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NEGLECTED ARTIFACTS:
A STUDY OF RE-WORKED CERAMIC SHERDS FROM THE LAKE PÁTZCUARO BASIN, MEXICO

By

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ABSTRACT

NEGLECTED ARTIFACTS: A STUDY OF RE-WORKED CERAMIC SHERDS
FROM THE LAKE PATZCUARO BASIN, MEXICO

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Recent archaeological work in the Lake Pátzcuaro Basin in Michoacán, Mexico has revealed a set of artifacts whose function has heretofore been unexplored. The artifacts are comprised of roughly circular, re-worked ceramic sherds. Only isolated references to similar such artifacts are made in the extant literature. This paper examines the largest known grouping of such artifacts and attempts to ascertain their function and their place in Prehispanic Tarascan society. Three hypotheses concerning the artifacts' function are examined: that they are spindle whorls, that they are gaming pieces, and that they are fishing net weights. Examination of the statistical and ethnographic data suggest that they functioned as the latter.

Dedicated to my loving and ever-optimistic husband, Doug, and my beautiful children, Anna and Sean

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I would like to thank Dr. Helen Pollard for providing me with the original data set and opportunity for research, as well as for her unflagging patience and assistance with the completion of my graduate degree. Her unsurpassed knowledge of and enthusiasm for the archaeology of Mesoamerica was the inspiration for my post-graduate studies.

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INTRODUCTION

> From time to time man discovers, along his pathway in life, some simple object from out of the remote past, small in size and insignificant in aspect that heretofore he has consistently overlooked; suddenly he becomes conscious of it, takes note of and acquires a deep interest in, only to find as he studies and ponders over the various phases involved that it becomes more and more an object of elusive determination as to what may be its purpose, and where it fits into the life of some people (Watt 1938:21).

Description of Artifacts

The subject of this thesis is a previously undefined class of artifacts, ceramic disks, from the Lake Pátzcuaro Basin in Michoacán, Mexico. This artifact set was collected from numerous sites located along the southwest corner of Lake Pátzcuaro under the direction of Professor Helen Pollard as part of the *Development of the Tarascan State: the Urichu, Xarácuaro, and Pareo Polities Project.* Formal excavations were conducted largely at the site of Urichu but also on the island of Jarácuaro (known in Prehispanic times as Xarácuaro) during the summers of 1990, 1991, 1994, and 1995. Additionally, numerous site surveys were conducted from February through June of 1996 in the areas surrounding Urichu, Xarácuaro, and Pareo. The project area lies at the heart of the Prehispanic Tarascan Empire, and the encountered occupation levels span the Classic through Post-Contact periods (c. A.D. 350-1525). (See Figure 1)

The artifacts themselves are re-worked ceramic sherds which have been fashioned into roughly circular shapes (Figure 2). Some are rather squarish but most are circular. In addition, most of the ceramic disks have either one or two notches. Only one is perforated, or drilled, and one has grooves carved into it. Both broken and whole ceramic disks, 522 in all, were recovered.

The function of this artifact group has been heretofore unclear. There are several brief mentions in the literature of similar artifacts from other Prehispanic Mexican sites, but they are always listed as "unknowns" or "miscellaneous." Some researchers have made informal suggestions as to the disks' functional purpose, including their use as spindle whorls and fishing net weights. Macías Goytia (1990:83), for example, speculates that, although the function of the pieces is not known, their discovery in great numbers and in riverine contexts suggests that they could have been used as weights for the nets used to catch *charal,* a term which refers collectively to several species of *Chirostoma*, including *Ch. grandocule, Ch. attenuatum,* and *Ch. patzcuaro.*

Objectives

To date, however, no one has undertaken a formal analysis of the ceramic disks. This thesis is the first formal analysis of these artifacts ever undertaken. The large sample size (the largest documented to date) and the detail available regarding their provenience and size measurements makes this collection of Tarascan disks ideal for performing a formal analysis.

This thesis has several objectives. The first objective is to determine which of the proposed functions, if any, can be correctly assigned to the artifacts. As stated above, to date, these functions have only been put forth informally. This analysis will formally test three hypotheses concerning the disks' function(s). This will be achieved by spelling out specific criteria which should be met to validate each particular hypothesis, and then using a variety of methods and lines of evidence to support or reject that hypothesis. The analysis will make use of elementary statistical techniques as well as ethnographic data.

The three hypotheses to be considered concerning the disks' true function are 1) that the disks are spindle whorls, or *malacates*, as they are known in Spanish; 2) that the disks were gaming pieces of some sort; and 3) that the disks were fishing net weights, or *net sinkers*. A thorough examination of the available data points to the third hypothesis as the most likely explanation of the artifacts' true function.

A further objective of this thesis is to clarify the artifacts' place in Tarascan society. Since the disks (net sinkers) represent an activity (fishing) which was central to the Tarascan economy, the set of disks examined in this paper can be viewed as a proxy for the Tarascan economy itself. They can be analyzed for spatial and temporal changes which might reveal developments or fluctuations in the economy of the Tarascans. The cultural and ideological associations of fish and fishing in Prehispanic Tarascan society will also be explored.

In addition, the Tarascan disks will be compared with similar artifacts reported in archaeological research from other areas in native North America, from both North American and Mesoamerican cultures.

Finally, suggestions and criteria for identifying these artifacts in the existing archaeological record and for future excavations will be set forth.

CHAPTER 1
METHODOLOGY AND ANALYSIS OF THE DATA

Methodology

Two basic methods of analysis will be employed in exploring the function of the ceramic disks: statistical analysis and ethnographic analysis. Unfortunately, certain lines of testing, such as use/wear analysis or examination of the ceramics' paste or firing hardness, are eliminated *a priori* because the artifacts are currently housed in their home country of Mexico. This author has access only to measurements which were made at the time of collection and initial examination. Fortunately, however, much can be done with the available measurements, and it is believed this is sufficient to illuminate the artifacts' function.

Ethnographic analysis will comprise the other main method of examining the data. Ethnographic data collected from the late nineteenth century through the mid-twentieth century are available for all topics relevant to this paper: *malacates* (Parsons and Parsons 1990; M. Parsons 1972; M. Parsons 1975), games and gaming pieces (Foster 1948; Bennett and Zingg 1935), and net sinkers (Foster 1948; Pollard, personal communication). Good ethnographic accounts of fishing practices in native North America (Meehan 1893; Rostlund 1952) and Mexico (Beals 1932; Bennett and Zingg 1935), including the Tarascans (Foster 1948) also exist. In this way ethnographic data can be compared to the statistical findings. Where the two methods concur, they will lend greater credence to a particular hypothesis.

It should be re-iterated that the hypotheses presented and tested in this paper are not original to the author; they have been informally proposed elsewhere. Rather, it is the first formal testing of these hypotheses which is the original contribution of the work presented herein.

Statistical Analysis of the Disks

Statistical analysis of the ceramic disk assemblage will form a major portion of this investigation. As Whallon posits in the opening of his "Simple Statistics" (1987:135), "... simple, descriptive statistics and display techniques are indispensable preliminaries to the application of even the most basic inferential statistics or tests." He further asserts that "... in almost every instance, one can learn more, more quickly, more clearly, and in more detail about one's data with these (simple) techniques than through the use of inferential statistics or tests". Very basic, summary statistics will therefore be calculated. For example, the means and range distributions of the disks' weight, diameter, and thickness will be determined and graphed. Notch and perforation morphology will also be analyzed.

Diameter, thickness, and weight

A total of 522 ceramic disks was recovered. Histograms for the characteristics of diameter, weight, and thickness all show positively skewed, unimodal distributions with the preponderance of values concentrated (Figures 3, 5, and 7).

A histogram of the disks' diameters exhibits a roughly unimodal distribution (Figure 3), with a mean diameter of 30.7 mm, a median score of 28.2, a mode at 25.2 mm, and minimum and maximum scores of 14.9 mm and 59.6 mm respectively (Figure 4).

A histogram of the disks' thickness shows a similarly shaped distribution (Figure 5), with a mean value of 5.7 mm, a median value of 5.1 mm, a mode at 5.2 mm, and minimum and maximum scores of 2.7 mm and 19.5 mm respectively (Figure 6).

A histogram of the disks' weight scores also demonstrates this same distribution shape, with the bulk of the scores positively skewed about the mean and a gradual tailing off of higher weight disks, with a few, much heavier, outliers (Figure 7). The mean weight of the disks is 6.2 grams, with a median score of 4.2 grams and a mode at 2.4 grams. There is a wide range of weights, with the lightest a mere 0.4 grams and the heaviest weighing in at 35 grams (Figure 8).

Although the mean, median, and mode of each of the three measurements are close in value, the tightest distribution is that of thickness. This *could* indicate a high degree of standardization in Tarascan pottery, out of which the disks were manufactured. Although thickness can plausibly be viewed as an unselected-for variable resulting from the re-use of ceramic pieces, it seems likely that weight and/or diameter were being consciously selected for, with a range of variation centered around an ideal value.

For example, more than a third of all diameter values for the disks fall within the 23-29 mm range (see Figure 3). It is quite possible that the disk makers were selecting for weight indirectly and used diameter to control for this, depending on the thickness of the sherd being recycled. In fact, weight distribution is even more strongly peaked, or leptokurtic, than that of diameter, with 52% of all disk scores falling in the 5-8 gram range (see Figure 7). Of the variables thickness, weight, and diameter, it is the latter two which are most strongly correlated, with a Pearson correlation coefficient (r) of 0.78

(Figures 9a-b). This is not a random pattern and indicates a clear selection on the part of the disk makers for weight and size.

Notch and perforation morphology

Comparing the frequencies of notch classes is also informative. Out of the 517 whole and broken disks with unambiguous notch morphologies, 66% have two notches (Figure 10). A pie chart of only the whole disks displays this patterning even more clearly, with 85% of disks having two notches (Figure 11). In contrast, this regularity is much less clear in a chart showing only the broken disks (Figure 12). Furthermore, the extremely low percentage of single notching among whole disks (just 1%) argues against its being considered a legitimate class. It seems likely that two notches was the intended norm. This morphology would certainly facilitate tying the disks to a net. Since 80% of all disks and 86% of whole disks have some notching, perhaps the unnotched ones were blanks to be finished at a later time.

Only one disk was perforated, or drilled. The rarity of this form argues against it, too, being considered a legitimate class or the intended final form. It may or may not have been used in the same capacity as the other Tarascan disks. Its diameter, thickness, and weight measurements (37.1 mm, 2.8 mm, and 3.5 g respectively) do fall within the parameters of at least some known *malacates,* or spindle whorls (see below).

Three disks had grooving on them. Again, they are the exception and not the rule. Interestingly, these three disks are much larger than most of the other disks. Their mean diameter, thickness, and weight measurements are much greater than the mean measurements for the rest of the disks: 48.9 mm (diameter), 15.6 mm (thickness), and 26 grams (weight), vs. means of 30.7 mm (diameter), 5.7 mm (thickness), and 6.2 grams (weight) for the rest of the disks. Although the sample size of the grooved disks is extremely small it is at least possible that they are in fact a different kind of artifact and were used in a different capacity than the other ceramic disks. It is equally plausible that they were originally manufactured to function in a different capacity but were later re-used as net sinkers.

Spatial and Temporal Patterning

In addition to analyzing the disks' inherent characteristics, statistical techniques can also be applied to their frequency distribution in time and space. All of the disks have proveniences, and many of them can be dated to a particular cultural period. Disks which were recovered during surveys rather than excavations could not always be definitively assigned to a particular period, e.g. if they were found without other diagnostic ceramic types. It should also be noted that if the disks were used as net sinkers, disks which were recovered from units which were under water during the Taríacuri phase may have *either* dropped off Taríacuri phase fishing nets and settled onto the lake bottom, *or* may in fact date from the earlier Late Urichu phase. In this case it is not possible to assign the disks to either phase with complete certainty. Other factors which can be analyzed include the density of ceramic disks at each site, their intra-site density and distribution, their density as a ratio of other ceramic artifacts, and their density by phase/date.

Density of disks per site

The areas around Urichu, Pareo, and Xarácuaro all yielded ceramic disks. Seventy-three (14%) were recovered from the environs of Urichu, 324 (62%) from Xarácuaro, and 124 (24%) from Pareo (Figure 13). Their relative density can be quantified as a proportion of all other (non-disk) ceramic sherds. These data are summarized in Figure 14. The zone with the lowest proportion of ceramic sherds to ceramic disks therefore has the highest density of ceramic disks relative to all other ceramics recovered. Pareo has the highest density of disks to sherds, with a ratio of 1:42. Xarácuaro comes in second, with a ratio of 1:61. Urichu comes in at a distant third, with a ratio of 1:1,389.

The density figures for the three zones is revealing. Urichu, with the highest number of sherds per disk, is furthest from the lakeshore. The ratios are much lower for Xarácuaro, which was in fact an island at the time of Late Postclassic occupation, and for Pareo, which was even closer to the lakeshore then than it is at present, due to lowered lake levels in recent times (Gorenstein and Pollard 1983; O'Hara 1993). According to O'Hara, the waters of Lake Pátzcuaro at the time of Conquest stood at between approximately 2041.5 and 2045.5 meters above modern sea level. This is between five and eight meters higher than at present (O'Hara 1993:54-55) (Figure 15). Pollard puts the current lake level at 2033 meters above sea level, 12.5 meters lower than at Conquest (personal communication). This line of evidence is entirely consistent with the hypothesis that the ceramic disks were used as net sinkers, or at least for lake-related activities, for one would expect their numbers to increase directly with proximity to the lakeshore. In fact, it is likely that many of the disks recovered from (now dry) Xarácuaro and Pareo units were underwater during the immediate pre-Conquest period. This would account for the low numbers of other (non-disk) ceramics found in these areas compared with Urichu. It also supports the net sinker hypothesis, for one would expect to find net sinkers, but not other types of ceramic artifacts, in areas that were previously underwater.

Intra-site density and distribution

We can examine the density and distribution of the ceramic disks within each zone both in absolute numbers and as a ratio to other ceramic artifacts recovered in hopes of discovering some sort of pattern.

In terms of absolute numbers, mapping the formal survey units with the top five scores for numbers of disks reveals a telling pattern. In Xarácuaro, all but one of the units with the most disks are clustered in the eastern part of the zone (see Figure 16). Since Xarácuaro was an island at time of contact and is a peninsula today, all areas of the zone can be considered to be in close proximity to the lakeshore. In this respect one can draw no special conclusions regarding the spatial patterning of the top-ranking units. However, the survey units with the most disks *are* clustered together in the same general area, and it is possible that this area, which was under the waters of Lake Pátzcuaro during the time of the Tarascan empire, was a prime fishing area.

In Pareo, all of the top-ranking units are clustered along the northern part of the zone, adjacent to the lakeshore (Figure 17). This pattern is even more striking in Pareo because the zone covers such a large area. None of the southern-most units yielded any disks at all. Only three areas in Urichu were excavated; all three yielded ceramic disks.

Again, these three areas are clustered together, but in this case, they are not adjacent to the lakeshore. Instead, they are in the western-most part of the zone (Figure 18).

Density of disks by phase

It was possible for Pollard's research team to date most of the excavated disks based on the ceramic typologies of other ceramic pieces found in the same levels. It should be noted that the (style) type of the disks themselves, even if discernable, is not adequate for dating because the disks are a secondary use artifact; that is, they were made from sherds of pottery pieces which were originally manufactured and used for entirely different (primary) purposes.

If the ceramic disks *are* net sinkers, we should expect that the ones recovered from now-dry areas around Pareo and Xarácuaro to date to phases when lake levels were significantly higher than they are today.

(phase table adapted from Pollard and Cahue 1999:262)

Table 1. Phases Represented by Ceramic Disks

Period	**Local Phase**	**Date**
Late Postclassic	Taríacuri	A.D. 1350-1525
Middle Postclassic	Late Urichu	A.D. 1100-1350
Early Postclassic	Early Urichu	A.D. 900/1000-1100
Epiclassic	Lupe-La Joya	A.D. 600-900/1000
Classic	Loma Alta 3/ Jarácuaro	A.D. 350-600

Two hundred and forty-eight, or almost half (47%), of the disks date to the Late Urichu phase (A.D. 1100-1350) (Figure 19). The Taríacuri, and then Early Urichu, phases are the next most numerous. An additional 63 disks could be dated to the Urichu phase, but not specifically enough to be dated Early or Late. This means that 350, or 75%, of the disks which could be definitively assigned to a particular phase can be assigned to either the Early or Late Urichu phases.

Consistent with the spatial data, the site of Urichu seems to break with this pattern. Interestingly, none of the disks recovered from Urichu dates to the Late Urichu phase (Figure 20). Pollard suggests that this is due to limited excavations in Area 2, the only part of Urichu with Late Urichu deposits (personal communication 2002). Most of the disks from Urichu date from the Taríacuri phase (n=31), Early Urichu (n=18), Jarácuaro (n=10), and Lupe-La Joya (n=9). The large number of Taríacuri phase disks reflects the increased population density at Urichu during this time (Pollard, personal communication 2002).

Xarácuaro yielded disks from all of the phases (Figure 21). By far, most disks from this zone (n=178) date to the Late Urichu phase, representing 55% of the disks from Xarácuaro. This is consistent with the fact that Xarácuaro experienced its highest population density during the Late Urichu phase. By this time, the island was home to full-time fishermen. The Urichu (n=61), Taríacuri (n=25), and Lupe-La Joya (n=16) are the next most numerously represented phases. Maps of the units which yielded the most disks at Xarácuaro for each of the Late Urichu and Taríacuri phases (see Figures 22 and 23) show a definite shift in disk distribution within the site. Disks dating to the Late Urichu phase are concentrated in the eastern half of the site. At this time, this area was above water. In contrast, by the Taríacuri phase, when the eastern part of Xarácuaro was submerged under water, the highest concentration of disks has shifted westward. The disks dating to the Taríacuri phase which are located in the western portion of Xarácuaro thus most likely reflect household areas where fishing nets were manufactured and stored. The disks which were found in Late Urichu phase deposits, on the other hand, may represent *both* a household pattern of Late Urichu fishing net manufacture and storage *and* later Taríacuri phase plainware sherds which were used as net sinkers and dropped off Taríacuri phase fishing nets onto the earlier, Late Urichu phase deposits below (Pollard, personal communication 2002).

Pareo yielded no disks at all from the Jarácuaro or Lupe-La Joya phases (Figure 24). As at Xarácuaro, over half of the disks (n=70, 56%) from Pareo date to the Late Urichu phase. Most of the remaining disks from this zone date to the Taríacuri (n=26) and Early Urichu (n=12) phases. Again, mapping the highest disk concentrations by phase is informative. Disks dated to Taríacuri phase deposits occur in high concentrations in the western, central, and eastern part of the zone (see Figure 25). Pollard (personal communication 2002) associates those in the western part of the site with fields outside the Tariacuri phase village of Arócutin. They were commoner residential areas bordering the lakeshore, and likely were associated with fishermen households. Likewise, the area to the east bordered both the Taríacuri phase town of Pareo and the lakeshore. These areas too were likely either fishermen's households or ideal places to repair nets (as they are now). Pareo had a well-known market and it is likely that fish caught here were exchanged via the market system. The small units in the center of the Pareo map represent the only areas which were above water during the high lake levels of the Taríacuri phase. They thus represent areas where fishing households or storage/repair areas were located. High concentrations of disks associated with Late Urichu phase deposits, on the other hand, are confined to the central portion of the Pareo area map (see Figure 25). As at Xarácuaro, disks found here may be associated either with fishing households or fishing net manufacturing/repair areas of the Late Urichu phase, *or* with later, Taríacuri phase nets which lost sinkers to the earlier deposits below. In light of the fact that there was a substantial population increase in this area during the Taríacuri phase, it is interesting to note that although high concentrations of disks are found in more areas of Pareo during the Taríacuri phase, larger numbers of them were actually associated with Late Urichu deposits, when the population was lower. However, if many of the disks which were found in Late Urichu deposits actually fell off of the nets of Taríacuri phase fishermen, then the numbers of net sinkers associated with each of these periods may more accurately reflect area population.

The temporal data suggests a sharp increase in the relative frequency of ceramic disks during the Late Urichu phase. Even if all the disks which were generally assigned to the Urichu phase in fact dated from the Early Urichu phase, which is unlikely, there would still be a greater than 100% increase in disks in the Late Urichu phase. If, on the other hand, all 63 Urichu phase disks are in fact from the Late Urichu phase, the Late Urichu phase increase could be as high as eight-fold. In all likelihood the actual increase lies somewhere between these two extremes.

Since the level of Lake Pátzcuaro was lower during the Late Urichu phase and higher during the subsequent Taríacuri phase (O'Hara 1993), two possibilities exist for the disks dated to the Late Urichu phase which were found in areas which were under water during the Taríacuri phase. Either they do in fact date from the Late Urichu and are artifacts of shoreline settlements, or they may have dropped off the nets of later, Taríacuri phase fishermen onto the lake bottom in areas that were previously inhabited during the Late Urichu phase of lower lake levels.

CHAPTER 2
HYPOTHESES

Three basic hypotheses concerning the ceramic disks' function(s) will be presented and tested. Each hypothesis entails certain specific criteria to which the data should conform in order to support it. The basic data set, which consists of a set of the disks' measurements and notch morphologies, as detailed above, will be analyzed in order to glean any inherent patterning. The artifacts' distribution in time and space will also be examined. Thus, the ceramic disks' formal characteristics as well as their spatial distributions can be compared to those of the artifacts represented in each hypothesis.

Malacate Hypothesis

The first hypothesis to be considered is that the disks functioned as spindle whorls, or *malacates,* as they are known in Mexico. This hypothesis has been previously presented in other site reports but not tested formally. *Malacates* are essentially a type of weight, attached to a spindle, used to help spin fiber of various sorts into yarn, thread, or string (Figure 27). *Malacates* are ubiquitous in Mesoamerican societies and can therefore easily be compared to the ceramic disks. Their morphology is fairly uniform, and can be compared to that of the ceramic disks. If the two groups of artifacts differ significantly in shape, size, or distribution, then it is unlikely that they represent a single class or type, or that they performed the same function.

The spatial distribution of both artifact groups can also be compared. Since it is well documented that spinning and weaving fibers was an activity performed by women in Mesoamerica, one can reasonably expect that *malacates* will be concentrated in or near household areas. If the ceramic disks have a different spatial patterning, the hypothesis that they performed a different function as well is further supported. In sum, if the ceramic disks were used as *malacates*, the following criteria should be met:

1. The disks' shape/form should closely resemble in form known *malacates* from the Tarascan cultural area as well as other relevant areas.
2. The disks should be concentrated in household areas, as *malacates* are.
3. The disks' average weight and size should fit within the size parameters of known *malacates*.

As far as morphology is concerned, known *malacates* from the Tarascan cultural area as well as those from the Valley of Mexico and the Teotihuacán Valley exhibit a much broader range of forms than do the Tarascan ceramic disks. These forms include, but are not limited to,: circular, biconical, truncated biconical, truncated conical, discoidal, straight and convex cylindrical, jar-shaped, and effigy-shaped. These and other forms are reported at length in Lister (1949), M. Parsons (1972, 1975), Parsons and Parsons (1990), Kelly (1947), and Pollard (1993). (Figures 28a-c). In contrast, almost all of the Tarascan disks are roughly circular and none exhibits any of the more exotic shapes.

Malacates differ from the Tarascan disks in several other morphological characteristics as well. The former are commonly decorated with punctate stamping or incised designs, and some are even painted. None of the Tarascan disks exhibits any such decoration. Indeed, this artistic embellishment would be completely unnecessary for something as utilitarian and "invisible" as a net sinker, if that is indeed what the Tarascan disks were. In addition, *malacates* were fashioned out of wet clay, often in molds. In contrast, the Tarascan disks were reworked sherds of pottery that had already been fired and initially used for another purpose. Perhaps most importantly, *malacates* were **always** perforated in order to accommodate a spindle around which the spun fiber was wound. In contrast, only one of the Tarascan disks is perforated. If perforation was important for the Tarascan disks, they probably would also, like the *malacates*, have been fashioned out of wet clay, for it would have been much easier to form a hole in wet clay than to perforate an already fired piece. All of these morphological differences make it most unlikely that *malacates* and the Tarascan disks were used for similar functions.

Carrasco (1976:224-26) (in Parsons and Parsons 1990:314) discusses Aztec women's spinning of cloth. He reports that commoner women spun fiber and wove cloth in their own households for tribute. In addition, specialized high-quality cloth was also produced by women who worked at the rulers' palaces. In both these instances, cloth was produced at the household level. Although none of the authors cited above discusses intra-site provenience of the *malacates*, in light of the ethnographic documentation it is entirely reasonable to assume that they are found mainly, if not exclusively, in household contexts. Little is known about the production of cloth in the Tarascan empire but it is reasonable to presume that it, too, may have been produced at the household level. More research needs to be done in this area.

