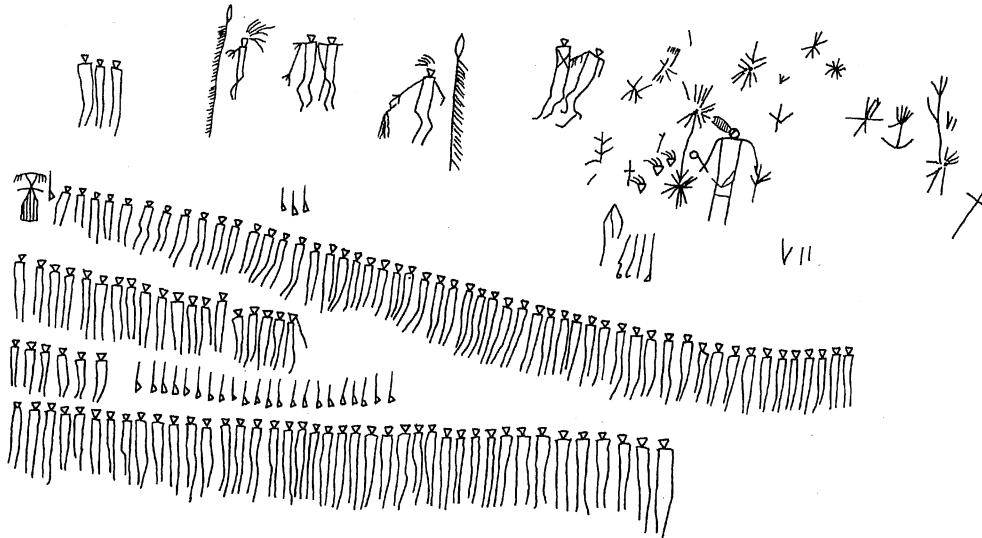


Figure 3: Cheyenne River Coup Count (drawn by James Keyser, reproduced with permission from [9, 244]).

A rock art panel at Craven Canyon, SD includes the sequence of repeated red painted symbols shown in Figure 4. The sequence of six crescents and dots in this text appears to emit from or travel into a frame of some sort. The pictograph strongly suggests a tally rather than a random doodle.

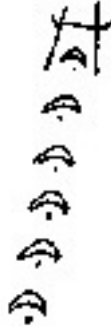


Figure 4: Tally sequence from Craven Canyon, South Dakota (drawn by the author after [21, page 202]).

The Cheyenne River and Craven Canyon examples have two features that suggest that they are tallies. First, there are several repeated signs. One would be hard pressed to identify a single isolated sign as a tally of one. Two signs together are also problematic. Three or four or five signs may be a tally. However, given the prevalence of the number four in North American Indian cosmologies [17], I think if one has a minimum of 6 repeated signs in a rock art text then that text may be a tally. Second, the repeated signs are organized. They possess an internal structure. The easiest structure to discern is the linear sequence. Indeed, it is the linear structure of most tallies that suggests that they are tallies. The examples from Cheyenne River and Craven Canyon possess a clear linear structure. Sometimes, the linear structure is extended to two-dimensions. Figure 5 on the next page shows two tallies painted on a large quartzite boulder in Alberta, Canada. The leftmost tally shows two sequences of circles that seem to be paired. The rightmost tally of nine flag-like symbols is grouped in triplets.

Beyond simple groupings of linear sequences, some tally texts are more dispersed, but nevertheless appear to be tallies. Figure 6 on the following page shows a flag-like tally painted on a rock panel whose exact location is unknown [22, page 174]. The twenty tally marks are not linearly sequenced, not paired, and not consistently grouped. Nevertheless, the text conveys the idea that twenty some-things are depicted. One of my students suggested that the “flags” in this panel represent family groups gathering for a ceremony (the size of the flag corresponds to the age of the participant). It is not clear how the artist intended the groups (if there are groups) to be parsed.