While intra-site provenience of this detail is also lacking for the Tarascan disks, it is readily apparent that the latter tend to be concentrated along what was shoreline or under water at the time of the Tarascan empire. Using a count of ceramic disks as a proportion of other ceramic sherds one can gauge the relative density of disks in a given area. At the Pareo sites, the survey units with the highest disk:sherd ratios were found in areas P33, P57, P17, P29, P42, and P51. All but P57 and P51 are adjacent to the lakeshore; and these two are close to it.

When compared by zone, disk:sherd ratios are quite revealing. The overall ratio for Urichu, which is the farthest from the lake, is by far the lowest, with a ratio of 1:1,641. The ratio is much higher for Xarácuaro, which was in fact an island at the time of protohistoric occupation: 1:61. Pareo, which was even closer to the lakeshore then than at present, due to lowered lake levels in recent times (O'Hara 1993), has the highest ratio of all, 1:41 (see Figure 14).

One possibility for this patterning might be that the disks are household artifacts and that Tarascan households were concentrated near the lakeshore. However, the fact that many of the Xarácuaro disks were found in areas that would have been underwater at the time of Prehispanic Tarascan occupation argues against this. This spatial patterning suggests instead that the significant factor for the Tarascan disks is proximity to lakeshore, rather than presence at the household level. More data regarding household distribution within the sites would be necessary to definitively reject the possibility that the disks are *malacates* or other household artifacts, but the fact that ceramic disks are concentrated near lakeshore areas, even places that would have been underwater at the time of use, strongly supports the net sinker hypothesis rather than the *malacate* alternative. It should also be noted that if the disks were *malacates,* then Urichu, as the largest community, should have the *highest* ratio of disks to other ceramics, not the lowest one.

Finally, the size and weight of known *malacates* can be compared to the Tarascan disks. Again, a significant size discrepancy would support their separation into two distinct artifact classes, especially when combined with the evidence cited above regarding their differences in morphology, method of manufacture, and spatial distribution.

Macías Goytia (1990) and Parsons and Parsons (1990) do not provide measurements for the malacates they discuss. Arnauld et al. (1993:161) report three examples from the Zacapu Lake Basin in Michoacán, ranging from 21-48 mm in diameter and 19-38 in thickness. While the malacates' diameters are well within the range exhibited by the Tarascan disks (14.9-59.6 mm), their thickness is not. The thickest Tarascan disk is only 19.5 mm, well exceeded by the 38 mm Zacapu piece. No weights are provided by Arnauld et al. but it is likely that at least the thicker examples outweigh the Tarascan disks. In comparison, Arnauld et al. report 41 examples of *tepalcates recortados,* or reworked sherds, with diameters and thicknessses ranging from 12-17 mm and 2-10 mm, respectively. While the diameters of these artifacts are a bit smaller than those of the Tarascan disks, their range does overlap. The thickness measurements, on the other hand, are closer to those of the Tarascan disks, which have a mean of 5.7 mm and a range from 2.7-19.5 mm.

Table 2. Size Parameters for Tarascan Disks

	mean	minimum	maximum
diameter (mm)	30.7	14.9	59.6
thickness (mm)	5.7	2.7	19.5
weight (g)	6.2	0.4	35

Lister (1949) and M. Parsons (1972, 1975) report much larger sample sizes of malacates which may therefore provide more reliable comparisons to the Tarascan disks. Lister reports 97 malacates from his excavations at Cojumatlán, Michoacán. They range from 10-55 mm in diameter. While the upper range overlaps those of the Tarascan disks, the lower range is smaller than the smallest Tarascan disk (14.9 mm). Lister provides thickness measurements for only two out seven types of malacates, but both of these are larger than the Tarascan disks' mean thickness of 5.7 mm. Three jar-shaped malacates have a mean thickness of 20 mm, and fifteen flat malacates average 7 mm.

M. Parsons (1972) reports over 200 spindle whorls from a surface survey in the Teotihuacán Valley, which she divided into stylistic types. Eighty-two Type I whorls were relatively large, ranging from 35-61 mm in diameter. Most fell between 40-52 mm (1972:47). The range of the Type I whorls is larger than that of the Tarascan disks' 14.9-59.6, and the range of the majority seem to be much larger than the Tarascan disks' mean of 30.7 mm. Thirty-four examples of Type II malacates were larger still, with a diameter range of 45-73 mm (1972:50). This is significantly larger than the range and the mean of the Tarascan disks. Seventy-eight Type III whorls ranged from 15-31 mm in diameter, with 88 % falling between 18-28 mm (1972:52). These overlap only the lower end range of the Tarascan disks. Two Type IV malacates averaged roughly 53 mm in diameter and weighed approximately 51 grams (1972:53). While this diameter is within the range of the Tarascan disks, it is much larger than their mean of 30.7 mm. No Tarascan disk comes close to weighing 51 grams; the heaviest is 35 grams and the mean is only 6.2 grams. Nine Type V malacates range from 39-56 mm in diameter and weigh between 26-62 grams. While the range in diameters overlaps the upper end of that of the Tarascan disks, the malacates' weight is, again, much larger overall than that of the Tarascan disks, which range from a mere 0.4-35 grams. Two examples each of Type VI and VII whorls follow the same sort of pattern in comparison with the Tarascan disks, with diameters of 42, 47, 51, and 52 mm, and weights of 44-55.8 grams. Two examples each of Type VIII and IX malacates fall within the Tarascan disks' range in both diameter and weight, but again, towards the higher end of the scale: 29-44 mm in diameter and 7.4-31 grams in weight (1972:54-5). In sum, while the Teotihuacán Valley malacates do overlap some of the measurement ranges of the Tarascan disks, there is enough size and weight discrepancy to prevent viewing them as members of the same artifact class.

The more than 600 Aztec malacates recovered from the Valley of Mexico also exhibit size discrepancies compared to the Tarascan disks (M. Parsons 1975). When analyzing the malacates' weight, hole diameter, and total diameter, M. Parsons found "a clear bimodal distribution" indicating that the whorls were "used to spin two different fibers:" cotton and maguey fiber (*ixtli*). The larger whorls were used to spin ixtli, while the smaller ones were used for spinning cotton (M. Parsons 1975:208). Parsons reports that the typical cotton whorl measured about 20 mm in diameter, while maguey whorls averaged about 50 mm in diameter (1975:210) (see Figure 28a). While both these figures are within the *range* of the Tarascan disks, as *averages* they are significantly lower, in the case of cotton whorls, and higher, in the case of the maguey whorls, than the Tarascan mean of 30.7 mm. In addition, a histogram of the Tarascan disks' diameters shows a clearly unimodal distribution (see Figure 3).

Pollard reports 11 cotton *malacates* recovered during her 1970 archaeological survey of Tzintzuntzan (Pollard 1993). Although the sample is small, it may be the best comparison to the ceramic disks because Tzintzuntzan also lies in the Lake Pátzcuaro basin and is thus culturally Tarascan. Fortunately, Pollard provides diameter and thickness measurements of the *malacates* so a precise comparison is possible. The nine complete examples have diameters which range from a minimum of 13 mm to a maximum of 26 mm and have a mean of 20 mm. Their height at center, which corresponds to the thickness measurement of the ceramic disks, ranges from 9 mm at minimum to 12.5 mm at maximum, with a mean of 10.4 mm. By contrast, the mean of the ceramic disks' diameter is 30.7 mm; of their thickness, 5.7 mm. A t-test calculated for diameters results in the rejection of the null hypothesis; i.e. demonstrates that the two sets of artifacts differ significantly in their measurements of diameter and therefore do not, in all likelihood, represent the same population (Figure 29). A t-test for thickness, on the other hand, failed to reject the null hypothesis (Figure 30). In this instance, the thickness of the Tarascan disks does not differ significantly from that of the Tzintzuntzan malacates. Since no weight measurements were made for the Tzintzuntzan malacates at their time of collection, no tests were possible for this characteristic.

A statistical comparison of the Tarascan disks to a set of 19 cotton malacates excavated by Pollard at Urichu as part of the same research project yielded mixed results. Once again, a t-test on the diameter measurements of the two artifact sets firmly rejects the null hypothesis that the two groups are part of the same population (Figure 31). Again, though, as with the Tzintzuntzan malacates, a t-test for thickness measurements failed to reject the null hypothesis. The thickness measurements of the Tarascan disks do not therefore differ significantly from those of the Urichu malacates (Figure 32). A t-test for weight likewise fails to reject the null hypothesis (Figure 33).

By way of comparison, t-tests were performed comparing the Urichu and Tzintzuntzan malacates for the measurements of diameter and thickness (again, it was not possible to compare weights). As one might expect, the test for diameter failed to reject the null hypothesis (Figure 34) . The test for thickness similarly failed to reject the null hypothesis (Figure 35). Thus, the tests seem to validate that the two *malacate* sets are from the same population, a finding which is consistent with the archaeological data.

On the other hand, although t-tests for thickness and weight turned up no significant statistical differences between the populations of Tarascan disks and known Tarascan *malacates*, I do not believe that this means that the two artifact groups should be viewed as belonging to the same class. That the t-tests performed for the variable of diameter firmly reject the null hypothesis argues that they come from different populations and thus should not be classified together. The similarities between the two artifact classes in terms of thickness and weight, however, do explain why several researchers have postulated that the Tarascan disks might be *malacates*. Seen within the larger body of evidence discussed within this paper, however, including the statistical evidence, it is clear that the Tarascan disks represent a class of artifacts distinct from Tarascan or other Mesoamerican *malacates*.

Kelly (1947:98) provides additional examples of discoidal, worked sherds, which she distinguishes from the *malacates* she analyzes. She reports 32 artifacts of this sort, 27 of which are unperforated and five of which are perforated. Although a higher percentage of this small sample is perforated compared to the Tarascan disks, the two samples are similar in that the vast majority are not perforated. Kelly does not provide weight or thickness measurements but reports a range in diameters from 15-65 mm, almost identical to the Tarascan disks' range of 14.9-59.6 mm. This suggests that the two groups may well belong to the same artifact class.

In conclusion, measurements from reported samples of Mesoamerican *malacates*, while exhibiting some overlap with the Tarascan disks, differ enough to prevent grouping them as a single artifact class. When combined with differences in spatial patterning and the overwhelming morphological differences, it is clear that the Tarascan disks are a distinct artifact class and that the hypothesis that they functioned as malacates can be definitively rejected.

Gaming Piece Hypothesis

The second hypothesis to be explored is that the ceramic disks were some kind of gaming piece. Limited ethnographic information exists concerning common games from modern Mexican peoples, including present-day Tarascans. Again, this information can be applied to the artifacts in question. For this hypothesis to be considered viable, the following predictions should be satisfied:

1. The ceramic disks should closely resemble known gaming pieces from the Prehispanic and/or modern Tarascan cultural area in size and shape.
2. The ceramic disks should be found in relatively small clusters, and not in great concentrations.
3. The ceramic disks should be concentrated in either household areas or common (non-ceremonial?) public areas.
4. The disks should all be of uniform size or fall into several discrete size ranges, as might be expected of gaming pieces.

Interestingly, the Tarahumara of northern Mexico produced artifacts which are similar to the ceramic disks which are the subject of this thesis. In this case, the disks are known ethnographically to be used in the popular game of *cuatro,* or *dihibama,* as the Tarahumara call it. This game is played with two teams, usually comprised of two men each, who try to throw the disks into a small goal in the opposing team's field. As reported in Bennett and Zingg (1976:341), the disks may be chipped out of stone, *or "made of old potsherds, rounded into shape by grinding"* (italics mine). It is in the latter case that the disks would, presumably, most resemble those artifacts under study here. How then to distinguish the two classes of artifacts? Are they in fact one and the same?

We do have available several points of comparison. Most obviously, perhaps, the *dihibama* disks would not be found in the immediate riverine environment, where fishing took place, but instead would most likely be found in the vicinity of living quarters or out in the open where a game court could be situated. The Tarascan disks, on the other hand, seem to be concentrated near the lakeshore where fishing nets would have been used.

As far as size is concerned, the two types of disks seem to have some similarities. Bennett and Zingg (1976:341) report that the Tarahumara disks can be as much as 3-4 inches (76.2-101.6 mm) in diameter and up to one inch thick (25.4 mm), although they can be much smaller. Their size is dependent upon the size of the court being used to play the game. In comparison, the Tarascan disks have a mean diameter of just 30.7 mm, with a minimum of 14.9 mm and a maximum of 59.6 mm. They have a mean thickness of 5.7 mm., with the smallest at just 2.7 mm thick and the largest at 19.5 mm. Although there seems to be some overlap in size ranges between the Tarascan disks and the Tarahumara disks, on the whole the Tarascan ones seem to be smaller, in some cases substantially so. Since no precise averages are provided by Bennett and Zingg, exact size differences are difficult to assess; however, the suggestion of an overall size discrepancy between the two groups of artifacts could reflect differing uses within their respective societies.

Perhaps most significantly, there is no evidence that the disks manufactured for playing *dihibama* are, or ever were, notched. In contrast, notching is clearly the norm for

Tarascan disks. Based upon these points of comparison, then, the Tarascan disks and the Tarahumara disks seem to comprise two separate and distinct artifact classes.

Brand (1951) makes no mention of a *dihibama*-like game being played in his ethnography of Quiroga, a modern Tarascan settlement in the Lake Pátzcuaro Basin; nor does Smith (1965) mention it in his dissertation on the inhabitants of the island of La Pacanda.

Foster describes several games played by present-day Tarascans in his 1948 ethnography, *Empire's Children: The People of Tzintuntzan* (1948:238-40). Among those utilizing gaming pieces is a game called *peleche*, similar to hopscotch. Played by two or more persons, each player has a pebble or potsherd which he tosses into various boxes marked out on the ground with chalk or in dirt according to the rules of the game. Although this game utilizes potsherds, it is doubtful that enough players could be involved to produce the quantity of disks found in the Prehispanic levels of the areas explored by Pollard. In addition, there is no mention by Foster of any purposeful modification of the potsherds, such as side-notching, used in the game.

The only other game Foster describes which uses game pieces is *el coyote* or *coyote y gallinas* ("the coyote" or "coyote and chickens"). Similar to checkers, the game is played on a 30 x 60 cm. square which is drawn on paper, on a board, or in the dirt. Beans, corn, or beer bottle tops serve as markers representing the coyote and 12 chickens. Foster does not report potsherds, modified or otherwise, being used as markers for this game, even though they are obviously used in *peleche*. It is therefore unlikely that markers used for this game account for the Prehispanic disks, assuming it was even played in that period.

Beals and Carrasco (1944) also discuss games played by the modern Tarascans, albeit those of the mountain areas and not necessarily those around Lake Pátzcuaro. They describe a "hockey-like" game played with sticks or paddles and balls. None of the equipment used in this game bears any resemblance at all to the Tarascan disks. Three other games described by the authors, *kolícatákua,* also known as *quince* or *patolli; móskukua;* and *kuaío,* or Coyote and Hens, do involve gaming pieces; unfortunately, however, these are not described in any detail so that they cannot be compared to the Prehispanic disks. Kolícatákua requires two players with four game pieces each, and móskukua and kuaío are both played by two players, each with 12 pieces. Again, it would be difficult to imagine game-playing on a scale sufficient to produce the numbers of Tarascan disks found, especially in areas that would have been underwater. At the time of Beals and Carrasco's ethnography several of these games were on the wane; it is entirely possible that some of them are no longer played at all. If they are, however, it would be extremely informative to collect some of the gaming pieces in order to compare their form with that of the disks. In the case of *quince*, the authors mention that it is played either in a household or in the plaza, depending upon the time of year. It is reasonable to assume that the other "board" games, which were played on the ground, were played in similar spaces. In this case, then, the distribution of these artifacts within a site would be different from that of the Prehispanic disk artifacts, thereby suggesting a possibly different function.

Although I originally hypothesized that a distribution of several discrete size ranges might be a marker for gaming pieces rather than net sinkers, it appears that none of the ethnographically documented games played by modern Tarascans uses pieces of more than one size in any given game. Therefore, this might not be a useful criterion for classification. In fact, the disks falling into discrete size categories could even be used to support the net sinker hypothesis, if different size nets were used. It may be, however, a moot point, since a histogram of the disks' diameters shows a distinctly unimodal distribution (see Figure 3). Aside from this, the lack of similarities in form (e.g. notching) between the Prehispanic Tarascan disks and any gaming pieces described in modern ethnographic sources strongly argues against classifiying them together. In addition, the sheer quantity of Prehispanic disks, as well as their spatial patterning (e.g. proximity to water) also seems to be unmatched by modern gaming pieces. Therefore, it seems reasonable to reject the hypothesis that the Prehispanic Tarascan disks were made as, or used for, gaming pieces.

Net Sinker Hypothesis

The final hypothesis posited for the ceramic disks is that they functioned as fishing net weights, or "net sinkers." Again, certain patterns in the data set would make this hypothesis more or less likely. For instance, a strong distribution of ceramic disks along present or past lakeshore would provide one indication that they functioned in this capacity. Other predictions concerning notch prevalence and morphology can be tested as well. Specifically, the following criteria should be demonstrable:

1. Ceramic disks should be distributed primarily in lakeshore areas.
2. Notching, or more specifically, double notching, should be prevalent, or the norm, as it would facilitate attachment of disks to fishing nets.
3. The disks should be found in rather large concentrations, at least in some areas where they were likely to have been used.

4. The disks should be of a suitable weight and size in order to be functional as fishing net weights.

5. The disks should have a limited range of variance for diameter, weight, and thickness measurements. The distributions may be either unimodal, bimodal, or multimodal, depending on how many types or sizes of nets were used.

As we have seen in Chapter 1 above, the Tarascan disks do indeed seem to be distributed in or near lacustrine areas. This is consistent with descriptions contained in *The Chronicles of Michoacán* (1970:127). This patterning is especially strong in the survey zones of Xarácuaro and Pareo. The exception is in the Urichu zone, where there were only three units which yielded any disks at all, from excavations conducted at the site of Urichu. These are clustered together in the western part of the site. Perhaps this represents an area where the artifacts were manufactured or stored. If the artifacts are fishing net weights this could be expected to take place at the household level, perhaps in separate storage sheds such as those used by the modern fishermen of La Pacanda (Smith 1965:23). Further research would be useful in clarifying this. At any rate, the spatial distribution patterning of the Tarascan disks is consistent with descriptions of Prehispanic fishing practices contained in *The Chronicles of Michoacán* (1970:127,131), including the one already noted above. In addition, *The Chronicles of Michoacán* describes how Lake Pátzcuaro fishermen "put their nets out to dry on some poles near the shore and had placed their fish there to dry also" (1970:131). The occurrence of Tarascan disks in close proximity to shoreline is consistent with the net sinker hypothesis since *cheremekua* nets were placed in shallow waters near the shore and also set near the shore to dry.

As mentioned above, double opposing side notching appears to have been the norm for the Tarascan disks. This morphology would certainly facilitate tying the disks to a net. It bears repeating that the notching morphology is absent in all known malacates and gaming pieces from the Mesoamerican cultural area.

Although large numbers of ceramic disks were recovered from all three sites (Urichu, Pareo, and Xarácuaro), their concentration in any single excavation unit is not such that their use as gaming pieces can be ruled out. For example, even the top-ranking units typically yielded anywhere from 14-21 disks. As discussed above, this is consistent with the number of pieces that could have been used for a game of *móskukua* or *kolicatákua*, providing that they were played in the Prehispanic era. The criterion for the artifacts being found in large concentrations, then, appears not to be entirely met, although the fact that they are found in largest concentration in lake areas (at least at two sites) seems to support the artifacts' use as net sinkers, not as malacates or gaming pieces.

Whether or not the ceramic disks are of a suitable weight and size to function as net weights may be more difficult to ascertain, but ethnographic information provided by Foster (1948:102) is useful in this regard. Clearly the Tarascan disks are much too small to function as weights for the *chinchorro* nets which were being used then in Tzintzuntzan. According to Foster, these were weighted only when fishing for bass, with unworked stones of 4-8 kilos. The Tarascan disks, on the other hand, weigh only from 0.4-35 grams. Perhaps they are analogous to the "tiny pebble sinkers" used to weight the *cherémekua* nets. These nets are used to catch *khuerepu*, or the young of a group of closely related fishes collectively referred to as *pescado blanco*, or white fish. These are members of the *Chirostoma* genus, including *Ch. estor, jordani, bartoni,* and *michoacanae* (1948:102-4). The young *ch. bartoni* is specifically referred to as *charal.*

Foster reports that small *cherémekua*, or gill, nets are about 60-80 cm wide; large ones three to four times that. Lengths for individual nets are up to about 25-30 meters, although they may be joined together to form huge nets as long as 250 meters. These large nets are used to fish bass (an exotic species introduced in modern times) from canoes. Foster provides the following description of the smaller *cherémekua* nets:

> The *cherémekua* gill net, though used to a considerable extent in other parts of Lake Pátzcuaro, is little used in the vicinity of Tzintzuntzan. The small-sized one is suspended between two poles, usually near the shore, with tiny pebble sinkers carrying it nearly to the bottom. Then the fishermen, either walking in the water and splashing or making noise from a canoe, drives the *khuerepu* and *charal* toward the net, and in trying to pass the fish are caught by the gills (1948:104).

Foster provides no additional description or illustration of these sinkers. Neither does a similar description in *The Chronicles of Michoacán* (1970:127) of fishermen who "put (their) nets along the shore to catch fish." Were they literally pebbles or is it possible that they could have been re-worked potsherds such as the Prehispanic disks? Perhaps potsherds were used in Prehispanic times for the same purpose? Perhaps they are used in other parts of the Lake Pátzcuaro basin where *cherémekua* nets are more popular? Pollard's observation that modern Tarascan fishermen have been known to (re-)utilize the Prehispanic disks as net weights makes this entirely possible (Pollard, personal communication).

The final criterion for this hypothesis, that the disks should exhibit a limited distribution in terms of size measurements, seems to be supported by the data. As discussed in Chapter 1 above, histograms and other graphing techniques all show rather tight, unimodal distributions for each of the measurements of diameter, thickness, and weight. This makes sense in light of the ethnographic data reported by Foster regarding small *cherémekua* nets, the only type of net which uses small sinkers. These nets are all similar in size; larger nets are formed only by combining a number of smaller ones, and these use only large stone sinkers.

In summary, the statistical and ethnographic data seem to support the net sinker hypothesis most strongly. Although the *numbers* of ceramic disks found are not inconsistent with the gaming piece hypothesis, they are also not inconsistent with the net sinker hypothesis. *The data are consistent with* all *of the criteria put forth for weighing the net sinker hypothesis* (no pun intended). In contrast, there are serious problems with both of the other hypotheses, that the disks were *malacates* or that they were gaming pieces. In light of available information, then, it seems pragmatic to accept the net sinker hypothesis as the most likely explanation of the Tarascan disks, at least for now. Future anthropological research may support or weaken this conclusion.

CHAPTER 3
ARCHAEOLOGICAL CONTEXT

Considerable confusion regarding the function of these North American artifacts exists in the literature. Similar artifacts are variously classed as different items, and, conversely, different types of artifacts are sometimes assumed to have the same function. These will be examined on a case-by-case basis to determine which, if any, functioned similarly to those from the Tarascan cultural area.

Ceramic Disks from Prehispanic Mexico

Ceramic disks similar to those recovered in Pollard's researches have been reported from other areas of the Lake Pátzcuaro Basin (Toledo et al. 1993) as well as from several other lake basins in Mexico. Arnauld et al. (1993) report them from the Zacapu Lake Basin, Michoacán; Macias Goytia (1990) reports them from Cuitzeo, Michoacán; Jeffrey Parsons (personal communication) reports them from the Basin of Mexico; and Yoko Sugiura-Nancarrow (personal communication) from the Toluca Valley and Lake Chapala. Some of these have already been discussed above.

Similar Stone Artifacts from North American Sites

In addition, notched and grooved stones of various sorts have been reported from all over native North America, including Michigan (Cleland 1966), Alaska (Weyer 1930; De Laguna 1934), Pennsylvania (Meehan 1893), New York (Ritchie 1944), California (Wallace and Lathrap 1975, Pohorecky 1976), and Texas (Watt 1938).

Evidence for the use of net sinkers in native North America is mixed and somewhat less conclusive than the evidence for fishing and fish consumption in general. Rostlund (1952:291) reports widespread distribution of grooved or notched stones throughout the eastern half of the United States. Although widely presumed by their excavators to be aboriginal net sinkers, Rostlund is critical of some, but by no means all, of the claims.

Clear evidence of their use in Pennsylvania is discussed in Meehan (1893), who documents the Native Americans of this region as expert fishermen whose diet was largely dependent on the abundant fish of Pennsylvania's rivers. As he reports:

> Sieves and gill nets had lead lines made of *small circular flat stones having two deep notches* to keep the lines from slipping. These "leads" have been found by the thousands in the Delaware and Susquehanna rivers... Dr. C.C. Abbott, curator of the Archaeological Department of the University of Pennsylvania,...came upon a series of about thirty seine "leads" stretched in an irregular line about eighteen inches apart. *From their position and other evidence found in connection therewith, it was apparent that they formed part of a net which had been set and then abandoned* (1893:8-9) (italics mine).

Meehan also points out that the use of fish nets in this region is well documented both archaeologically and ethnographically. Not only do many pottery sherds bear net imprints, but early writers in the region bear witness to having seen them used (1893:8). In the case of aboriginal Pennsylvania, then, support for the use of net sinkers is multi-fold: a strong tradition of fishing, including weighted nets, which is documented both archaeologically and ethnographically, and the fact that many sinkers were found in actual riverine contexts. In this case, at least, it appears that the morphological characteristics of the artifacts (small, flat, circular stones with side notches) is a good indicator of their use as net weights.

Custer (1996) also documents net sinkers at numerous sites in and adjacent to Pennsylvania ranging in age from the Early Archaic to the Late Woodland periods. Net sinkers were found at the Harry's Farm Site in New Jersey's Upper Delaware Valley, radiocarbon dated to between 7380-7320 B.P. (Early to Middle Archaic). According to Custer (1996:114) it is one of the "small, repeatedly occupied base camps at which varied floral and faunal resources were procured, processed, and consumed" which typify this era. Three caches of stone tools, including one of net sinkers, were found at the Late Archaic (3000-1000 B.C.) Faucett Site, also in the Upper Delaware Valley (1996:201). Several Late Woodland (A.D. 1000-1550) sites have yielded numerous net sinkers, including 29 at the Williamson Site and 95 at the Overpeck Site. Both are described by Custer (1996:293-4) as basic hunting and gathering camps which were characterized at this time by, among other things, "an economic adaptation involving the intensive exploitation of anadromous fish in conjunction with hunting and gathering." Moeller (as reported in Custer 1996:295-6) has reported dense accumulations of faunal remains, including fish, in refuse pits from the Late Woodland period sites on the Pennsylvania side of the Delaware River, testifying to their importance as a food resource.

The net sinkers discussed in Custer (1996:185) appear to be identical to those reported by Meehan: they are small (ca. 6-7 cm in diameter), round cobbles with pecked bilateral notches. Significantly, they are noticeably distinct in form from atlatl weights from the same area (1996:193).

Evidence for the use of net sinkers in prehistoric New York is also strong (Ritchie 1944). Ritchie catalogues over 9,800 net sinkers from seven pre-Iroquoian sites in New York state. Occupation levels yielding net sinkers range from roughly 3000 B.C. - A.D.

1600. The 5,000 year-old Lamoka site alone yielded some 8,000 of them (Rostlund 1952:96-7). Ritchie does not explain the criteria he used to categorize the net sinkers, but their sheer number and their morphological consistency support their classification as a unique artifact class. With only one or two exceptions, all of the net sinkers are flat, ovate sandstone disks with two side notches. Except for the fact that they are made of sandstone and are more nearly oval than circular, they are nearly identical to those artifacts analyzed in this thesis. And, as with the Tarascans, their abundance reflects a strong reliance on fishing, a contention borne out by the presence of additional archaeological evidence such as fish hooks, gorges, and shell middens. All of the artifacts labeled as net sinkers were excavated from sites adjacent to water. Again, the link between a developed fishing technology and the presence of large numbers of flat, circular or ovate notched stones is strong, and lends credence to classifying the latter as net sinkers. Unfortunately, Ritchie does not provide specific information about the intra-site provenience of the net sinkers (although undoubtedly it was noted at the time of excavation). However, like so many Tarascan settlements, this site is adjacent to lake waters suitable for fishing.

The northeastern Native Americans' use of net sinkers has been documented not only archaeologically but also ethnohistorically. Samuel de Champlain left extensive written records of his travels throughout this region, and makes numerous mentions of fishing practices among the natives he encounters. In general he considered the natives of this region to be excellent and skilled fishermen, and the waterways to be very productive (see Biggar 1929). Speaking specifically of the Iroquois' territory and the St.

Lawrence river, he relates

> ...the rivers, streams lakes, and ponds are as numerous as one can wish, with abundance of salmon, very beautiful fine large trout of every kind, sturgeons of three sizes, shad, very good bass, some weighing twenty pounds, suckers of all kinds, some of them very large, and pike, some of them five feet long, catfish without scales in two or three varieties, large and small whitefish a foot in length, pickeral smelts, tench...

Of the New York area, he mentions that the inhabitants of Lake Couchiching, adjacent to Lake Huron, "make great catches of fish which they preserve for the winter" (1929:56). Although in this instance he does not record their method of harvest, he goes on to state that at the adjoining Lake Simcoe "the great catch of fish takes place by means of a number of weirs which almost close the strait, leaving only small openings where they set their nets in which the fish are caught..." (1929:56-7). Of the sedentary Attigouautan tribe, who lived on the peninsula between the Georgian Bay and Lake Huron, he recorded their practice of making and trading fish nets with some of their nomadic neighbors (1929:131). These nets were made by the women of the tribe, out of spun hemp fiber (1929:136). In contrast, among other tribes in the area the men fashioned the nets, which were employed in winter as well as summer (1929:166-7). As to fishing in the winter, which greatly impressed him, Champlain records:

> ...they make several round holes in the ice and that through which they are to draw the seine is some five feet long and three feet wide. Then they begin to set their net by this opening; they fasten it to a wooden pole six or seven feet long, and place it under the ice, and pass this pole from hole to hole, where one or two men put their hands through and take hold of the pole to which one end of the net is tied, until they come back to the opening five or six feet wide. *Then they let the net drop to the bottom by means of certain small stones fastened to the end of it.* After it has been on the bottom they draw it up again by main force by its two ends, and thus they bring up the fish that are caught in it (1929:167-8; italics mine).

Champlain does not mention which species of fish were harvested in this way. It is possible that nets (with sinkers) were used to capture the well-known Great Lakes whitefish (*Coregonus* sp.[Cleland 1966:172]), a species entirely unrelated to the whitefish *("pescado blanco",* or *Chirostoma estor)* of the Tarascans' territory. This type of winter use of nets is what Schoolcraft reports when he describes the same practice:

> Another mode of taking fish in the winter, is by making a series of orifices, through the ice, in a direct line. A gill-net is then pushed, by its head-lines, from one orifice to another, until its entire length is displayed. *Buoys and sinkers* are attached to it, and it is then let down *into deep water, where white fish,* and other larger species, resort at this season. The next morning the net is drawn up, the fisherman secures his prey, and again sets his net as before. By this mode, which is very common throughout the lakes where deep water abound, these species are captured at the greatest depths, while sheltering themselves in their deepest winter recesses (1852:51) (italics mine).

A legitimate question is why the natives of Pennsylvania and New York used stone for their net weights when pottery was obviously abundant. One would imagine that it would be much less labor intensive to grind pottery sherds than stone into grooved disks, although this needs to be tested experimentally. The exception, perhaps, would be sandstone. It is a relatively soft stone and for the natives of the New York area may have provided the durability of stone with the ease of workability of fired ceramic. Perhaps stone is more durable; it may not be more difficult to work after all (for instance, it may not shatter as easily as pottery), but that does not then explain why the Tarascans used pottery. Perhaps the Tarascans' pottery, which was of superior craftsmanship, was more durable than that of the native Pennsylvanians, and thus durable enough that stone (and the labor involved in working it) was not necessary. Or, less likely, perhaps the natives of the northeast used pottery too, but it has not survived in the archaeological record as the stone did. As Ritchie notes, the pre-Iroquoian pottery "is not remarkable for quality, being rather coarsely grit-tempered and friable" (1944:110). Certainly stone net sinkers are known archaeologically from other areas of the world, such as Neolithic Finland (Broadbent et al. 1993:197-8). As Joseph Chartkoff (personal communication) suggests, perhaps stone's density makes it more suitable for use in active waters. This would account for its use in the rivers of the northeastern United States. Likewise, pottery sherds would have been perfectly adequate for the relatively calm shallows of Lake Pátzcuaro. The different media used for net sinkers could even reflect differences in gender-based division of labor. The preference for one material over another when both were available is still open to explanation. It may simply be idiosyncratic or it may have to do with inherent properties of the chosen medium. Additional archaeological, ethnographic, and experimental data would all be useful in clarifying this question.

Rostlund (1952) documents the fishing expertise of the Native Americans who occupied the Great Lakes region. The cultures of this region provide a relevant point of comparison to the Tarascans not because they harvested the same species of fish but rather because they developed, at least in some times and places, a similar specialization or focus on fish resources as a dietary staple (Cleland 1966). Their use of set gill nets was noted by numerous European explorers in the area (e.g. Schoolcraft 1852). Due to their habit of feeding on small lake-bottom organisms and the fact that they are not biting fishes, members of the whitefish family which inhabit the Great Lakes are not readily taken by many common techniques such as fishhooks, weirs, or spears (Rostlund 1952:28-9); although Jenness reports that the Ojibwa of Parry Island commonly took whitefish with spears (in Cleland 1966:172). Schoolcraft, too, notes that "The white fish, so common to the whole line of lakes, never bites at a hook, and is captured solely by nets or" "spears" (1852:53). Therefore, wherever whitefish were an abundant food source, we might reasonably expect net fishing, and net sinkers, to have been employed. As Rostlund reports, "It was the larger and fatter whitefishes more than the small lake herrings that were sought by the native fishermen, and the problem of how to catch these night and bottom feeders was solved by means of the set gill net (1952:29). Furthermore,

> "...it (is) very clear that the gill-net fishery par excellence in native North America was found in this region of great interior lakes inhabited by the whitefish family; and it may be added that this great food resource could not have been adequately exploited had the gill net been unknown...I submit that as fishermen these people from the Great Lakes toward the Mackenzie Valley were second to none in aboriginal North America (1952:29-30).

Schoolcraft testifies that the natives of this region successfully employed the gill net technique described above during the wintertime: "Fish are sometimes brought up in the immediate vicinity of Michillimackinac, from a depth of eighty fathoms (1852:51).

Although he does not report net sinkers, Cleland finds it likely that net fishing was practiced in some areas of the Great Lakes, especially during the Middle Woodland period (300 BC-AD 400):

> With the advent of Middle Woodland influence from the south, fish became a more important subsistence item and a new technique was employed to catch them, either nets or weir traps. The use of this technique is indicated by the fact that the fish remains of this horizon more nearly represent a random sample of both the species and sizes of fish which were in the river. When one employs a seine or builds a fish weir, large as well as small fish are caught; these are non-selective fishing techniques (1966:141).

Such a faunal "signature" was found in the Middle Woodland levels of the Schultz site in Michigan, located on the Tittabawassee River in Saginaw County, where it most likely represents a focused reliance on fish as a food resource in early spring when other food resources were scarce (1966:141-4). Cleland reports evidence documenting a seasonal fishing village pattern in the Saginaw, Michigan area by at least 2,000 B.C. (1966:55). By the Middle Woodland period (300 B.C. – A.D. 400) this fishing specialization most likely utilized nets and was responsible for a substantial increase in population density and summer residential stability (1966:94-5; 141; 143). Cleland's extensive study of this region's archaeological record led him to conclude that the "...large aboriginal villages of the Upper Great Lakes were sustained and attained economic stability through an adaptation specialized in the exploitation of fish resources" (1966:162). No net sinkers have been found at the Juntunen site in Mackinac County, Michigan; nevertheless, Cleland argues that the sheer quantity of whitefish remains found there make it likely that weighted gill nets were used by its inhabitants since whitefish are not easily speared (1966:176). Cleland might just as easily have been speaking of the Lake Pátzcuaro Tarascans as the Great Lakes natives when he states that "fish were the staple food element in the diet of Juntunen site peoples and... the very location and existence of the site was a function of available fish resources in that locality" (1966:194).

Several researchers have reported net sinkers from California (see Moratto 1984). For example, Pohorecky (1976:54-94) reports eight stone sinkers from the Willow Creek sites in Monterey County. These were found with a variety of other fishing paraphernalia as well as tools and other articles manufactured from shells and fish bones, including fishbone awls, worked shell, shell spoons and scrapers, shell fishhooks, and shell beads. Two carbon 14 dates of A.D. 72 +/- 250 and A.D. 112 +/- 400 were obtained from the sites (Pohorecky 1976:97 in Moratto 1984:240). Much earlier examples of "notched and grooved net sinkers" are reported from Wallace and Lathrap (1975) (see Moratto 1984:259) for a site in Alameda County (Ala-307), which the excavators dated to 1910+/-450 B.C. and 750+/-300 B.C. Again, these were found in context with other features, such as shell middens, which clearly indicate a reliance on fish as a food resource. Other sites and examples from this state abound and are beyond the scope of this paper to detail. Interested readers are directed to Moratto 1984 for a more comprehensive treatment.

The case from Lovelock Cave, Nevada (Loud and Harrington 1929) is less clear, but nevertheless establishes a connection between fish remains, fishing paraphernalia (nets, hooks, etc.), and manufactured stone disks. In this case, the stone disks are not notched but drilled (Figure 36). No specific claim is made by the excavators that the perforated disks were used to weight nets; they classified them simply as "perforated stones" (1929: plates 55 and 65). Remarkably well-preserved fragments of fishing nets of several kinds were found, however, in rather large quantities (Figure 37). Some of these have been estimated to have reached 30-35 feet in length, with one exceeding 42 feet (1929:89). Certainly the stones *could* have been used as net sinkers, although evidence to support this is not as strong as in Pennsylvania or New York.

Similar evidence comes from the Aleutian village of Hot Springs at Port Möller, Alaska (Weyer 1930). Abundant fish remains in refuse pits and occupation levels indicate that the inhabitants were fishers as well as hunters (1930:246). More than 50 artifacts of various shapes, including some which are roughly circular, were found and specifically classified by Weyer as net sinkers. Most of these are grooved, but at least one type is perforated. All are stone (Figure 38). Again, the evidence that the artifacts were used as net sinkers is rather circumstantial (Weyer does not explain his classification), but certainly consistent with the cultural context. It should be noted that the use of stone rather than pottery would be expected this far north.

Although de Laguna (1934) also excavated in coastal Alaska and also found numerous notched stones (Figures 39a-b), she came to a very different conclusion regarding their function. Noting that "... the distribution of the notched and grooved stones does not correspond to that of the fish hooks," nor to areas near the water, or rich in fish bones, de Laguna suggests that "... they may have had nothing to do with fish" (1934:170-1). Instead, she cites ethnographic and archaeological evidence that they were used as various types of bolas and throwing stones. While her evidence is strong, it does not *exclude* the possibility that at least *some* of the stones were also used to weight fishing nets or lines. De Laguna further remarks that "It is interesting to note that the Aleut name for the bird bola weight is the same as that for the fish-line sinker, suggesting that the specimens *may have been actually interchangeable*" (1934:171, italics mine). The possibility exists that some artifacts originally fashioned as bola weights were reused as fish line sinkers, further confusing the archaeologist. At any rate, they almost certainly were not used on true netted seines or gill nets, for as Rostlund points out (1952:97), the Aleuts did not acquire these until after contact with the Russians.

Not all side notched stones functioned as net sinkers, however. A good example of this comes from central Texas, where a large number of such stones have been found and claimed by several early researchers to be net sinkers (Watt 1938) (Figures 40a-b). The artifacts fell into four morphological categories: 1) natural pebbles unworked except for side notches (the most common type, 1938:46); 2) flaked or chipped; 3) ground or pecked; and 4) unifacially worked (usually flaked) (1938:24). Although the first category is morphologically similar to known net sinkers (c.f. Ritchie, quoted in Watt 1938:44), the remaining three are not. The average length (many are oval or nearly rectangular) of these artifacts is 45 mm (1938:26), which is somewhat larger than the mean diameter of 30.7 mm for the Tarascan disks. Although the smallest specimen measured 30 x 20 x 12 mm, which is within the diameter range of the Tarascan disks, the largest, at 100 x 55 x 35 mm, is clearly outside the range of any known Tarascan disk. That the size ranges of the two sets of artifacts differ so much may argue for separate functions as well.

Workmanship on the artifacts, according to Watt, ranges from "crude" to "skillfully shaped objects of highly specialized forms" (1938:26). One might reasonably question why net sinkers would need to be skillfully shaped or highly specialized. As discussed above, they do not require excessive amounts of craftsmanship to function adequately. Some of the stones are grooved around the entire circumference of their long axis (1938:30), which clearly entails much more work than is necessary to attach a sinker to a net. Watt concurs, stating

> Anyone who has run trot lines or throw lines along Central Texas streams has never lost much time finding suitable rocks to use without expending any labor on fashioning them to a peculiar shape. Also the hardness of the material requires hours of patient work to shape to perfect form (1938:55).

It is possible that more specialized or decorated forms functioned as "charms," without which the net would be considered useless for catching fish. Such charms were reportedly used by the North American Chipewyan (Oswalt 1988:77). It is also possible, of course, that they served a purpose or purposes altogether unrelated to net fishing.

Although many of the artifacts were found "across the trends of streams" (Watt 1938:48), none has apparently been found in an actual stream bed (1938:55), unlike those in the northeastern states. Many were also found in camp sites on high banks adjacent to rivers (1938:53). Watt makes a valuable point when he says

> The term net sinker is most commonly applied and accepted for these objects and the impelling reason is the fact that the sites where found (sic) are predominantly along the streams or shores of other waters. However, the fact must not be overlooked that this is a condition that applies to almost all camps of any nature (1938:55).

Not surprisingly, then, Watt concludes that it is very unlikely that these artifacts were used as net weights. He deems their most likely use to have been as grips and shuttles for winding arrow shafts (1938:56-7), but does not rule out other, less likely, uses, for lack of evidence: hammers, pendants, ornaments, or charm stones.

In sum, then, although not all cases of purported net sinkers can be substantiated, they were undoubtedly used for this purpose in some areas and periods. Referring to the so-called Waco sinkers, Watt sums up the problem of identification:

> The early writers named...them sinkers, from a definite knowledge that notched pebbles were attached to fishing lines or nets as weights to hold them under the water; however similarity of form does not necessarily determine that all such similar forms were used for identical purposes (1938:54).

When evaluating the evidence for fishing net weights, several factors seem important in lending credence to their functional classification. First and foremost would seem to be the existence of a developed fishing technology and thus a substantial cultural reliance upon fish as a food source. Rostlund posits that "...the degree of proficiency in the use of fish nets is a measure of how effectively the fish resource is utilized..." (1952:84). As he points out,

> Wherever nets can be used, more fish can be taken with them and with less effort than by any other method. But fish nets are not so easily manufactured as some other fishing gear, and the very fact that people spend time and effort in making nets can only mean that they are seriously

> engaged in fishing. A highly developed net fishery is a distinguishing mark of a specialized or professional fisherfolk. (1952:81)

It is among just such cultures that we would most reasonably expect to find fishing net weights. With this criterion, the classification of discoidal stones or sherds, with or without notches, as a functional artifact used as a net sinker, seems eminently reasonable for not only the natives of northeast North America and the Great Lakes but also the Tarascans, who were highly skilled fishermen.

CHAPTER 4
FISH AND FISHING IN THE TARASCAN EMPIRE

Fish Nomenclature

Scientific Name	Spanish Name	Tarascan Name
Chirostoma. attenuatum	charal	
Ch. patzcuaro	charal	khuerepu, k'uerépu, cuerepu/o
Ch. grandocule	charal	khuerepu (etc.); chakuami
Ch. estor	pescado blanco	urapeti, kurúca urapeti/urapiti
Ch. jordani	pescado blanco	
Ch. bartoni	pescado blanco, charal (Foster)	kuerepo turipiti
Ch. michoacanae	pescado blanco	
Algansea lacustris		akumara, acumarani
Goodea luitpoldi		thiru, t'íru

Table 3. (Compiled with information provided in Toledo 1991:166; Foster 1948; Craine and Reindorp 1970; and Pollard 1993).

Fish in the Tarascan Diet and Economy

Not surprisingly for a society situated in a large lake basin, fish formed a staple of both the Tarascan diet (Gorenstein and Pollard 1983:105-7) and economy (1983:103-8). In fact, the Aztecs' name for the Tarascans' territory, *Michoacán,* literally means "the place of the masters of fish" in Nahuatl, their native tongue (Coe 1984:142).

Fish comprised the Tarascans' single largest export, and were widely exchanged outside the Lake Pátzcuaro Basin for essential foods such as maize, beans, and chile peppers (Gorenstein and Pollard 1983:109).

Ethnographic sources record the taking of several important species of fish in the Prehispanic period, including *Chirostoma estor (Kurúca urapeti), Ch. bartoni (charal), Ch. grandocule (k'uerépu), Algansea lacustris (akumara),* and *Goodeidae spp. (t'íru)* (see Gorenstein and Pollard 1983:171).

Fish provide important nutrients, and helped make the Lake Pátzcuaro basin an especially productive environment. Although lakeshore comprised only 15% of the basin land area, it supported 69% of the settlements and 74% of the population in the protohistoric period (Gorenstein and Pollard 1983:153).

Gorenstein and Pollard note that "the species used protohistorically are well distributed in the lake, some preferring littoral niches (e.g. *C. bartoni)*, others the open water *(C. estor)*, and others the open deep water *(C. grandocule)"* and estimate the annual fish yield of Lake Pátzcuaro as 4,732,800 kilograms (1983:176-7). They further point out that "Since the protohistoric lake was considerably larger, it provided more open water which is the niche of the more valued and abundant fish *(urapiti [C. estor], pescado blanco; cuerepu)* (1983:176-7).

Fish in general provide vitamins A, D, B1 (thiamine), and B2 (riboflavin) (Rostlund 1952 in Cleland 1966:196). Gorenstein and Pollard (1983:173) calculate that a 100 gram portion of fish (*C. estor, or pescado blanco)* would have provided 67 usable calories and a range of important nutrients such as niacin, iron, calcium, zinc. According to *The Concise Encyclopedia of Foods and Nutrition* (Ensminger et al. 1995), most fish contain 18-20% protein, of which 85-95% is digestible. Dried *charal,* which could be consumed whole, provided even more nutrition. Ortiz de Montellano calculates that each fish in this form is comprised of more than 61% protein and contains three times the daily requirement of niacin per 100 grams and a substantial amount of vitamin A (1990:115). Fish comprises a high quality, "complete" protein, meaning that it contains all the amino acids humans need for proper nutrition (Ronzio 1997:369). Fish meets or exceeds the recommended daily intake of five of these amino acids (Gorenstein and Pollard

1983:173). With a three ounce (85 gram) portion of lean white fish providing over 20 grams of protein (Pennington 1998:332-7), a modest portion of fish could make a substantial contribution to daily protein needs (U.S.R.D.A. is 63 grams for adult males and 50 grams for adult females -- see Ronzio 1997).

Ethnohistoric documents, such as *The Chronicles of Michoacán*, record the techniques used by the Tarascan fishermen and the types of fish taken, including the use of nets, fish hooks, and baskets (1970:111,114,116-17, 131-2). Fishermen may not have always specialized in a single technique, as *The Chronicles of Michoacán* contains a story of a fisherman who fished at night with a net and by day with a hook (1970:114). Nets could be cast from canoes on the deep, open lake or set up along the shore (1970:127). It is likely that the nets set up near the shore were used to catch *Ch. bartoni*, since this is the species which prefers a littoral habitat. It is also probable that these are the nets which utilized net sinkers of the sort analyzed in this thesis.

Lumholtz observed a multitude of methods for catching fish among the Tarahumara of northern Mexico. Although the Tarahumara are not ethnically Tarascan, their fishing practices are useful in illustrating the variety of fishing practices among native peoples in Mesoamerica. These included catching by hand, the use of open mats, spears, stone corrals, and other types of traps to trap fish, as well as poisoning the water. Lumholtz also reported that during the summer the Tarahumara sometimes improvised a net of sorts by fastening multiple blankets together and dragging the river. The Tarahumara weighted the net by making a hem along the bottom about four inches deep and filling it with sand (in Bennett and Zingg 1976:121-4). No net sinkers were used.

At the time of the Spanish Conquest, Tarascans harvested fish using fishhooks as well as various sorts of nets (see above and below) (*The Chronicles of Michoacán* 1970). Fish were generally prepared roasted, cooked, or sun-dried (Alcalá 1980, in Guzmán et al. 2001). It was also common to present visitors to the king, or *cazonci,* with gifts of fish. The *Relacíon de Michoacán* relates how Cristóbal de Olid requested several types of fish upon his arrival in the Tarascan kingdom, among them, "*cuerepo" (Chirostoma patzcuaro), "acumarani" (Algansea lacustris), "urapeti" (Ch. estor),* and "*thiru" (Goodea luitpoldi)* (Guzmán et al. 2001).