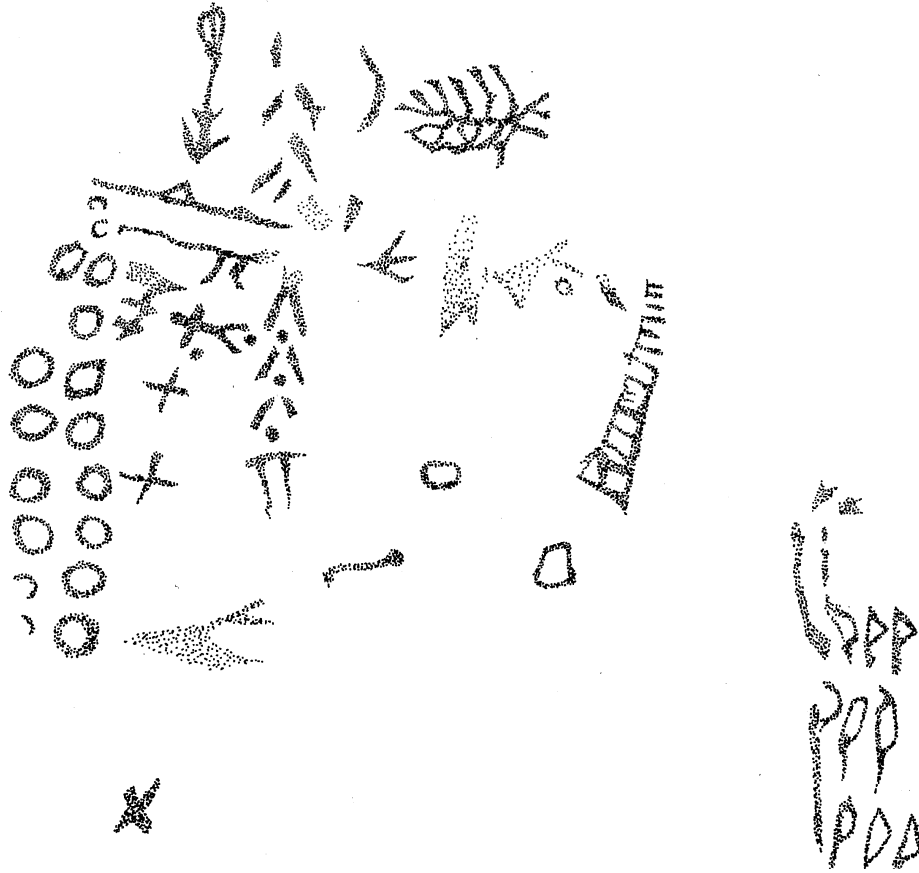


Figure 5: Several tallies from Alberta (drawn by James Keyser, reproduced with permission from [9, page 283]).

As we study the tallies on rock art, a particularly difficult question arises: How is one to distinguish a tally from a design? It is not uncommon for people to make marks on their bodies with wet paint applied to their fingertips. Could they also use their painted fingers to create designs on rocks? Some rock art panels include numerous finger-painted dots. For example, consider the panel from Lava Beds National Monument in California shown in Figure 7 below. Are these dots a tally or are they simply a pleasurable design? If they do represent a tally, then what is being tallied? The three streams of dots below the wavy line are grouped into streams of 9, 10 and 11 dots. This is an increasing arithmetic progression. The three streams of dots above the