The island of La Pacanda, in Lake Pátzcuaro, was an important Tarascan settlement in Prehispanic times, and, like many other Tarascan settlements in the lake basin, engaged in fishing as an important economic activity. Fishing, along with farming, remains an economic staple, and modern-day Pacandeños derive the bulk of their income from selling fish and produce at local markets outside the island (Smith 1965:18, 41).

Smith (1965) mentions several fishing techniques still in use at the time of his dissertation, including *chinchorro, cherémequa*, and butterfly nets. He makes no specific mention of net sinkers. However, as the reader will recall, Foster (1948:102-4) reported that large, "unworked stones of 4-8 kilos" were used with modern chinchorro nets to fish bass and small, "pebble" sinkers were used with the *cheremékua* nets. Since recent years have been a time of rapid economic and technological change (Smith 1965:168), it is possible that fishing technology changed in the seventeen years separating Foster's and Smith's ethnographies. Alternatively, Smith may not have reported them even though they were still being used. It is also quite possible that fishing practices and their role in the economy may be different from pre-Conquest times. For example, Sugiura's description of modern fishing techniques in the Toluca basin makes no mention of net weights (Sugiura 1998), despite the fact that she has recovered several examples of worked sherds from local archaeological sites which she believes to be Prehispanic net weights (Pollard, personal communication). Further archaeological research is needed to clarify this.

Like the Pacandeños, the people of Quiroga, also in the Lake Pátzcuaro Basin, practiced fishing as an important economic activity during Prehispanic times (Brand 1951:162). Unlike the Pacandeños, however, the inhabitants of Quiroga have lost their lake access rights in modern times and thus cannot fish or hunt waterfowl as they once did. These items must now be purchased from their neighbors in other lakeside towns such as Santa Fé and Tzintzuntzan. Fish, though now purchased, are an important source of protein, and, particularly in the form of dried *charal*, also provide calcium for the Quirogans' diet.

Gorenstein and Pollard (1983:122) provide population estimates for several Tarascan empire administrative centers. They also calculate how many people in each area could have been supported by a maize-only diet. The estimated populations of Urichu and Pareo are both below what could have been supported by a maize diet. However, the population estimates for the island of Xarácuaro are well above what could have been supported by maize alone. The inhabitants of this island would have needed supplemental food to nourish themselves adequately. Despite *The Chronicles of Michoacán*'s assertion (1970:13) that "The fishermen did not eat the fish but took it all to the Cazonci and the lords, for they ate nothing but fish," fish seems a likely candidate for this role, and would account for the large numbers of net sinkers found in the area.

Fishing remains an important activity among the modern Tarascans, as documented by Foster (1948) and Toledo (1991), although its range is perhaps more limited. Brand reports, for example, that in present-day Quiroga, also in the Lake Pátzcuaro basin,

> Very little hunting or fishing is done by the inhabitants of the Quiroga area. Since they have no lake rights they neither catch fish nor hunt ducks. These items are purchased from peoples of Santa Fe, Tzintzuntzan, and other lake communities...This is far different from the conditions which obtained before the coming of the Spaniards...In prehistoric times...fishing for the various fish of the lake...(was) very important (1951:162).

At the time of Foster's ethnography (1948), all fishing on Lake Pátzcuaro was done by Tarascans, and fishing was the third most important industry in Tzintzuntzan, one of the lake's major settlements (1948:101). Foster discusses net fishing technology at length, and although the ceramic disks are considerably lighter, with a mean weight of 6.21 grams, than the 4-8 kilos he observed to weight the large *chinchorro* seines used to fish bass from canoes (1948:102), they may be analogous to the "tiny pebble sinkers" he reports were used with a type of gill net commonly suspended between two poles near the lakeshore and used to catch the young of the famous Tarascan whitefish, or *khuerepu* (1948:104).

Although reduced in scale, fishing remains, nevertheless, an important economic and cultural activity. Artisanal fishing is still practiced in Lake Pátzcuaro; as of 1993 it still produced 29% of the fish harvest and contributed a full 80% of the fish consumed locally (Toledo et al. 1993:135).

Of the five native methods still used, *cherémecua* nets currently dominate, with some 15,194 reported in use in 1986. They are generally 25-50 meters in length.

Because of their light mesh, *cherémecuas* cannot be used to catch all types of fish. *Chinchorro* (literally "small boat") nets are also widely used but are now made with synthetic monofilament rather than cotton as in earlier times. Since the synthetic nets are stronger (and probably lighter) than the cotton ones, it is possible that they are also made larger than they were previously. They are comprised of two "arms," with a central pocket. The arms of the *chinchorro* nets currently range from 70-300 meters in length. Their small mesh size (5-20 mm) enables them to capture all species in almost all size ranges. The use of butterfly nets is in sharp decline. As of 1955 it was still the dominant fishing technique, but by 1989, only 38 were left in use. Fishing hooks remain in use but are of only minimal importance (Toledo et al. 1993:143-4).

Of four *Chirostoma* species (*Ch. estor, Ch. grandocule, Ch. attenuatum,* and *Ch. patzcuaro*) which are native to Lake Pátzcuaro, the first, known locally as *pescado blanco*, or "whitefish," is distinguished from the latter three, collectively referred to as *charal*, because it grows to sizes greater than 20 cm in length. The greatest recorded size for the first few months of 1991 was 39 cm, although most average from 12-18 cm (Toledo et al. 1993:137). Faunal remains of these fish have not yet been studied in an archaeological context; research in this area would be useful in determining whether these size ranges were similar in Prehispanic periods or whether modern conditions such as fishing practices or the introduction of carnivorous bass has reduced their size.

Fish in Mesoamerican Ideology

Having thus demonstrated that the Tarascan disks most likely functioned as fishing net weights, it becomes appropriate to examine the larger role of fish in

Mesoamerican culture beyond its economic importance. Establishing the ideological or mythical meanings of fish in the cultural framework may assist in interpreting future discoveries of fish remains in the archaeological record, although, of course, it will not explain every one. For example, knowing that fish are an important symbol of the creation of life in Mesoamerican cultures may enable the archaeologist to consider multiple layers of meanings when he or she uncovers remains interred within a tomb. These meanings may be quite different from those gleaned from the faunal remains of a household refuse pit.

Fish play an important part in the mythology of Mesoamerica and adjacent areas. From the Caribbean Taino, for example, comes this myth of the sacrificed son of god, as reported by Joseph Campbell (1989:315):

> There was a man called Yaya, whose name we do not know. He had a son called Yaya-el, who wanted to kill him, and so, was exiled. For four months he was exiled, after which his father slew him, packed the bones in a mortuary urn, and hung the urn from the roof, where for some time it remained.
>
> Then Yaya one day said to his wife, "I would like to see our son, Yaya-el." She was pleased. So, taking down the urn, he turned it upside down to have a look at the bones, but what fell out were fishes, large and small. And seeing that the bones had turned into fish, the couple ate them.
>
> When one day Yaya had left his house to go to inspect his gardens, the four sons arrived of a woman who had died in giving birth to them. Itaba Cahubaba, she was called, The Blood-bathed Old (Earth) Mother. She had been cut open and the four taken out... when Yaya had departed from his house, these four entered to get the mortuary urn... all were gorging themselves on the fishes it contained when Yaya was heard returning. In haste to hang the urn up, they hung it badly. The urn fell, broke, and out poured so much water that it flooded the earth. Many fish came too. The origin of the sea was from that urn...

This myth illustrates a clear association of fish and water with the origins of life and as an important source of sustenance for people. As Campbell points out, the mythic archetypes of a son sacrificed to or by his deity father, as well as the association of this son with a meal of fish should be familiar to anyone familiar with the Judeo-Christian mythic tradition (Campbell 1989:315).

In Mesoamerica proper, water and fish play important parts in Mayan creation myths as well. For example, First Father in his Maize God aspect is both killed and reborn in the waters of the sea (Freidel et al. 1993:92). The primordial sea, depicted again and again in Maya art, is also "the place of Creation, where First Father raised the sky and where First Mother modeled the flesh of humanity from maize dough and water" (1993:284).

Fish comprise one of the thirteen constellations used in the Maya zodiac (Freidel et al 1993:102). In Maya mythology, the Hero Twins are credited with defeating death and banishing the Xibalbans from the world. They also make possible the Fourth Creation of the World, the one in which humans are created (1993:110-11). When the Maya Hero Twins, Hunahpu and Xbalanke (One-Ahaw and Yax-Balam) are killed by the Lords of Xibalba (the underworld) in a raging fire, the jealous and murdering gods crush their bones and throw the dust into a river. Five days later, the Twins emerge as catfish men (1993:109,348).

The Maya ballgame was performed as a ritual reenactment of the creation of the world, and was played in order to maintain the balance of the cosmos. The ritual ballgame was played by elites and involved the sacrifice of human captives. As Friedel et al. explain, "Ballgame sacrifice renewed the basic covenant between gods and people" (1993:362). Art from these ballcourts, which are ubiquitous in the Maya cultural area, is rich with the imagery of Maya creation myths. For example, carved panels at the ballcourt of Yaxchilan depict the ruler Bird-Jaguar wearing the net skirt of the Maize God (First Father) and with a fish on his back, "reminiscent of the Hero Twins who first resurrected with catfish faces" (1993:360). Panels at the ballcourts of La Amelia and Dos Pilas depict similarly outfitted rulers (1993:361-2).

The so-called Maya "fish-in-hand" glyph appears widely on Maya art and architecture in the context of blood-letting and sacred rites. It is a verb which apparently means something like "to manifest a vision or a divinity" (Schele and Freidel 1990:473). Again, there is an association of fish with something sacred, as well as with religious rites which were performed with the objective of maintaining a balance between the earthly and the divine.

Whether or not fish connoted these same meanings for the Tarascans is not known. Certainly the Tarascans shared many Mesoamerican cultural traditions, such as ritual ballcourts and human sacrifice, with their neighbors and predecessors. Kubler (1967, 1970), drawing on Panofsky's (1960:84-106) "law of disjunction," which the latter used to describe the discontinuity of meaning associated with similar iconographic elements between classical antiquity and medieval Europe, cautions against assuming that similar or even identical motifs carried the same meanings across time and/or space, even within the same general areas. Speaking of medieval Europe, Kubler asserts that "Continuous form does not predicate continuous meaning, nor does continuity of form or of meaning necessarily imply continuity of culture" (cited in Nicholson 1976:160). He takes a similar stance on applying a direct historical approach to Mesoamerican iconography (1976:160). Nicholson, however, holds a more optimistic view, stating that "Whether all major Mesoamerican groups participated in an essentially similar religious-ritual system or not... it seems clear that at least a core of interrelated basic concepts was widely shared" (1976:162-3). At the same time, he admits that "...the whole question of Mesoamerican Preclassic-Classic-Postclassic continuities in religious iconography requires a much more thorough, comprehensive analysis than it has yet received" (1976:163). He states that

> ...iconographic continuity can be best established by careful determination of similarity of images through time. And a single motif, it would probably be...agreed, would normally have less value than a consistently associated *cluster* of iconographic elements, the more complex the better (1976:163).

Even when iconographic continuity is established, however, it must also be demonstrated that their associated meanings were also carried through time. Nicholson realizes that

> Without the aid of coeval or otherwise relevant texts it is undeniably very difficult to determine whether representations and symbols formally similar but temporally widely separated actually did convey basically similar meanings (1976:170).

The problem of continuity of meaning is especially difficult to solve in the case of the Tarascans, for not only did they lack a writing system, but the examples of fish to which we are trying to assign a cultural meaning are faunal remains, not art icons. Nevertheless, I believe that, at least as grave offerings, the Tarascan fish remains may be viewed as the equivalent of an artistic depiction, as both are consciously constructed by their makers. The fact that fish are consistently associated with the origins of life in different cultures across a significant portion of time and space in Mesoamerica as well as adjoining areas, however limited the above examples are, is at least enough to *suggest* that the Tarascan grave offerings may have represented some similar idea. Thus, I would agree with Nicholson (1976:173) that "the direct historical approach can be profitably employed in Mesoamerican research to interpret...the iconographic systems of cultural traditions...;" further, I might suggest that this approach is not only appropriate, but may also be the most fruitful one, if carefully applied.

Fish in Tarascan Ideology

Among the Tarascans, as is so often the case with important foods among other cultures, strong linkages exist between fish as an economic staple and as an ideological icon.

On the island of La Pacanda, responsibility for organizing the modern-day fiesta of Corpus Christi ("El Corpus") is shared by three formal groups comprised of most of the adult men of the village. The three groups are known, interestingly, as *Los Chinchorreros* ("those who fish with chinchorro nets"), *Los Cherémequeros* ("those who fish with cherémequa nets"), and *Los Trabajadores* ("the workmen;" "those who work the land") (Smith 1965:90). Although membership in the groups does not literally reflect occupation (1965:91), the groups do represent central economic activities of the islanders (1965:96). During part of the ceremony, for example, the *Chinchorreros* and *Cherémequeros* dance in a line with their namesake fishing net, trying to capture a large, cloth fish effigy which dances in the middle of them. Although these activities are obviously important to the economy of the islanders, they serve to illustrate that the line between economic and symbolic activities is not clear-cut, and in fact may be indistinguishable. Whether the symbolic import of fish and fishing among the modern-day Pacandenos is due to the influence of Christianity introduced by the Spaniards or has roots that extend deep into their Tarascan heritage is difficult to say, since both provide viable precedents. Certainly fish and fishing play a part in both Christian and Prehispanic Tarascan mythology. For this reason, perhaps the source of the modern-day practices is irrelevant. It may be just those Christian ideas and symbols which had close parallels in their own culture that the Prehispanic Tarascans were most likely to identify with and incorporate into their new, changing culture. Certainly a similar process occurred when the Maya became Christianized (see Friedel et al. 1993).

Fish in Tarascan mythology

In comparison with other Prehispanic civilizations, relatively little is known about Tarascan religion and mythology. Much of what is known to us has come from *The Relacíon of Michoacán.* Modern-day ethnographies and archaeological work have given us additional insights. Nevertheless, significant bits and pieces can be gleaned from these various sources and are sufficient to prove that fish did play an important role in Tarascan mythology and ideology.

We do know that the island of Xarácuaro (one of the three sites discussed in this paper) was one of eight religious centers of the Tarascan empire (*Chronicles of Michoacán*). According to Gorenstein and Pollard, "All were clustered around the lake (Pátzcuaro) at sites which were highly visible to the settlements at higher elevations of the Basin slopes," with Xarácuaro serving the west (1983:123-4). On it was a "great temple" (*Chronicles of Michoacán*:113). The island's inhabitants were referred to as *"hurendetiechan,"* (Joaquin 2000:711) from *"hurendi,"* (sage or knowing); thus *hurendetiechan* = "the wise ones from the island" or "the people who were here first" (Pollard, personal communication 2001). Xarácuaro itself was known as "*Varucaten* *hazicurin,"* from *varun,* "island," *varucata,* "a fish thing," and *hazicurin,* "on a high place." Joaquin (2000:721) thus translates "Varucaten hazicurin" as 'On the place of the fish.' We also know from the archaeological evidence (abundance of net sinkers) that fishing was a central activity of the island's inhabitants.

Xaratánga was the Tarascan moon goddess (Pollard 1993:134,137); she was also associated with childbirth and fertility as well as with the sea (1993:134), lakes, and marshes (1993:151). Conch shells (a symbol of the primordial, life-giving sea?) were used in worshipping her (1993:134). The Tarascans believed that she had the power to conceal fish from the fishermen (1993:137). Significantly, among the Tarascans the worship of Xarátanga was associated with the ritual ball game, which, among the Mayans, had clear and documented associations with the sea and with creation. Depictions of vanquishing rulers with fish on their backs occur at several Maya ballcourts, including Dos Pilas, La Amelia, and Yaxchilan (Freidel et al. 1993:360-2). Xarátanga shared several of these associations, then: water, fish, creation, sacrifice, and life and death. As documented above, this grouping of symbols and meanings occurred elsewhere in Mesoamerica and the Caribbean.

Xarátanga's major temple was at Xarácuaro, although it was moved in the Postclassic, most likely as a result of the merging at this time of earlier, native religious beliefs with those of the ethnic Chichimecs, who founded the Postclassic Tarascan royal dynasty. The mythology chronicling this process yields interesting clues to the Tarascan culture, economy, and political process of state formation. According to *The Chronicles of Michoacán* (Craine and Reindorp 1970:113-20), one evening some lords of Curicaveri encounter a fisherman named Curiparaxan from Xáracuaro who is fishing from his canoe.

The lords confront the fisherman, who in turn builds a fire and feasts them on his catch, which the priests find very tasty. In talking with the fishermen, the lords discover that they, too, are related to the gods worshipped on Xarácuaro and Pacandan. They ask the fisherman if he has a daughter and arrange to meet her. They subsequently take the daughter away to raise her, predicting to the fisherman that she "will conquer this land, and you for your part will stand with one foot on the land and one on the water" (1970:116). This prophecy echoes not only the dual importance of agriculture and fishing to the Tarascan economy, but also the merging of two separate cultural and religious systems, the indigenous Tarascan and the ethnic Chichimec. The myth records the Chichimecs' founding of the royal dynasty and the formation of the Tarascan state: The fisherman's daughter grows up and marries one of the Chichimecs, Pavacume, and then gives birth to the legendary Taríacuri, who becomes the first ruler of the Tarascan state. It also describes the merging of two separate religious systems. As Pollard relates:

> The forging of the centralized state after A.D. 1300 required the creation of a common language of cosmic forces. The patron gods of the dominant ethnic elite were elevated to celestial power, while the various regional deities and worldviews, which were themselves products of generations of change, were elevated, incorporated, or marginalized (1970:134).

The myth is central to understanding the history and culture of the Tarascan empire.

Other mythic references to fish in *The Chronicles of Michoacán* include a story about some priests of Xarátanga who drink too much bad wine and send some serving women to catch some fish to cure their hangover (Craine and Reindorp 1970:111-13). The women try in vain but "could catch no fish because Xarátanga, who was such a great goddess, had already concealed them" (1970:112). Not wanting to fail their masters, the women substitute chopped up snake and make a stew for the priests. Not surprisingly, the snake stew does not produce the anticipated cure. This myth seems to suggest that the Tarascans believed that fish possessed either some real or symbolic healing qualities. In addition, it documents Tarascan elites' consumption of fish. *The Chronicles of Michoacán* (Craine and Riendorp 1970:12-13) states that the *Varuri* was the government official in charge of all the net fishermen who supplied fish to the *Cazonci* and all the lords, who ate "nothing but fish." Fish would have been an obvious nutritional supplement to an elite diet, but could this consumption also have had religio-symbolic value which reinforced their elite status? Given fish's religious associations, it is a possibility which cannot be overlooked and which deserves further investigation.

Fish in Tarascan burials

Fish remains have been found in the tombs of Epiclassic-Early Postclassic elites at the site of Urichu (Pollard and Cahue 1999; Guzmán et al. 2001), attesting to their cultural importance. Whether this importance was confined to their nutritional aspects or also encompassed ideological meanings remains to be explored. Thus, the ethnographic present can be compared with ethnohistoric records and the archaeological record so that similarities and differences between Prehispanic and modern Tarascan fishing practices can be explored.

One Classic-Epiclassic period (A.D. 350-1000) tomb of Urichu elites has yielded fish remains (Pollard and Cahue 1999; Guzmán et al. 2001). One internment was an adolescent of undetermined sex; the other contained two adult males. Tripod bowls containing fish bones and scales were found in both burials. Although the adolescent is of undetermined sex, it should be noted that this burial lacked grave goods typically associated with women, such as spindle whorls and shell beads (Pollard and Cahue:275).

Thus, it is possible (but as yet undetermined) that all three individuals associated with the fish remains were male. Whether or not this is significant or merely coincidental is unknown at this point. Archaeological evidence of the Tarascans' use of fish is extremely rare; these tombs represent the only example of fish remains found with human burials and only the second example of interred fish remains at all (Guzmán et al. 2001). The other known example is the discovery of whitefish (*Chirostoma sp.*) buried at the *yacatas* in Tzintuntzan dating to the Late Postclassic (Martín del Campo 1946; Polaco y Guzmán 1997, in Guzmán et al. 2001:152). The sample size is extremely small and would have to be enlarged significantly before any reliable patterns could emerge.

Pollard and Cahue state that elites of this period derived their status partially "from their participation in the macroregional exchange system by which (elite) goods were obtained; their importation as finished goods reveals the dependence of these elites on social/economic power generated in other parts of western Mesoamerica" (1999:275). Perhaps the fish remains represent a locally harvested commodity which was traded outside the immediate area in exchange for symbolically valuable goods from other regional centers which in turn reified and enhanced the status of the Urichu elites. Alternatively, the elites' burial association with a locally prized fish could foreshadow a trend in which their identity and status became "primarily associated with locally produced, distinctively Tarascan, goods and control of tributary, military, political, and ideological networks" associated with the emergence of the Tarascan state in the Postclassic (A.D. 900-1525) period (Pollard and Cahue 1999:259). If so, it is, indeed, an early example of this trend. Since the burials contain other elite status items, such as polychrome ceramics, it is highly unlikely that they reflect an individual's occupations as a fisherman. According to Pollard and Cahue, the tomb belongs to one local elite with local heads of high rank.

The fish remains in both burials are of the locally abundant fish known as "t'iru" in Tarascan (Pollard and Cahue 1999:270; Guzmán et al. 2001:155-6), or scientifically as *Goodea luitpoldi.* This fish is also referred to as *thiron* in the *Relacíon de Michoacán.* This is rather curious in light of the fact that it is the members of the whitefish family (Atherinidae: *Chirostoma bartoni, C. estor, C. grandoculae,* and *C. patzcuaro*), or *pescado blanco* as they are referred to collectively, which are well-documented as economic and cultural staples of Tarascan society, both Prehispanic and modern (Guzmán et al 2001). The tomb remains thus represent the first archaeological evidence of the use of *t'iru* by Classic and Epiclassic period elites, as well as attesting to the importance of fish during the Classic period. Furthermore, this tradition spanned at least 400 years, as the remains associated with the two adult males date to between A.D. 405-505, and the fish remains associated with the adolescent burial yielded radiocarbon dates between A.D. 800-1000 (2001:159). Guzmán et al. (2001:160) suggest the possibility that the Classic and Epiclassic Tarascan preference for *t'iru* was replaced by one for whitefish (*Chirostoma spp.*) by the Postclassic period. Future research will be needed to substantiate this as well as explore the reasons for the change, if it indeed exists.

Although it was not possible to determine the method of preparation of the fish remains (e.g. cooked, dried, etc.), it *is* known that they were deposited in the tomb whole, since their stomach contents were found. This can be contrasted with the usual culinary preparation of fish in the town of Ucasanástacua, where the *t'iru* are eviscerated before being dried in the sun (2001:160). Guzmán et al. suggest several possibilities for the *t'iru* remains uncovered in the tomb: perhaps in Prehispanic times these fish were consumed whole, or the fish were placed in the tomb soon after being captured, without time taken for the usual preparations. Alternatively, perhaps the fish were not meant to be food offerings but instead represent something symbolic (2001:160). The fact that the remains are of *t'iru*, and not of the whitefish which were so important as a food resource, may support this hypothesis. Alternatively, *t'iru* may have been consumed only by elites and not commoners; although the fact that they were consumed by elites is not inconsistent with the hypothesis that they had some symbolic value. Apparently, great care was taken in selecting the offerings, as the fish remains in each tripod bowl were remarkably homogeneous in size (2001:160).

Future discoveries of this kind should be extremely useful in reconstructing temporal and/or spatial trends in fish remains associated with elite burials, as well as in shedding light on the economic and symbolic importance of fish in the Tarascan civilization.

SUMMARY AND CONCLUSIONS

This is the first systematic study of the unique class of artifacts which were used as net sinkers in Prehispanic Tarascan society.

The statistical as well as the available ethnographic evidence strongly suggest that the most likely function of the ceramic disks examined in this paper was sinkers for fishing nets. Any single line of evidence considered individually is not sufficient to support this hypothesis, but taken as a whole, the totality of available evidence makes it overwhelmingly likely.

As discussed above, the disks are distributed in highest concentration along lake areas, at least in the survey zones of Pareo and Xarácuaro. Urichu breaks with this pattern, for reasons unknown. Perhaps the ones found in the environs of Pareo and Xarácuaro were lost while in active use during fishing, while those found at Urichu were discarded or lost at a different stage in their life cycle of use.

Double side notches are clearly the norm, a morphology which makes eminent sense for net sinkers, as it would enable them to easily be tied to a fishing net. So well-suited are they to this task that modern fishermen sometimes (re-)use them in this capacity when they come across them. This paper establishes the fact that there are major morphological differences among *malacates*, gaming pieces, and net sinkers, and documents these differences systematically.

Since this is the first systematic study of Tarascan disks, it is difficult to say what constitutes a large concentration. However, as a ratio to other ceramic sherds, the disks are found in substantially higher concentrations at Xarácuaro and Pareo than they are at

Urichu. They are also found in larger overall quantities at Xarácuaro and Pareo than at Urichu (see Figure 13). Xarácuaro yielded by far the most disks (324). Quite likely this reflects the fact that all areas of this zone are in close proximity to the lakeshore (some were even under water during the Taríacuri phase) and thus all parts of this zone would have been adjacent to fishing areas. It is also likely that during the Tarascan period the island was home to a substantial number of fishermen, who would have had sheds for storing their nets and/or other areas for manufacturing and repairing them. The quantity of disks is also relatively high at Pareo (125), whose northern portion bordered the lake and would also have been eminently suitable for fishing. In fact, at Pareo the disks are concentrated almost exclusively along the northern part of the zone. Less clear is why Urichu, which also has a substantial area bordering the lakeshore, yielded relatively few disks (73). Several portions of the zone, including the location of modern towns, were not excavated or surveyed, and perhaps this accounts for some of this pattern. However, large portions of the zone which directly border the lake were investigated and yielded few or no disks. It is possible that fishing was not an important activity at Urichu, for reasons which have yet to be determined.

The disks' size and weight are also suitable for functioning in the capacity of net sinkers, and are likely to be analagous the "tiny pebble sinkers" Foster documented used with the *cherémekua* nets used to catch *khuerepu* and *pescado blanco* (1948:102-4). As posited above, it is likely that the fish harvested in this manner were of the species *Ch. bartoni.*

The unimodal distribution of the disks' diameter, weight, and thickness suggests that there was a large degree of uniformity in either net size and/or the size of the meshes within the nets.

T-tests performed in order to compare the Tarascan disks with known populations of malacates were somewhat indeterminate in their results. T-tests comparing the diameter means of the Tarascan disks with those of *malacates* found during the same investigation (the *Proyecto malacates*), as well as those from Tzintzuntzan, determined that the disks represent a separate population, and thus in all likelihood a separate artifact class. However, t-tests for the variable of thickness found no significant differences in means among these three samples. This may contradict the separate artifact distinction but it may also just show that the two artifact classes are very similar in this respect and thus identification must rely on other factors and measurements. Further complicating the picture, a t-test comparing weight means for the Tarascan disks and the *Proyecto malacates* found in the same investigation rejects the null hypothesis with a one-tailed test and fails to reject it with a two-tailed test. Again, this may argue against dividing the artifacts into two separate classes or it may demonstrate that the Tarascan disks are very similar in weight to *malacates* used to spin cotton. The t-test results demonstrate the importance of using as many lines of evidence as possible, for if size and weight are the only criteria used it would be very difficult indeed to separate the disks from the *malacates.*

Although the statistical and ethnographic evidence strongly suggest that the ceramic disks recovered during Pollard's archaeological research were used to weight Tarascan fishing nets, several questions and directions for future research remain.

As touched upon above, considerable confusion exists in the literature when it comes to recognizing net sinkers in the archaeological record. I suggest that the following criteria be met in order to uniformly classify artifacts as net sinkers in future archaeological work:

1. Artifacts are constructed of a suitably weighty material (stone in aboriginal United States; ceramic in Mesoamerica).
    a. Ceramic artifacts are fashioned from re-worked pottery sherds, not fired from wet clay (i.e., they are a "secondary use" artifact).
2. Artifacts exhibit opposing, double-sided notching, a morphological characteristic which facilitates their attachment to the fishing net.
3. Artifacts are roughly circular, or, less commonly, rectangular with rounded corners, in shape.
4. No central perforation (diagnostic of Mesoamerican spindle whorls) is present.
5. Artifacts fall within baseline size parameters established for the collection of net sinkers analyzed in this paper (see Table 2 above) (at least for Mesoamerican examples):
6. Artifacts are found within or in close proximity to lacustrine or riverine areas.
7. Artifacts were made and used by a society which had a focused (in Cleland's sense – see Cleland 1966) or heavy reliance on fish as a food resource and which had a highly developed fishing technology.

This should help distinguish net sinkers from artifacts which have physical similarities but which functioned differently (e.g. as bola weights or *malacates*) and thus rightfully belong to other classes. For example, the size, weight, and morphology of the ceramic disks analyzed in this paper can provide baseline measurements against which future discoveries can be compared. Those falling within the range of the Tarascan disks, at least in the Tarascan cultural area, should be considered likely net sinkers, especially if they are found in lacustrine or riverine contexts.

It is most ironic that, although it is well-known that the Prehispanic Tarascans were skilled fishermen and that they used vertical nets, and that fish comprised a staple of their economy, net sinkers have never been officially identified in the archaeological record of this area or studied systematically. This thesis firmly identifies and documents them for the first time as a unique and important artifact class.

Since it is not possible to observe the behaviors of past cultures, it is the lot of the archaeologist to infer behavior from material remains. With net sinkers firmly identified in the archaeological record for the first time one can now use this artifact class as a proxy for the Tarascan economy, at least for a part of it. Although fishing comprised a major portion of the Tarascan economy, it appears that the net sinkers analyzed in this thesis most likely reflect the harvest of only one species of fish, *Ch. bartoni.* Nevertheless, this is an important contribution to the study of the Tarascan economy. The fishing of other species may not be possible to document directly through archaeological remains. It is now up to future research to document the patterns and fluctuations of this fishing economy.

One area which needs clarification is the channels of fish distribution within the Tarascan empire. Gorenstein and Pollard (1983) have documented that fish were distributed through the market system but what is not entirely clear is to what extent the government controlled this flow. It is also quite likely that fish comprised a major tribute commodity, but again, the quantities involved remain to be determined.

How much fish and of which species were consumed by elites versus commoners is also a question for future research. As noted above, *The Chronicles of Michoacán* (Craine and Riendorp 1970:12-13) state that the *Varuri* was the government official in charge of all the net fishermen. Were these net fishermen required to surrender the totality of their catch to support the ruling class or just a portion of it? Were they free to exchange some of their catch within the market system? Were there government-supported fishermen and "free enterprise" fishermen or did all fishermen split their harvest between tribute and the market system? These questions beg clarification.

Many other sites remain to be explored and could yield fruitful information. For example, the island of La Pacanda, which has a fishing tradition dating back to Prehispanic times, should have an equally rich archaeological record. It is at just such a site that one could expect to find net sinkers similar to those found by Pollard et al. and analyzed herein. In addition, La Pacanda and similar sites can serve as ethnographic models for what one might expect to find archaeologically regarding fishing practices. For example, at least some of the households on this island include small sheds adjacent to the lakeshore, in which fishing nets and other equipment are left overnight during the busiest part of the fishing season (Smith 1965:23). Are remains of these sheds found elsewhere in the Lake Pátzcuaro Basin? It is likely that they could be, and that, if they are found, they might be a rich source of fishing artifacts, including fishing net weights. Although fishing is no longer practiced in Quiroga, it too is just one of the many communities who engaged in it heavily during Prehispanic times and where one could expect to find archaeological evidence, including net sinkers, of its practice.

The identification of net sinkers in the Tarascan archaeological record is an important piece of the puzzle of Prehispanic Tarascan life, but it is only a starting point. It is my sincere hope that the research contained herein will enable future investigators to document the Tarascans' economy and culture more fully and in greater detail than ever before.

APPENDIX

Table 4. Tarascan Disk Raw Data

catalog	condition	notches	diameter (mm)	thickness (mm)	weight (g)	phase
2482	W	NN	18.6	5.9	2.5	E. URICHU
2507	W	2N	37.8	6.2	12.6	LUPE - LAJOYA
2507	B	NN	39.7	4.6	6	LUPE - LAJOYA
2460	B	1N	31	4.8	3.2	LUPE - LAJOYA
2488	W	2N	35.6	5.4	8.9	TARIACURI
2479	W	NN	26.9	6.8	6.6	LUPE - LAJOYA
1007	W	NN	29.6	4.9	5	TARIACURI
1007	B	NN	26.6	5.2	3.5	TARIACURI
1016	W	2N	32.3	5	4.3	TARIACURI
1016	W	NN	28.9	5	4	TARIACURI
1131	W	NN	27	6.8	6.2	TARIACURI
1916	W	NN	26.4	6.9	5.6	E. URICHU
2461	B	NN	45.5	5.5	7.5	MIXED
1228	B	1N	24	5.5	2.3	LUPE - LAJOYA
4425	B	drilled	37.1	2.8	3.5	MIXED
1918	W	2N	40.7	7.2	16.4	MIXED
2495	W	2N	40.9	8	15	TARIACURI
2495	W	NN	23.6	8.3	5.1	TARIACURI
1987	W	NN	25.6	6.4	6.3	LUPE - LAJOYA
1987	W	NN	29.9	6.7	7.2	LUPE - LAJOYA
1059	W	NN	15.5	3.7	1	TARIACURI
2061	W	NN	38.9	8.2	14.4	TARIACURI
4526	B	NN	26.7	3.1	1.6	E. URICHU
1222	B	NN	30.3	4.5	2.8	JARACUARO
1222	B	1N	18.5	5	1.4	JARACUARO
2073	W	NN	25	4.9	3.2	JARACUARO

Table 4 (cont'd).

catalog	condition	notches	diameter (mm)	thickness (mm)	weight (g)	phase
1994	W	NN	44.5	9.2	21.4	E. URICHU
4463	B	NN	28.5	6.5	4.5	TARIACURI
4463	B	NN	23.4	4	2	TARIACURI
4461	B	NN	25.8	5.6	3.5	TARIACURI
2464	B	NN	33.7	11.4	7.9	E. URICHU
2464	W	NN	19	3.3	1.5	E. URICHU
2465	B	1N	29.4	4	2.4	E. URICHU
4486	W	2N	25.7	6.9	4.8	JARACUARO
4487	B	NN	25.5	4.6	3.8	JARACUARO
1964	B	1N	35.7	3.7	4.2	JARACUARO
4527	B	NN	26.4	4.2	2.4	JARACUARO
1112	B	1N	31.4	5.7	3.9	TARIACURI
1112	B	NN	36.5	5.1	6.9	TARIACURI
1860	W	NN	41	5.9	4	LUPE - LAJOYA
1150	W	NN	25.7	6	4.9	TARIACURI
1889	W	NN	15	12.3	5.5	TARIACURI
4426	W	2N	30.3	3.9	3.5	E. URICHU
3846	W	1N	37.8	9.9	12.6	E. URICHU
1919	W	NN	15.1	5.1	1.4	JARACUARO
4427	W	NN	18.8	4.1	1.8	JARACUARO
1122	B	1N	33.3	8.7	7.8	TARIACURI
1709	W	2N	31.8	9.4	11.1	TARIACURI
1709	B	NN	35.4	6.2	6.4	TARIACURI
2493	W	2N	39.5	10.5	2	E. URICHU
1475	B	NN	31.6	10.7	4	E. URICHU
1475	W	NN	18	4.5	1.6	E. URICHU

Table 4 (cont'd).

catalog	condition	notches	diameter (mm)	thickness (mm)	weight (g)	phase
1784	B	NN	32	7.6	4.2	E. URICHU
1238	B	1N	45	4.3	6.4	LUPE - LAJOYA
1471	W	NN	33.7	11.4	16.7	JAR/LUPE
1471	W	NN	14.9	4.6	1.4	JAR/LUPE
3853	W	NN	18.2	4.6	1.9	TARIACURI
3848	B	NN	48	7	19.6	TARIACURI
698			15.5	3.1	0.4	E. URICHU
1984	B	1N	35.5	5	3.6	E. URICHU
773	B	1N	38.8	5.3	6.7	E. URICHU
772	W	NN	21	3.9	2.3	E. URICHU
779	W	NN	39.6	4.5	9	E. URICHU
3858	W	NN	38.1	5	9.5	TARIACURI
3284	W	NN	23	9.8	7	TARIACURI
3851	W	NN	15.2	5.2	1.6	TARIACURI
3850	B	NN	37.1	6.1	10.2	TARIACURI
3854	W	NN	16.3	5.1	1.7	TARIACURI
3856	W	NN	19.6	4.7	2.6	TARIACURI
3134	W	NN	33	9.1	11	JARACUARO
3852	W	NN	19	3.5	1.6	TARIACURI
3855	W	NN	16.9	3.4	1.5	TARIACURI
3857	W	NN	18.1	4.1	1.7	TARIACURI
3903	W	2N	47	6	11.8	TARIACURI
3895	W	2N	20.9	5.6	2.8	TARIACURI
3989	W	2N	20.9	8.8	4.7	TARIACURI
3994	W	2N	34.1	5.8	6.1	TARIACURI
3997	W	2N	21.9	5.1	3.4	TARIACURI

Table 4 (cont'd).

catalog	condition	notches	diameter (mm)	thickness (mm)	weight (g)	phase
3997	W	2N	23	4.4	2.4	TARIACURI
3997	W	1N	22.5	6.3	2.9	TARIACURI
4528	B	1N	30.4	4	3.8	TARIACURI
3948	W	2N	20.4	3.9	2.1	TARIACURI
3967	W	2N	24.6	5.5	4.1	TARIACURI
3967	B	1N	27.6	7	3.6	TARIACURI
3976	W	2N	20.3	3.6	1.6	TARIACURI
3651	W	NN	27.4	8.9	9	L. URICHU
3651	B	NN	28.2	3.7	2.7	L. URICHU
3638	W	2N	36	7.1	11.8	L. URICHU
3638	W	2N	36.4	7.1	11	L. URICHU
3638	W	2N	33.1	6.2	7.8	L. URICHU
3638	W	2N	30.1	4.6	5.1	L. URICHU
3638	B	NN	29.6	5.2	4.5	L. URICHU
3638	W	NN	31.1	5.7	6.1	L. URICHU
3638	B	2N	26.2	3.3	2.2	L. URICHU
2674	B	1N	34.4	7	4.2	L. URICHU
3642	W	NN	22.2	5.6	3.4	L. URICHU
2688	W	2N	34	4.8	7	?
2670	B	1N	37.4	3.6	3.3	L. URICHU
2692	W	NN	31.3	5.5	6.6	LUPE - LAJOYA
4553	W	2N	28	6.3	5.9	LUPE - LAJOYA
2694	W	2N	20.2	5.2	4.1	L. URICHU
3672	W	2N	47.7	5	14.6	E. URICHU
3672	W	2N	38.8	5.1	8.1	E. URICHU
3672	B	1N	29.2	3.8	2.9	E. URICHU

Table 4 (cont'd).

catalog	condition	notches	diameter (mm)	thickness (mm)	weight (g)	phase
3672	W	2N	29.5	4.7	5.3	E. URICHU
3672	B	NN	33.4	4	4.5	E. URICHU
3672	W	2N	24.5	3.3	2.6	E. URICHU
3672	W	2N	24.9	4.9	2.4	E. URICHU
2728	W	2N	42.9	5.1	9.9	L. URICHU
2728	W	2N	23.5	5	3.4	L. URICHU
2719	W	2N	29.6	3.9	4.6	L. URICHU
2719	B	NN	31	8	5.7	L. URICHU
2719	W	2N	26.2	5.1	3.7	L. URICHU
4544	W	2N	44.8	6.2	12.7	L. URICHU
2685	W	2N	27.7	6.2	5	L. URICHU
2685	W	2N	22.6	5.8	4.2	L. URICHU
3168	W	2N	37.4	8.7	15.2	L. URICHU
3168	W	2N	23.1	5.2	3.6	L. URICHU
2696	B	NN	36.6	4.9	5.6	E. URICHU
2730	W	2N	29.7	3.9	4.4	L. URICHU
2710	W	2N	59.6	5.9	18.1	L. URICHU
2710	B	1N	41	5.3	6.6	L. URICHU
2710	B	NN	29.9	5.7	4.1	L. URICHU
3641	B	2N	39	3.8	6.5	JARACUARO
3641	W	2N	27	6.3	5.3	JARACUARO
3641	W	2N	24.4	4	3.1	JARACUARO
3641	W	2N	21.6	3.8	2.1	JARACUARO
3641	W	2N	21.9	4.2	2.1	JARACUARO
3565	B	1N	36.4	4.7	4.5	L. URICHU
3565	B	1N	34.5	5.3	3.7	L. URICHU

Table 4 (cont'd).

catalog	condition	notches	diameter (mm)	thickness (mm)	weight (g)	phase
3565	W	2N	25.5	4.3	2.8	L. URICHU
3565	W	2N	20.5	4.4	2.1	L. URICHU
3647	W	NN	35.5	8.1	11.4	L. URICHU
3647	B	NN	34.2	5.1	4.8	L. URICHU
3640	W	2N	46.9	6.6	15.8	L. URICHU
3640	W	2N	35.5	9.2	12.5	L. URICHU
3640	W	2N	32.3	5.2	7	L. URICHU
3640	W	2N	28.1	3.2	3.4	L. URICHU
3640	W	2N	26.8	4.2	4.2	L. URICHU
3640	W	2N	25.9	3.5	2.6	L. URICHU
3640	W	2N	22.5	4.6	2.9	L. URICHU
3640	B	2N	21.2	4.1	1.4	L. URICHU
2936	W	2N	40.7	6.4	11.8	L. URICHU
2936	B	NN	40	5.7	7.5	L. URICHU
2936	W	2N	37.1	9.5	15.2	L. URICHU
2936	W	2N	34.5	6.9	10.6	L. URICHU
2936	W	2N	31.3	4.7	5.3	L. URICHU
2936	W	2N	26.4	4.8	4.5	L. URICHU
2936	W	2N	23	4	3	L. URICHU
2936	B	NN	22	5	2.4	L. URICHU
2936	B	2N	26.7	3.7	2.3	L. URICHU
3510	B	NN	40.6	3	3.9	L. URICHU
3510	W	2N	30.5	5.4	6.3	L. URICHU
3510	W	2N	24.6	5.9	4.5	L. URICHU
3510	B	1N	24	4.7	1.9	L. URICHU
3510	W	2N	21.7	4.7	2.6	L. URICHU

Table 4 (cont'd).

catalog	condition	notches	diameter (mm)	thickness (mm)	weight (g)	phase
3510	W	2N	20.1	4.6	2.1	L. URICHU
3414	W	2N	35.7	4.3	5.8	L. URICHU
3414	W	2N	28.1	4.8	5.3	L. URICHU
3414	W	2N	27.4	5.4	3.8	L. URICHU
3414	B	1N	19.7	3.9	1.3	L. URICHU
3395	W	2N	22.5	3.9	2.4	L. URICHU
3474	B	2N	27.5	3.6	3.4	URICHU
3474	W	2N	25	5.6	3.8	URICHU
3474	B	1N	24.3	4.7	2.7	URICHU
3474	W	2N	23.9	3.2	2.2	URICHU
3474	W	2N	22.3	4	2.5	URICHU
3474	W	2N	22.2	6.2	2.8	URICHU
3474	W	2N	21.7	5.4	2.9	URICHU
3639	W	2N	47.7	4.1	10.4	?
3562	B	NN	29.4	6.2	3.2	?
3555	W	2N	34.2	6.3	9	L. URICHU
3163	W	2N	25.9	5	4	L. URICHU
3163	W	2N	28.3	6.4	5.6	L. URICHU
4549	B	1N	30.4	6.9	6.5	L. URICHU
3470	B	1N	47.6	6.4	8.2	URICHU
3470	W	2N	25.3	5.1	3.5	URICHU
3560	B	1N	46.6	5.2	7.9	URICHU
3560	B	1N	42.4	4.2	6.8	URICHU
3560	W	2N	37.2	6.1	10.5	URICHU
3558	B	1N	51.4	8	16.1	L. URICHU
3558	B	2N	45.8	6.3	12.7	L. URICHU

Table 4 (cont'd).

catalog	condition	notches	diameter (mm)	thickness (mm)	weight (g)	phase
3558	W	2N	45.4	7.4	15.9	L. URICHU
3558	B	1N	47	6.2	12.2	L. URICHU
3558	W	2N	41.7	10.4	12.9	L. URICHU
3558	W	2N	33.5	5.8	8.3	L. URICHU
3558	B	NN	34	4.1	4	L. URICHU
3558	W	2N	24.1	5.9	3.7	L. URICHU
3558	B	1N	20.9	4.2	2	L. URICHU
3558	W	2N	20.5	3.1	2.6	L. URICHU
3558	W	2N	22.6	3.5	2.2	L. URICHU
3558	W	2N	21.6	4.2	2.4	L. URICHU
3558	W	2N	23.4	5.2	1.8	L. URICHU
3558	W	2N	21.3	5.5	2.2	L. URICHU
3558	B	1N	19.8	2.9	1.1	L. URICHU
3558	B	2N	19	5.3	2.1	L. URICHU
3558	B	1N	17.1	4.5	1.3	L. URICHU
2676	W	2N	22.5	4.9	2.6	?
2698	B	1N	28.4	5.9	4.3	L. URICHU
2698	W	2N	25.6	5	4.1	L. URICHU
2698	W	2N	25.2	4.6	3.5	L. URICHU
2698	W	2N	21.8	4.2	2.4	L. URICHU
3637	W	2N	38.4	4.4	6.8	L. URICHU
3637	W	2N	24.3	3.5	2.4	L. URICHU
3637	B	NN	28.2	3.8	2.1	L. URICHU
3637	B	1N	27.3	4.5	2.4	L. URICHU
3637	W	2N	23.3	3.7	2.2	L. URICHU
3637	W	2N	23	5	2.4	L. URICHU

Table 4 (cont'd).

catalog	condition	notches	diameter (mm)	thickness (mm)	weight (g)	phase
3637	W	2N	21.2	4.6	2.6	L. URICHU
3637	W	2N	21.6	3.9	2.3	L. URICHU
3637	B	2N	22.7	4.6	2.2	L. URICHU
3637	B	1N	22.5	3.5	2	L. URICHU
3561	W	2N	45.7	6	14.3	URICHU
3561	W	2N	40.7	14.3	17.7	URICHU
3561	W	2N	29.8	5	4.5	URICHU
3561	B	1N	30.8	5.7	3.7	URICHU
3561	W	2N	27.4	6.2	5.7	URICHU
3561	W	2N	27.9	3.8	3	URICHU
3561	W	2N	24.7	5.5	4.5	URICHU
3561	W	2N	25.9	5.4	4	URICHU
3561	W	2N	23.9	4	2.7	URICHU
3561	W	2N	23.4	5.6	2.3	URICHU
3561	W	2N	21.4	3.7	3	URICHU
3561	W	2N	22	5.2	2.6	URICHU
3561	W	2N	23.9	4	1.6	URICHU
3561	W	2N	21.5	4.1	2.5	URICHU
3389	W	2N	26.1	4.3	3.8	URICHU
3389	W	2N	26.6	4.1	3.3	URICHU
3389	W	2N	25.2	6.4	4	URICHU
3389	W	2N	23.1	5.4	3.9	URICHU
3535	B	2N	32.3	4.5	5.2	L. URICHU
3394	B	2N	45.5	6.7	6	L. URICHU
3394	B	NN	39.5	7.4	11.8	L. URICHU
3394	W	2N	33.6	5.2	7.3	L. URICHU

Table 4 (cont'd).

catalog	condition	notches	diameter (mm)	thickness (mm)	weight (g)	phase
3394	B	2N	33	3.1	2.3	L. URICHU
3394	W	1N	30.3	6	6.9	L. URICHU
3394	W	2N	29.9	4.1	4.7	L. URICHU
3394	W	2N	29.3	3.9	3.4	L. URICHU
3394	W	2N	28.3	4	3.3	L. URICHU
3394	W	2N	24	4	3	L. URICHU
3394	W	2N	24.3	4.7	2.8	L. URICHU
3394	W	2N	23.6	5	3.8	L. URICHU
3394	W	2N	23.2	6.2	4.5	L. URICHU
3394	W	2N	24.8	4.7	3.1	L. URICHU
3394	W	2N	22.8	4.1	3.7	L. URICHU
3394	W	2N	26	4.5	2.8	L. URICHU
3394	W	2N	24	6.1	2.8	L. URICHU
3394	B	1N	25	4.9	1.8	L. URICHU
3394	W	2N	21.6	4.3	2.5	L. URICHU
3394	B	2N	20.1	3.2	1.3	L. URICHU
3394	B	NN	19.5	3.5	1.2	L. URICHU
3403	W	2N	29	4.6	3.4	L. URICHU
3403	W	2N	25.3	5.3	3.5	L. URICHU
3403	W	2N	25.2	4.1	3.2	L. URICHU
3636	W	2N	23.2	4.6	3.1	L. URICHU
3636	W	2N	20.7	5.2	2.9	L. URICHU
3559	W	NN	28.5	9.6	9.6	L. URICHU
3645	W	NN	45.3	6.5	13.7	L. URICHU
3644	W	2N	36.6	10.5	13.7	L. URICHU
3644	W	2N	27.5	5	3.6	L. URICHU