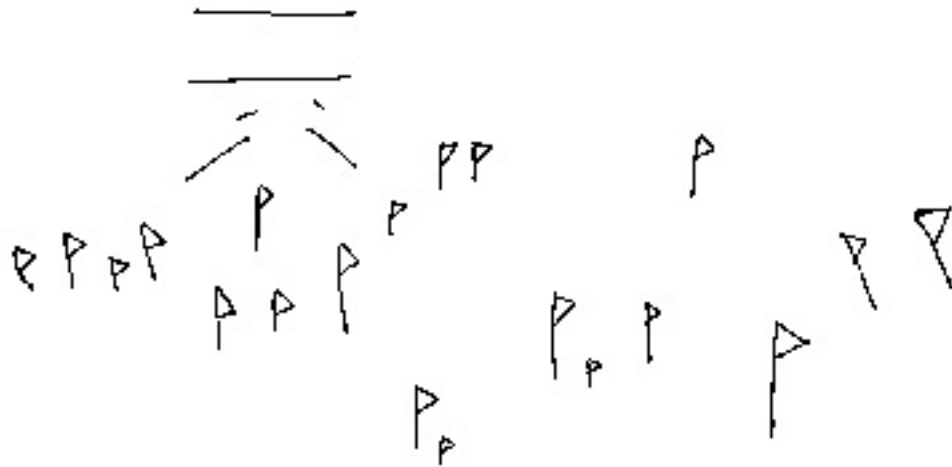


Figure 6: Painted rock tally from unknown location (drawn by the author after [22, page 177]).

wavy line are grouped in streams of 9, 7, and 5 as we read left to right. This is a decreasing arithmetic progression. Could the finger dots represent some mathematical recreation?

Another issue in identifying dot patterns as tallies is that the dot may also be used to indicate a path or a trail. In this case the number of dots may be only an artistic choice rather than a tally. An instance of the ambiguity between artistic choice and tally is seen at the Jeffers Petroglyph Site in Minnesota. In cluster 5 of this site (see Figure 8), we see eleven dots strung behind a stick figure. The dots lead to (or from) a group of petroglyphs. Do the dots represent the path the stick figure follows or do they count a time period (eleven days?) needed for the entity represented by the figure to travel to (or from) a location? Do the dots represent both a path and a tally or neither?

There are essentially two approaches to interpreting tallies that have not been explicitly identified by their makers. The first is to uncover a structural isomorphism between the count and grouping of tallies and that of some natural phenomenon. Marshak [14] made use of this technique in postulating astronomical counts in tally marks on Paleolithic bones. Murray [15], in the tradition of Marshak, sees astronomical observations in the rock tallies of Northeastern Mexico.



Figure 7: Finger dots painted on panel in California (drawn by the author from photograph in [23, page 7]).

The second approach is a kind of cultural triangulation that attempts to match the tally marks with identifiable objects or events that are cultural associated with the rock art. Merrell, for example, believes that the tallies in the Lava Tube Cave petroglyphs in Idaho “denote cave visits or perhaps represent the caches of meat stored in the caves” [12, page 36]. As another example of this second approach consider the tally marks that are known as part of the vertical series. The vertical series is the name attached to a collection of rock art panels that are characterized by vertical sequences of geometric figures. The vertical series sites are found in the Black Hills, Bighorn Mountains, western and southern Montana and southern Alberta. Keyser and Klassen [9] propose some ethnographic evidence for the interpretation of some of the vertical series signs. Several of the signs correspond to those used in Sioux winter counts [9]. For example, the dotted crescent may



Figure 8: A portion of Cluster 5 of the Jeffers Petroglyphs (drawn by the author after [3, page 99]).

represent a star or time unit and the symbol that looks like a capital H an abundance of food [9]. In this spirit, the tally sequence from Craven Canyon shown in Figure 4 may represent six time units (months, years?) connected in some fashion to an abundance of food. It may be five lean months followed by a month of food abundance or six abundant months or, of course, nothing whatsoever to do with months or food.

Ultimately, the bulk of the interpretations of tally marks are pure speculation. My favorite interpretation is that of George Bull Tail. He is quoted as saying that the tally marks were made “by the Little People to keep track of numbers or something” [4]. Bull Tail sees the rock tallies from the same perspective of anyone who is distant in time from the tally maker. The marks sure look like tallies, but if they are we are at a loss to say what they are tallying.

This inability to tease out the exact meaning of the marks shouldn’t deter us from pursuing the study of rock tallies. There may be cultural or natural connections that can be lifted from the archaeological record or from ethnohistorical accounts. The patterns of tallies may also indicate the artist’s interest in representing number patterns.

Rock art tallies provide a nice source of data for speculation and creativity. They also provide a nice focus for cross-disciplinary study. I have challenged my students to devise mathematical justifications for the patterns in these rock art panels. As students try to discern the meaning of the rock art they find themselves learning about the geography of the American West, Native American culture, archaeology, and astronomy.

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