Table 4 (cont'd).

catalog	condition	notches	diameter (mm)	thickness (mm)	weight (g)	phase
3644	W	2N	25.9	4	2.7	L. URICHU
3644	W	2N	23.7	4.7	3.3	L. URICHU
3644	W	2N	24.5	6.2	2.9	L. URICHU
3644	W	2N	21.5	4.8	2.8	L. URICHU
3644	W	2N	21.4	4.5	2.1	L. URICHU
3472	W	2N	36.2	5.7	9.5	L. URICHU
3472	W	2N	30.2	4.4	5.1	L. URICHU
3472	W	2N	30.9	5.6	6.3	L. URICHU
3472	B	NN	27.3	3	1.9	L. URICHU
3472	W	2N	24.3	5.2	2.8	L. URICHU
3472	W	2N	21.1	3.8	1.8	L. URICHU
3650	B	NN	30.3	3	1.8	L. URICHU
3650	W	NN	28.1	4.8	4.1	L. URICHU
3554	W	2N	27.3	6.1	4.5	L. URICHU
3554	W	2N	23.8	4.2	3.1	L. URICHU
3554	W	2N	22.3	5.2	2.8	L. URICHU
3554	W	2N	20.2	3.2	1.5	L. URICHU
3633	W	2N	21.7	4	2.7	URICHU
3648	W	2N	26.4	5.1	3.9	URICHU
3648	W	2N	25.1	5.2	3.3	URICHU
3648	W	2N	25.3	4.3	3.7	URICHU
3648	W	2N	25.2	4.6	3.7	URICHU
3648	W	2N	22.2	5	2.8	URICHU
3648	W	2N	22.1	5.1	2.7	URICHU
3648	W	2N	21.6	6.6	3.1	URICHU
3643	B	NN	36.1	7	9.5	L. URICHU

Table 4 (cont'd).

catalog	condition	notches	diameter (mm)	thickness (mm)	weight (g)	phase
3643	B	NN	26.4	5.1	2.4	L. URICHU
3568	W	2N	25.2	6	4.5	L. URICHU
3568	W	2N	25.3	3.8	3.5	L. URICHU
3568	W	2N	25.2	3.7	2.4	L. URICHU
3568	W	2N	23.4	4.2	2.9	L. URICHU
4550	B	1N	42.7	5.2	8.8	L. URICHU
3384	W	2N	31	3.7	7	L. URICHU
3384	W	2N	29.6	6.7	3.8	L. URICHU
3384	B	2N	28.9	3.9	2.8	L. URICHU
3384	W	2N	27	3.9	3	L. URICHU
3384	W	2N	23.9	4.1	2.6	L. URICHU
3384	W	2N	23.8	6.5	3.2	L. URICHU
3385	W	NN	39.2	8.5	10.2	L. URICHU
3385	B	2N	32.4	5.8	7.9	L. URICHU
3385	W	2N	30.1	7.1	4.3	L. URICHU
3385	W	2N	28.1	4.4	6	L. URICHU
3385	W	2N	27.2	5.8	4.8	L. URICHU
3385	W	2N	22.2	5	3.1	L. URICHU
3385	W	2N	21.5	5.5	2.7	L. URICHU
3385	W	2N	20	5.6	2	L. URICHU
3794	W	2N	34.5	3.8	5.9	L. URICHU
3794	W	2N	23.4	5.8	3.9	L. URICHU
3629	B	NN	33.5	3.7	8.1	L. URICHU
3629	W	2N	33.3	5.6	3.9	L. URICHU
3629	W	2N	22.1	4.2	2.3	L. URICHU
3461	W	2N	32.3	5.5	5.1	L. URICHU

Table 4 (cont'd).

catalog	condition	notches	diameter (mm)	thickness (mm)	weight (g)	phase
3461	W	2N	26.9	5.3	5.1	L. URICHU
3461	W	2N	25.7	3.9	2.6	L. URICHU
3465	B	1N	36	7.2	8.7	URICHU
3669	W	2N	23.4	5.2	3.1	URICHU
3542	B	2N	56.7	5.2	15.2	L. URICHU
3542	W	2N	45	15.8	18.9	L. URICHU
3635	W	2N	43	7.3	13.3	LUPE - LAJOYA
3635	W	2N	34.5	5.6	7.9	LUPE - LAJOYA
3635	W	2N	30.6	5	4.3	LUPE - LAJOYA
3635	W	2N	30.1	5.5	4.7	LUPE - LAJOYA
3635	W	2N	28.5	6.5	4.7	LUPE - LAJOYA
3635	W	2N	28.1	3.6	2.8	LUPE - LAJOYA
3635	W	2N	27.1	5.8	3.5	LUPE - LAJOYA
3635	W	2N	27.2	5.2	3.8	LUPE - LAJOYA
3635	W	2N	22.6	5.2	3.6	LUPE - LAJOYA
3635	W	2N	24.1	5.3	3.7	LUPE - LAJOYA
3635	W	2N	23.4	6.7	3.4	LUPE - LAJOYA
3635	W	2N	22.6	6.1	3.1	LUPE - LAJOYA
3635	W	2N	21.6	5.2	2.4	LUPE - LAJOYA
3563	W	2N	38.7	7.4	13.9	LUPE-LAJOYA/E. URICHU
3563	B	1N	38.7	4.8	4.6	LUPE-LAJOYA/E. URICHU
3563	W	2N	37.2	4	5.3	LUPE-LAJOYA/E. URICHU
3563	B	NN	30.6	5.6	4.5	LUPE-LAJOYA/E. URICHU
3563	B	1N	28.3	3.1	2.2	LUPE-LAJOYA/E. URICHU
3563	W	2N	26.1	4.8	3.4	LUPE-LAJOYA/E. URICHU
3563	W	2N	23.6	5	3.2	LUPE-LAJOYA/E. URICHU

Table 4 (cont'd).

catalog	condition	notches	diameter (mm)	thickness (mm)	weight (g)	phase
3563	W	2N	22.5	5.1	2.9	LUPE-LAJOYA/E. URICHU
3789	B	1N	33.6	3.7	3.1	?
3466	W	2N	42.4	7.5	16.4	LUPE-LAJOYA/E. URICHU
3466	W	2N	22.4	6.2	2.9	LUPE - LAJOYA/ E. URICHU
3933	B	1N	34.3	12	13.7	TARIACURI
3933	W	NN	28.5	7	6.2	TARIACURI
3945	W	NN	41.2	7.6	15	L. URICHU
3946	W	2N	41.5	10.2	15.6	TARIACURI
3946	W	NN	25.6	7	3.9	TARIACURI
3951	B	1N	39.4	7.1	11.3	TARIACURI
3907	W	groove	51.6	13.8	24.2	L. URICHU / TARIACURI
3907	B	1N	40.3	13.1	24.5	L. URICHU / TARIACURI
3907	B	1N	39.4	12.5	14.4	L. URICHU / TARIACURI
3907	W	2N	37	12.5	18	L. URICHU / TARIACURI
3907	W	NN	35.9	7.2	11	L. URICHU / TARIACURI
3907	W	2N	34.2	7.5	6.7	L. URICHU / TARIACURI
3907	B	1N	26.1	6.4	3.5	L. URICHU / TARIACURI
3907	W	2N	24.6	8.1	5.8	L. URICHU / TARIACURI
3941	W	2N	35.2	13.8	16.7	TARIACURI
3941	B	1N	34	5.2	3.6	TARIACURI
3941	W	2N	31.6	8.9	11.2	TARIACURI
3941	W	2N	28.5	4.8	4.8	TARIACURI
3941	W	2N	25.4	9.1	5.6	TARIACURI
3941	W	2N	25.2	4.7	3.5	TARIACURI
3941	W	NN	24.9	11.9	6.3	TARIACURI
3899	W	2N	26.8	4.3	4	L. URICHU / TARIACURI

Table 4 (cont'd).

catalog	condition	notches	diameter (mm)	thickness (mm)	weight (g)	phase
3899	W	2N	23.3	5.4	3.3	L. URICHU / TARIACURI
3911	W	2N	36.2	5.4	8.9	L. URICHU / TARIACURI
3911	W	2N	25.6	5.9	5.1	L. URICHU
4547	B	1N	44.4	7.9	13.4	L. URICHU
3920	W	2N	57	5.5	21.8	URICHU
3920	B	1N	42.5	5	8	URICHU
3920	W	2N	36.3	9.8	11.6	URICHU
3920	W	2N	33.5	8.4	11.2	URICHU
3920	W	2N	31.9	7.7	9.7	URICHU
3920	W	2N	31.5	10	10.9	URICHU
3920	W	2N	35	8.3	10.2	URICHU
3920	W	2N	32.5	7.9	9.3	URICHU
3920	W	2N	30.8	12.1	6.6	URICHU
3920	W	2N	30.2	6.6	6.3	URICHU
3920	W	2N	28.7	9.5	10.5	URICHU
3920	W	2N	28.8	6.6	5.3	URICHU
3920	W	2N	26.8	7.7	7.5	URICHU
3920	W	2N	26.2	10.5	7.3	URICHU
3920	W	2N	25.2	4.2	3.7	URICHU
3920	W	NN	24.8	9.1	6.5	URICHU
3920	W	2N	22.2	4.4	3.2	URICHU
3920	W	NN	25.2	10.2	3.1	URICHU
3920	W	2N	21.8	5.1	2.3	URICHU
4548	W	2N	25.1	4.5	2.9	URICHU
3893	W	2N	32	7.4	8.4	L. URICHU / TARIACURI
3893	B	1N	23	7.1	4	L. URICHU / TARIACURI

Table 4 (cont'd).

catalog	condition	notches	diameter (mm)	thickness (mm)	weight (g)	phase
3893	B	2N	22.5	4.4	1.4	L. URICHU / TARIACURI
3893	W	2N	21	5	1.7	L. URICHU / TARIACURI
4278	W	2N	36.3	9.8	14.1	L. URICHU / TARIACURI
4282	W	2N	27	7.4	6.5	TARIACURI
4410	B	2N	34.7	6.1	6	E. URICHU
3818	W	2N	53.7	3.6	10.4	E. URICHU
3818	W	2N	42.1	3.3	7.8	E. URICHU
3548	W	2N	54.3	4.6	15.9	E. URICHU
3548	W	2N	21.7	3.8	2.1	E. URICHU
3436	W	2N	59.1	5.3	20.5	L. URICHU
3436	W	2N	24.7	4.1	2.6	L. URICHU
3436	W	2N	48.8	6	13	L. URICHU
3436	W	2N	40.2	7.2	10	L. URICHU
3436	B	NN	31.9	3.6	2	L. URICHU
3399	W	2N	38.7	8	15.7	URICHU
3399	W	2N	25.3	4.7	2.6	URICHU
3398	W	2N	43.6	6.9	10.9	TARIACURI
3398	W	2N	28.3	4.9	5.4	TARIACURI
3398	B	1N	18.8	5.1	1.4	TARIACURI
3788	W	2N	23.5	4.7	2.8	TARIACURI
3788	B	1N	22.2	5	1.8	TARIACURI
3455	W	2N	23.7	4.7	5	TARIACURI
3631	B	1N	24.3	4	2.1	TARIACURI
3632	W	2N	26.2	6	5.3	TARIACURI
3632	W	2N	19.2	3.6	1.8	TARIACURI
3393	W	2N	24.1	4.9	3.4	TARIACURI

Table 4 (cont'd).

catalog	condition	notches	diameter (mm)	thickness (mm)	weight (g)	phase
3822	B	2N	24.3	6.5	4.5	TARIACURI
3646	W	2N	51.7	9	20.3	L. URICHU
3649	B	NN	40.7	4.5	4.4	L. URICHU
3660	W	2N	42.6	2.7	6.1	L. URICHU
3660	W	2N	39.5	5.8	11	L. URICHU
3683	W	2N	44.3	5.6	14.4	L. URICHU
3683	B	NN	29.6	6.2	4.3	L. URICHU
3541	W	2N	49	7.6	19	L. URICHU
3557	W	2N	29.7	5.8	5.3	L. URICHU
3557	W	2N	20.6	3.9	1.9	L. URICHU
3566	B	NN	44.8	6.7	12.3	L. URICHU
3566	W	2N	26.4	5.2	3.3	L. URICHU
3566	W	2N	24.6	4.8	3.6	L. URICHU
3566	W	2N	25.5	4.1	3.8	L. URICHU
3787	W	2N	51.7	4.1	13.8	L. URICHU
3787	W	grooves	36.3	19.2	19	L. URICHU
3446	B	1N	49.4	7.8	12	L. URICHU
3446	W	2N	28.2	4.9	4	L. URICHU
3446	W	2N	25.8	4.3	2.8	L. URICHU
3446	W	2N	26.3	7.7	4.5	L. URICHU
3446	W	2N	21.8	4.2	2.6	L. URICHU
3446	W	2N	21.7	4.3	2.4	L. URICHU
3567	W	2N	26.5	3.8	2.8	L. URICHU
3779	W	2N	24.7	5	3.3	L. URICHU
4546	B	1N	28.9	7.8	7.3	L. URICHU
3442	W	2N	59.1	3.8	16	L. URICHU

Table 4 (cont'd).

catalog	condition	notches	diameter (mm)	thickness (mm)	weight (g)	phase
3442	B	NN	53.9	3.9	9.7	L. URICHU
3442	W	2N	49.3	5.9	18.1	L. URICHU
3442	W	2N	48.7	4.5	12	L. URICHU
3442	B	2N	47.7	3.1	9	L. URICHU
3442	W	2N	47.6	4	10.5	L. URICHU
3630	B	1N	55.3	5.1	8.8	L. URICHU
3630	B	NN	45.1	3.7	4.2	L. URICHU
3630	B	1N	37.5	3.8	5	L. URICHU
3630	W	2N	31.7	4.7	3.9	L. URICHU
3630	B	NN	23.7	3.6	1.5	L. URICHU
4543	B	1N	52.4	3.2	6.3	L. URICHU
4543	W	2N	21.5	3.7	1.8	L. URICHU
3456	W	2N	23.4	4.3		L. URICHU / TARIACURI
3821	B	1N	45.7	6.7	12.7	E. URICHU
3821	W	2N	30	4.3	4.6	E. URICHU
3821	W	2N	24.5	5.4	3.7	E. URICHU
3656	W	2N	51.3	4.4	14	E. URICHU
3656	W	2N	46.4	5.9	15.1	E. URICHU
3656	W	2N	31.1	3.9	4.1	E. URICHU
4551	B	NN	36.6	4.1	3.4	E. URICHU
3564	B	1N	42.9	3.1	4.4	L. URICHU
3564	W	2N	27.4	3.8	3	L. URICHU
3564	W	2N	25.8	5.7	4	L. URICHU
3556	B	1N	42.3	5.1	7.1	L. URICHU
3556	W	2N	42	5.1	9.2	L. URICHU
3556	W	2N	27.5	4.2	3.5	L. URICHU

Table 4 (cont'd).

catalog	condition	notches	diameter (mm)	thickness (mm)	weight (g)	phase
3564	W	2N	30	4.3	4.3	L. URICHU
3564	B	1N	28.3	3.9	2.7	L. URICHU
3564	B	2N	23.6	5.8	3	L. URICHU
3448	W	2N	35.4	8.1	9.6	L. URICHU / TARIACURI
3448	B	NN	32.4	3.8	2.7	L. URICHU / TARIACURI
3440	W	2N	18.2	3.3	2.3	L. URICHU
3438	W	2N	41.3	5.1	10.4	L. URICHU
3438	W	2N	33.1	5.5	8.1	L. URICHU
3449	B	1N	56.3	6.2	14.4	L. URICHU
3449	W	2N	52.9	3.8	13	L. URICHU
3815	W	2N	49.5	6.3	16.2	L. URICHU
3815	W	2N	46.1	9.8	23.3	L. URICHU
3801	W	2N	39.9	19.5	24	L. URICHU
3451	W	2N	27.3	7.2	16.2	L. URICHU / TARIACURI
3634	W	2N	38.1	9.3	10.2	TARIACURI
3634	W	2N	26.1	4.3	3.1	TARIACURI
3634	W	2N	23.6	4.6	2.4	TARIACURI
3450	W	2N	43.5	5.7	11.9	?
3450	B	1N	40.9	4.7	5	?
3450	B	1N	36.5	3.7	5.2	?
3450	W	2N	20.7	3.6	2	?
3922	B	2N	22.7	4.4	2.4	?
3888	W	2N	32.5	19.5	19.5	TARIACURI
3888	W	2N	25.5	6.2	4.3	TARIACURI
3888	W	2N	23.6	6	4.2	TARIACURI
3926	B	2N	40.7	7	10.3	L. URICHU

Table 4 (cont'd).

catalog	condition	notches	diameter (mm)	thickness (mm)	weight (g)	phase
3926	B	1N	39.7	5.3	7.5	L. URICHU
3926	W	2N	38	6.1	11.1	L. URICHU
3926	B	1N	32.5	6.6	3.8	L. URICHU
3926	W	2N	23.3	4.6	2.5	L. URICHU
3927	W	2N	24.8	4.7	3.2	TARIACURI
3885	W	2N	26.1	6.8	4	L. URICHU
3885	W	2N	22.3	3.5	2.1	L. URICHU
3885	W	2N	20.6	4.6	2.4	L. URICHU
3654	W	2N	36.4	5.1	8.6	?
3666	W	2N	42.1	4.8	8.2	TARIACURI
3652	W	NN	40	6.5	11.3	L. URICHU
4172	B	NN	32.2	4.7	4.3	?
4173	B	2N	38.6	6.8	12.4	?
4173	B	NN	36.9	6.3	6.4	?
4174	B	2N	51.2	6.5	20.7	TARIACURI
4375	W	2N	22.7	4.5	3.1	L. URICHU
4545	W	corner	33	5.9	8.1	L. URICHU
4377	W	1N	51.3	10.8	32.8	E. URICHU
4312	W	2N	30.5	6	5.3	TARIACURI
4317	W	2N	45	6.8	14.7	TARIACURI
4340	B	NN	46.6	6.8	8.7	L. URICHU / TARIACURI
4336	W	2N	23.2	4.6	3.2	TARIACURI
4318	W	grooves	59	14	35	TARIACURI

ILLUSTRATIONS

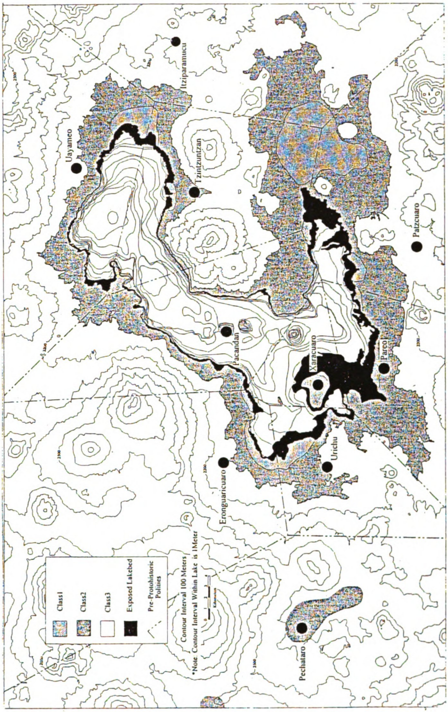


Figure 1. Lake Pátzcuaro and surrounding sites

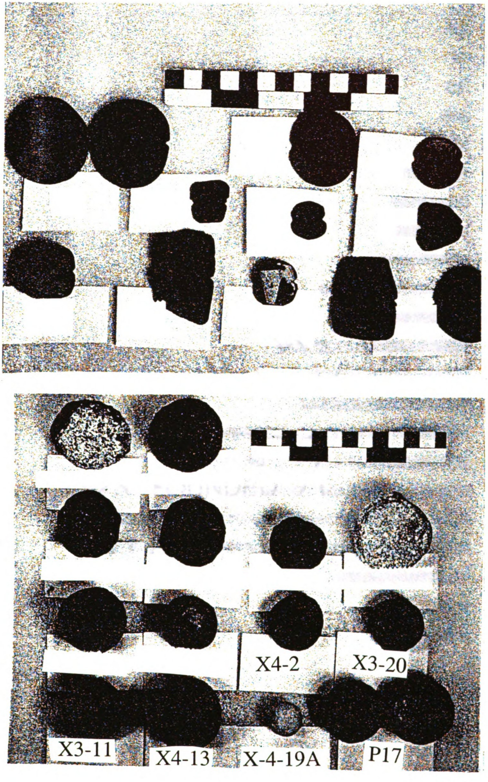


Figure 2. Prehispanic Tarascan disks

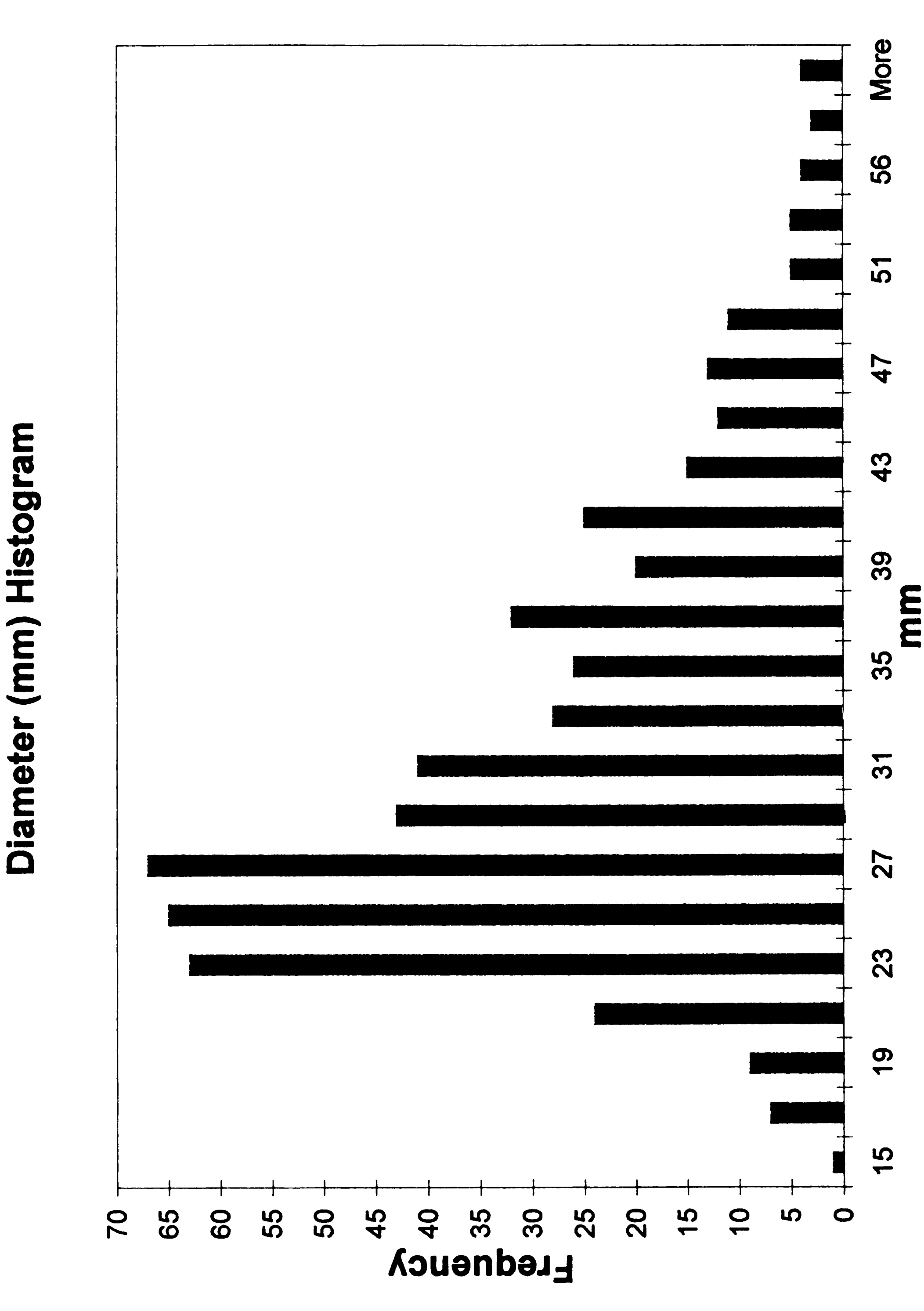


Figure 3. Histogram of disk diameters (all disks)

Diameter (mm)	
Mean	30.71013
Standard Error	0.397192
Median	28.2
Mode	25.2
Standard Deviation	9.083465
Sample Variance	82.50934
Kurtosis	0.253698
Skewness	0.888559
Range	44.7
Minimum	14.9
Maximum	59.6
Sum	16061.4
Count	523

Figure 4. Diameter summary statistics

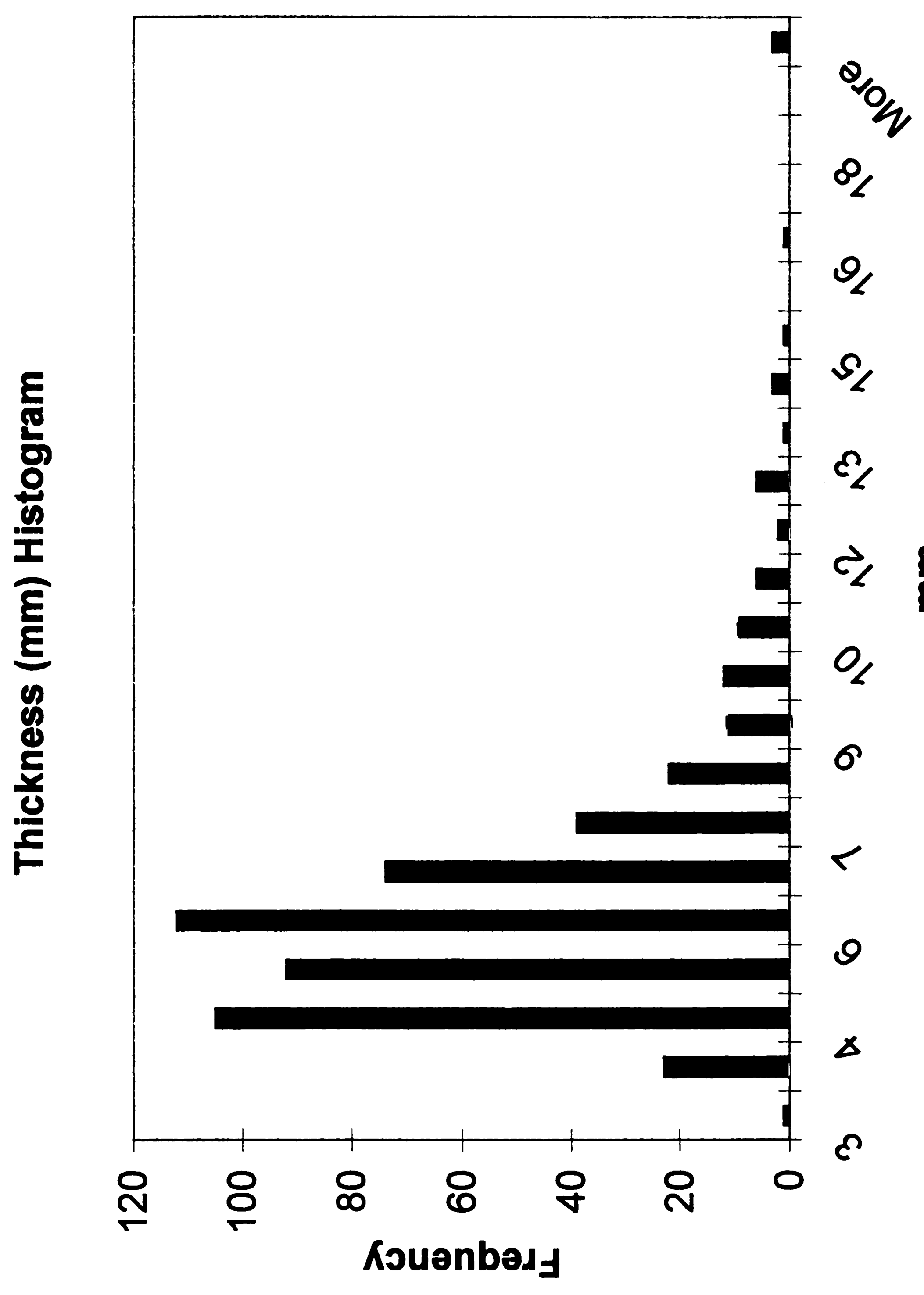


Figure 5. Histogram of disk thickness (all disks)

Thickness (mm)	
Mean	5.700574
Standard Error	0.098527
Median	5.1
Mode	5.2
Standard Deviation	2.253235
Sample Variance	5.077069
Kurtosis	9.199168
Skewness	2.453411
Range	16.8
Minimum	2.7
Maximum	19.5
Sum	2981.4
Count	523

Figure 6. Thickness summary statistics

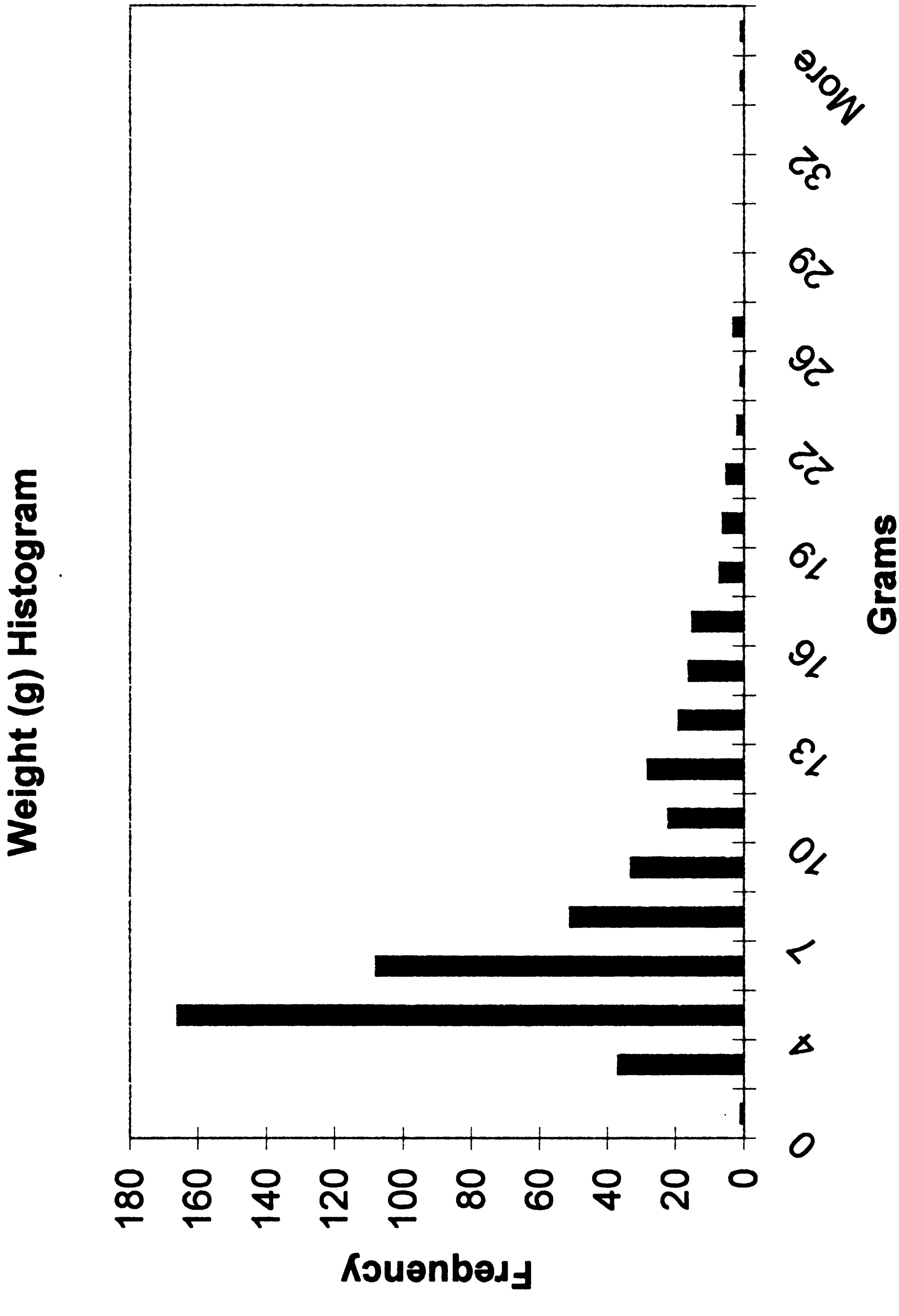


Figure 7. Histogram of disk weights (all disks)

Weight (g)	
Mean	6.209962
Standard Error	0.217892
Median	4.2
Mode	2.4
Standard Deviation	4.97825
Sample Variance	24.78297
Kurtosis	4.447671
Skewness	1.867175
Range	34.6
Minimum	0.4
Maximum	35
Sum	3241.6
Count	522

Figure 8. Weight summary statistics

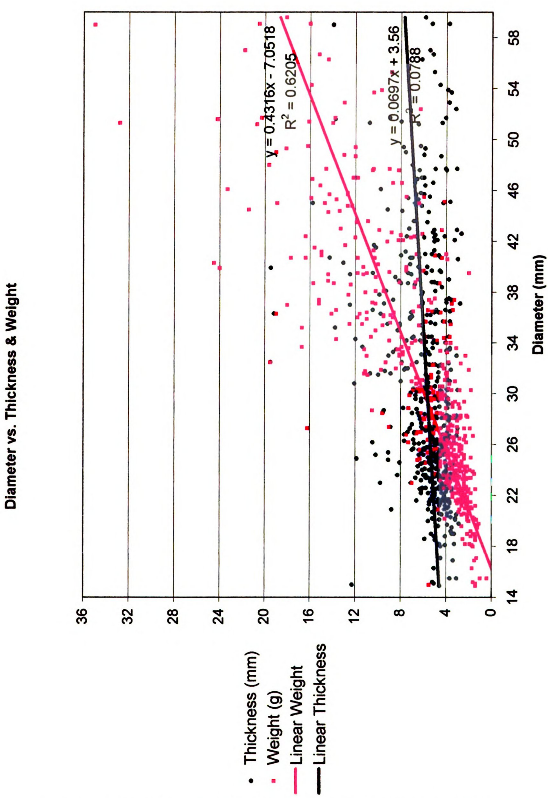


Figure 9a. Regression plot of disk diameter vs. thickness and weight
The image is presented in color in the thesis.

	diameter (mm)	*thickness (mm)*	*weight (g)*
diameter (mm)	1		
thickness (mm)	0.281014001	1	
weight (g)	0.788038538	0.645722262	1

Figure 9b. Pearson correlations for variables of diameter, thickness, and weight

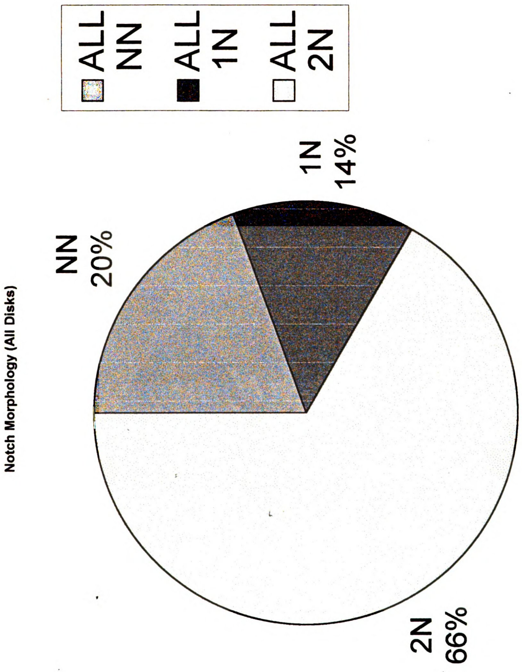


Figure 10. Notch morphology (all disks)

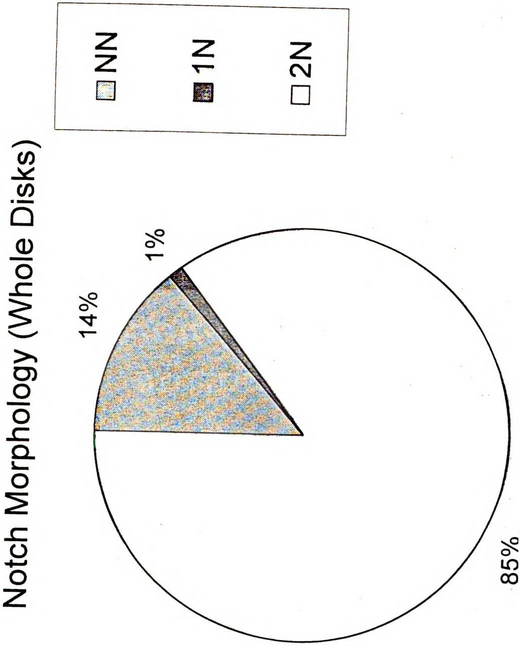


Figure 11. Notch morphology (whole disks)

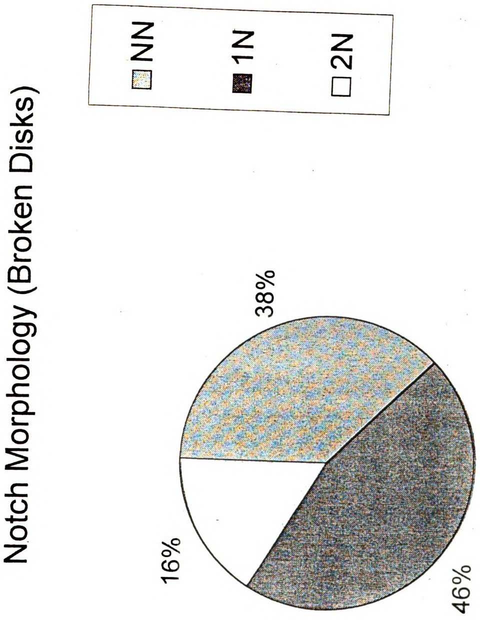


Figure 12. Notch morphology (broken disks)

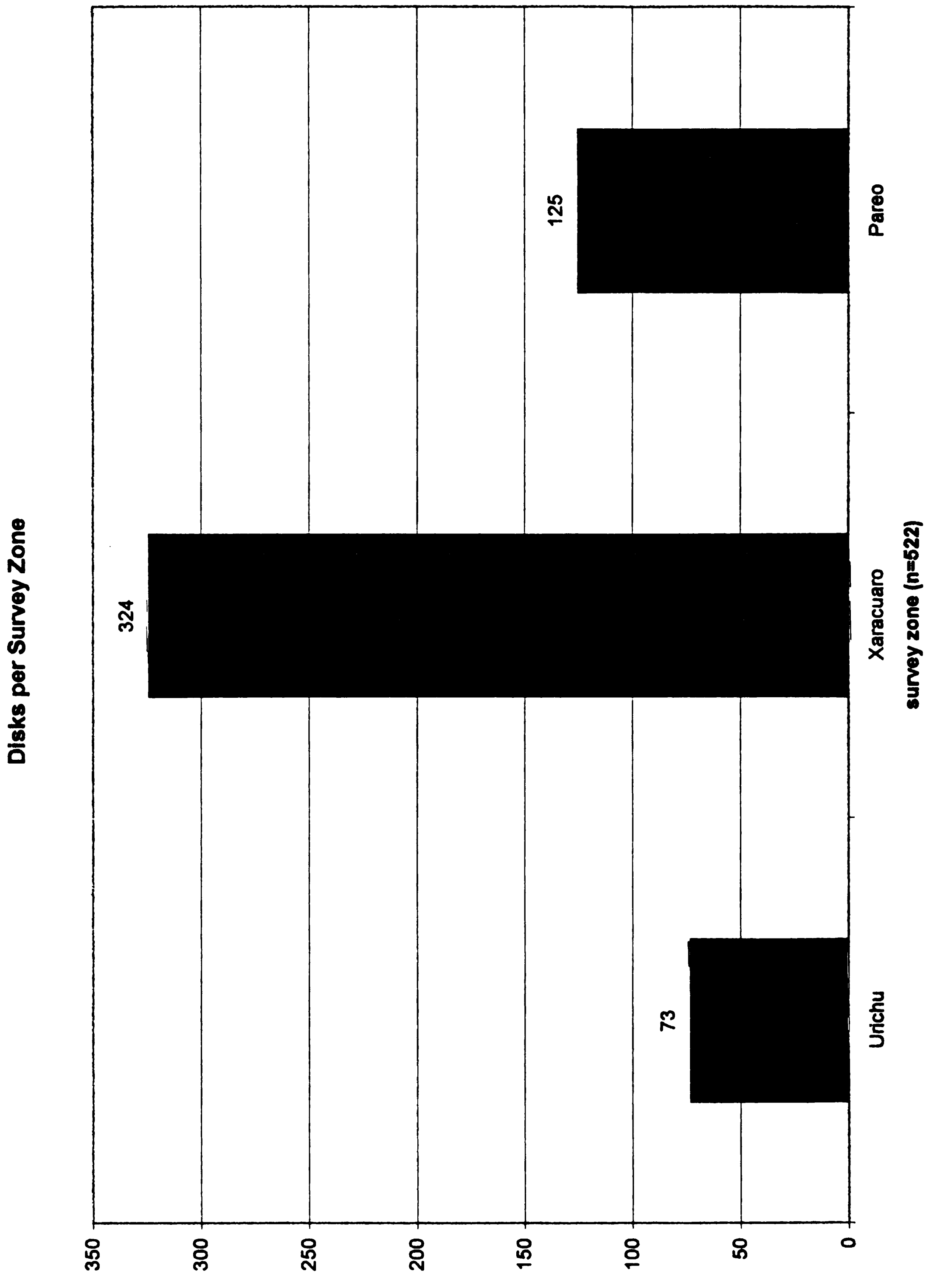


Figure 13. Disks per survey zone

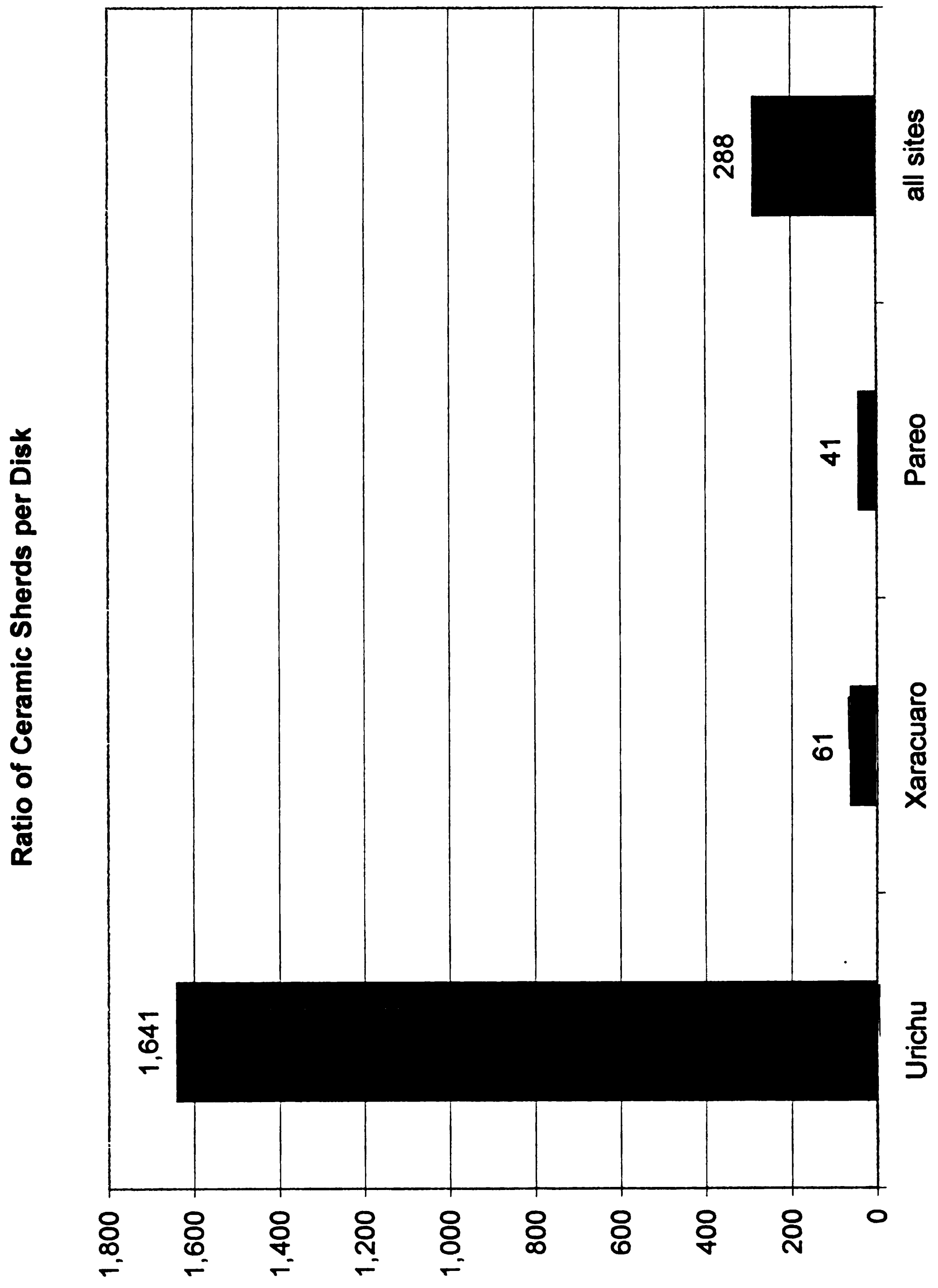


Figure 14. Ratio of ceramic sherds per disk

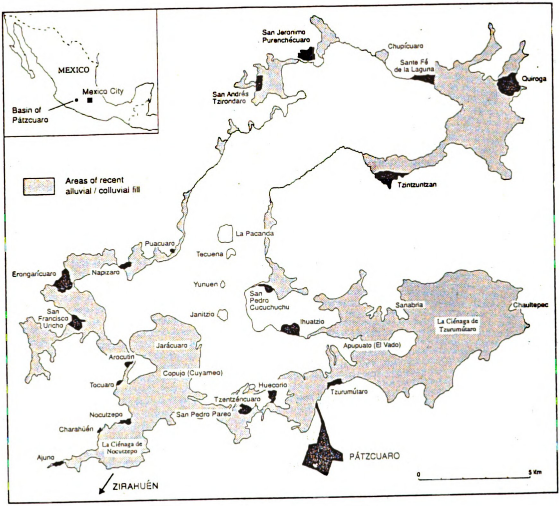


Figure 15. Map of Lake Pátzcuaro showing exposed lake bed due to lowered water levels (from O'Hara 1993)

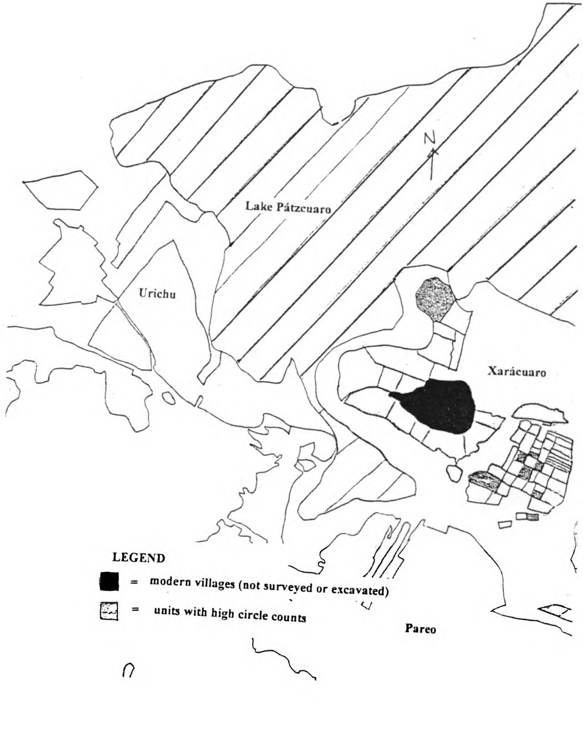


Figure 16. Map of Xarácuaro units with the highest disk counts

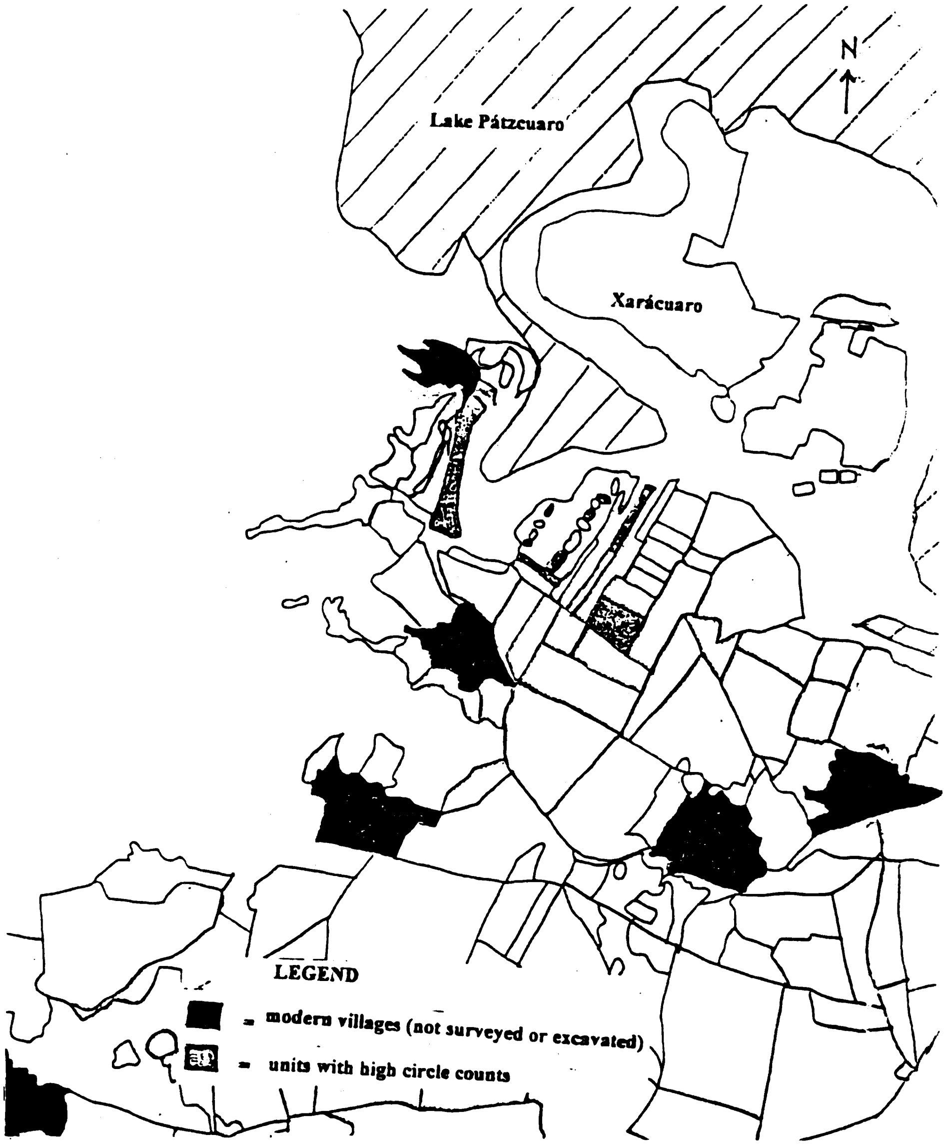


Figure 17. Map of Pareo units with the highest disk counts

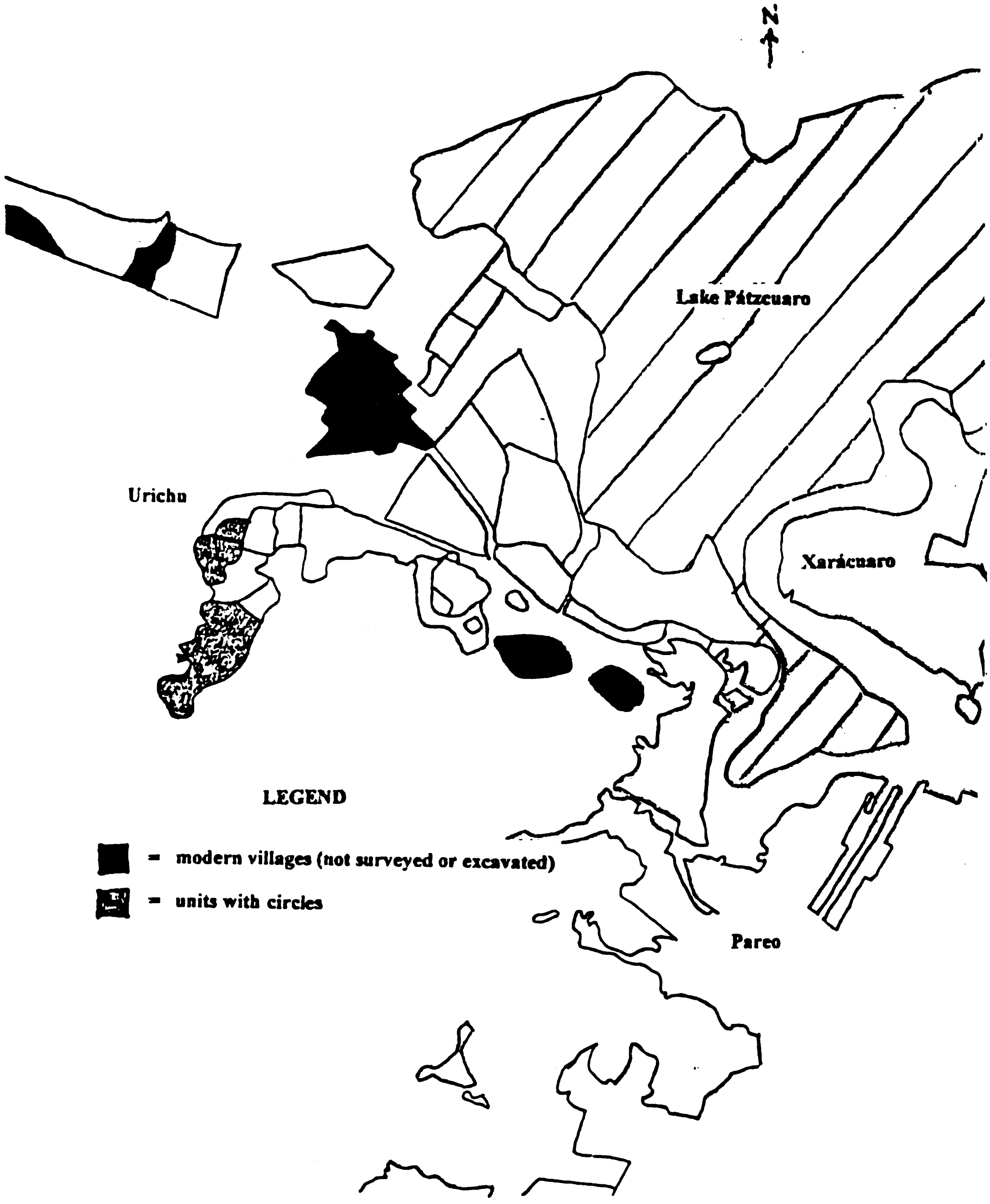


Figure 18. Map of Urichu units with the highest disk counts

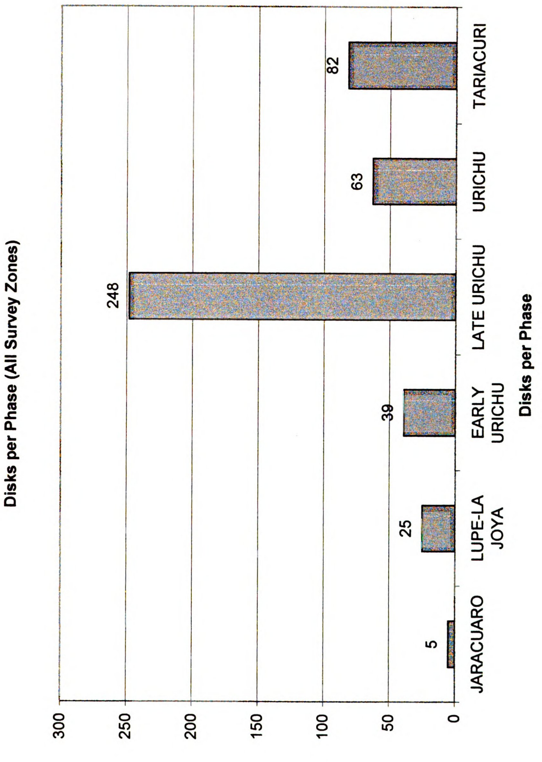


Figure 19. Disks per phase (all survey zones)

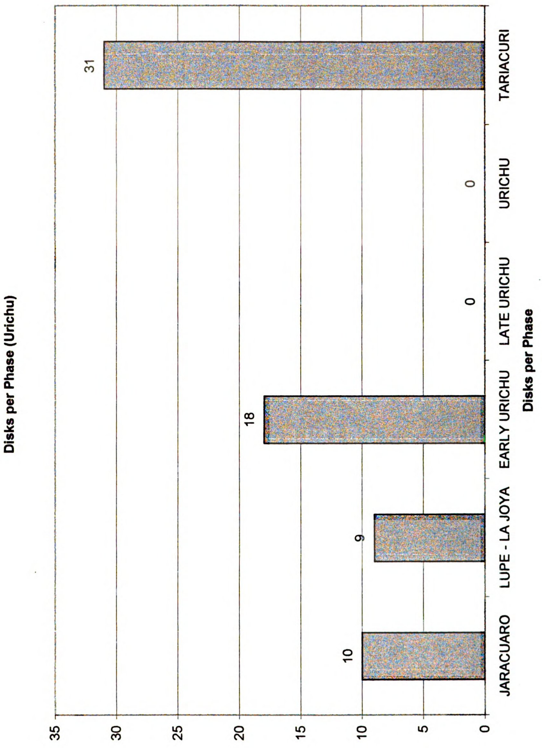


Figure 20. Disks per phase (Urichu)

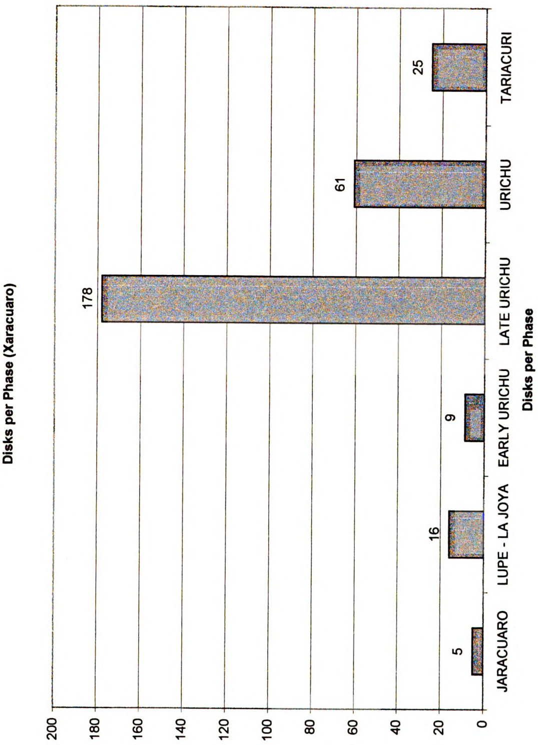


Figure 21. Disks per phase (Xarácuaro)

Figure 22. Map of Xarácuaro units with highest Late Urichu phase disk counts

Figure 23. Map of Xarácuaro units with highest Taríacuri phase disk counts

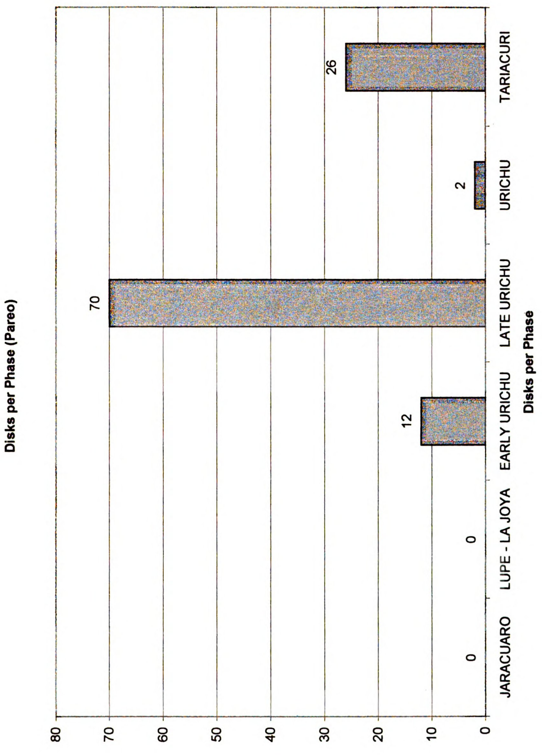


Figure 24. Disks per phase (Pareo)

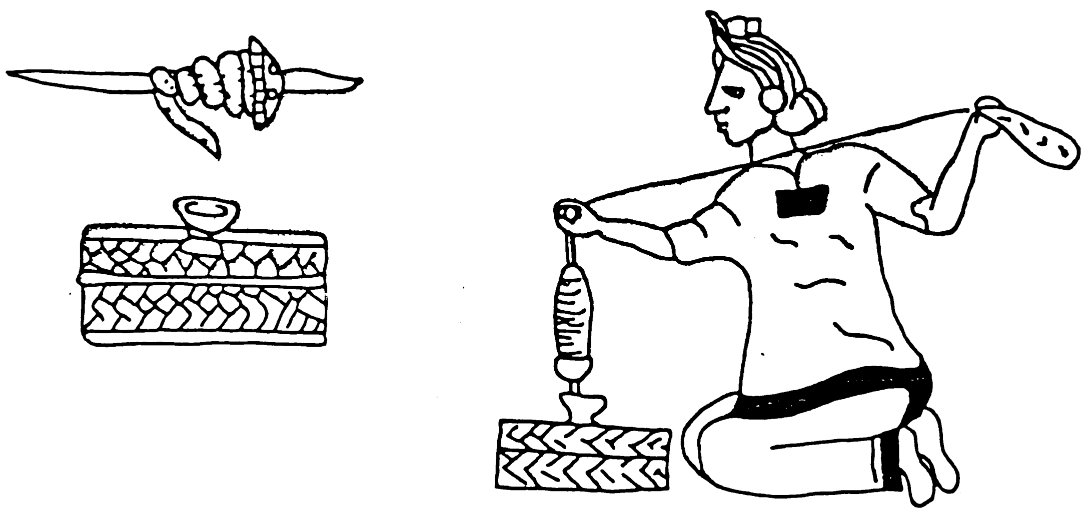


Figure 27. Prehispanic spinning (from Florentine Codex)

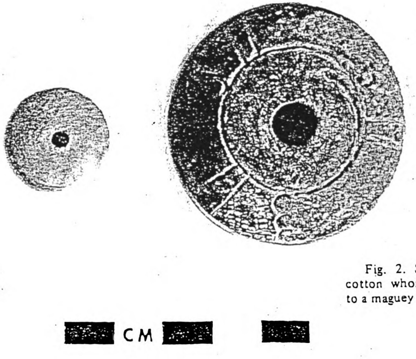


Fig. 2. Shows the size of a cotton whorl (left) as compared to a maguey whorl (right).

Figure 28a. Prehispanic malacates from central Mexico (from Parsons and Parsons 1990)

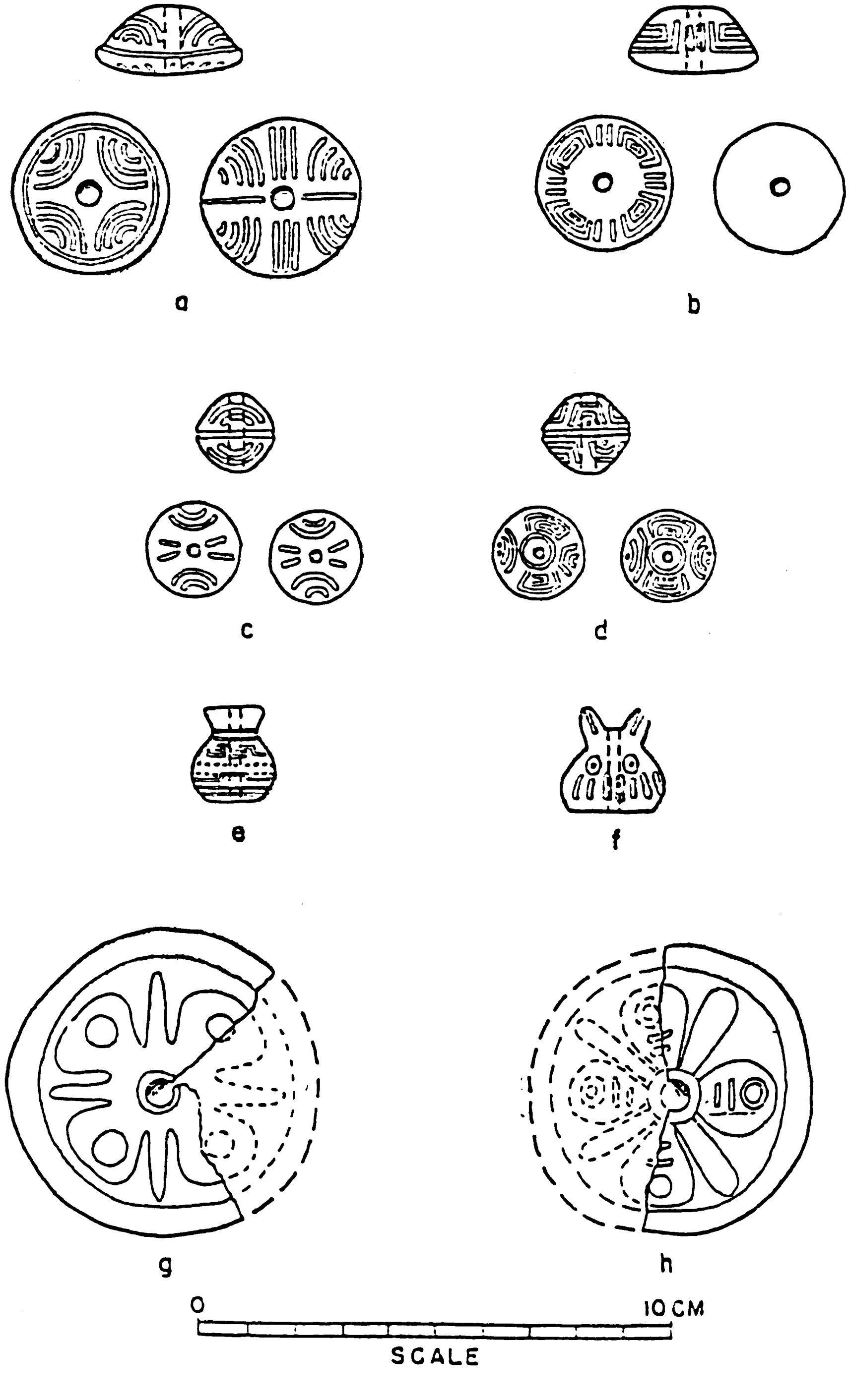


Figure 28b. Prehispanic malacates from Cojumatlán (from Lister 1949)

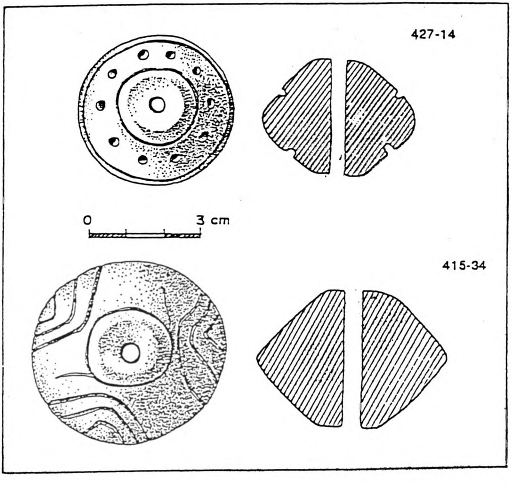


Figure 28c. Prehispanic malacates from Zacapu Lake Basin, Michoacán (from Arnauld et al. 1993)

t-Test: Two-Sample Assuming Unequal Variances

	Variable 1	*Variable 2*
Mean	30.69483	19.35
Variance	82.54494	28.66944
Observations	522	10
Hypothesized Mean Difference	0	
df	10	
t Stat	6.522735	
P(T<=t) two-tail	6.7E-05	
t Critical two-tail	2.228139	

t-test for diameter: Tarascan disks vs. Tzintzuntzan malacates

reject null hypothesis

Figure 29. T-test for diameter: Tarascan disks vs. Tzintzuntzan malacates

t-Test: Two-Sample Assuming Unequal Variances

	Variable 1	*Variable 2*
Mean	5.699425287	10.1315789
Variance	5.08612251	23.495614
Observations	522	19
Hypothesized Mean Difference	0	
df	18	
t Stat	-3.97003161	
P(T<=t) two-tail	0.000897804	
t Critical two-tail	2.100923666	

t-test for thickness: Tarascan disks vs. Tzintzuntzan malacates

do not reject null hypothesis

Figure 30. T-test for thickness: Tarascan disks vs. Tzintzuntzan malacates

t-Test: Two-Sample Assuming Unequal Variances

	Variable 1	*Variable 2*
Mean	30.694828	23.10526316
Variance	82.544944	25.0994152
Observations	522	19
Hypothesized Mean Difference	0	
df	23	
t Stat	6.2403675	
P(T<=t) two-tail	2.288E-06	
t Critical two-tail	2.0686548	

t-test for diameter: Tarascan disks vs. Urichu malacates

reject null hypothesis

Figure 31. T-test for diameter: Tarascan disks vs. Urichu malacates

t-Test: Two-Sample Assuming Unequal Variances

	Variable 1	*Variable 2*
Mean	5.6994253	10.1315789
Variance	5.0861225	23.495614
Observations	522	19
Hypothesized Mean Difference	0	
df	18	
t Stat	-3.970032	
P(T<=t) two-tail	0.0008978	
t Critical two-tail	2.1009237	

t-test for thickness: Tarascan disks vs. Urichu malacates

do not reject null hypothesis

Figure 32. T-test for thickness: Tarascan disks vs. Urichu malacates

t-Test: Two-Sample Assuming Unequal Variances

	Variable 1	*Variable 2*
Mean	6.2017274	5.1470588
Variance	24.79517	5.2388971
Observations	521	17
Hypothesized Mean Difference	0	
df	21	
t Stat	1.76822	
P(T<=t) two-tail	0.0915506	
t Critical two-tail	2.0796142	

t-test for weight: Tarascan disks vs. Urichu malacates

do not reject null hypothesis

Figure 33. T-test for weight: Tarascan disks vs. Urichu malacates

t-Test: Two-Sample Assuming Unequal Variances

	Variable 1	*Variable 2*
Mean	23.10526	19.35
Variance	25.09942	28.669444
Observations	19	10
Hypothesized Mean Difference	0	
df	17	
t Stat	1.835011	
P(T<=t) two-tail	0.084064	
t Critical two-tail	2.109819	

t-test for diameter: Urichu malacates vs. Tzintzuntzan malacates

do not reject null hypothesis

Figure 34. T-test for diameter: Urichu malacates vs. Tzintzuntzan malacates

t-Test: Two-Sample Assuming Unequal Variances

	Variable 1	*Variable 2*
Mean	10.131579	11.2
Variance	23.495614	6.0111111
Observations	19	10
Hypothesized Mean Difference	0	
df	27	
t Stat	-0.7881384	
P(T<=t) two-tail	0.437481	
t Critical two-tail	2.0518291	

t-test for thickness: Urichu malacates vs. Tzintzuntzan malacates

do not reject null hypothesis

Figure 35. T-test for thickness: Urichu malacates vs. Tzintzuntzan malacates

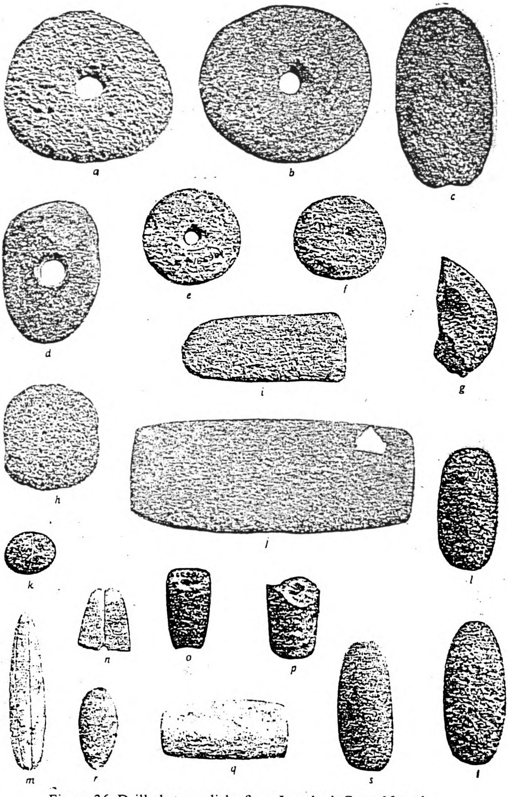


Figure 36. Drilled stone disks from Lovelock Cave, Nevada

(from Loud and Harrington 1929)

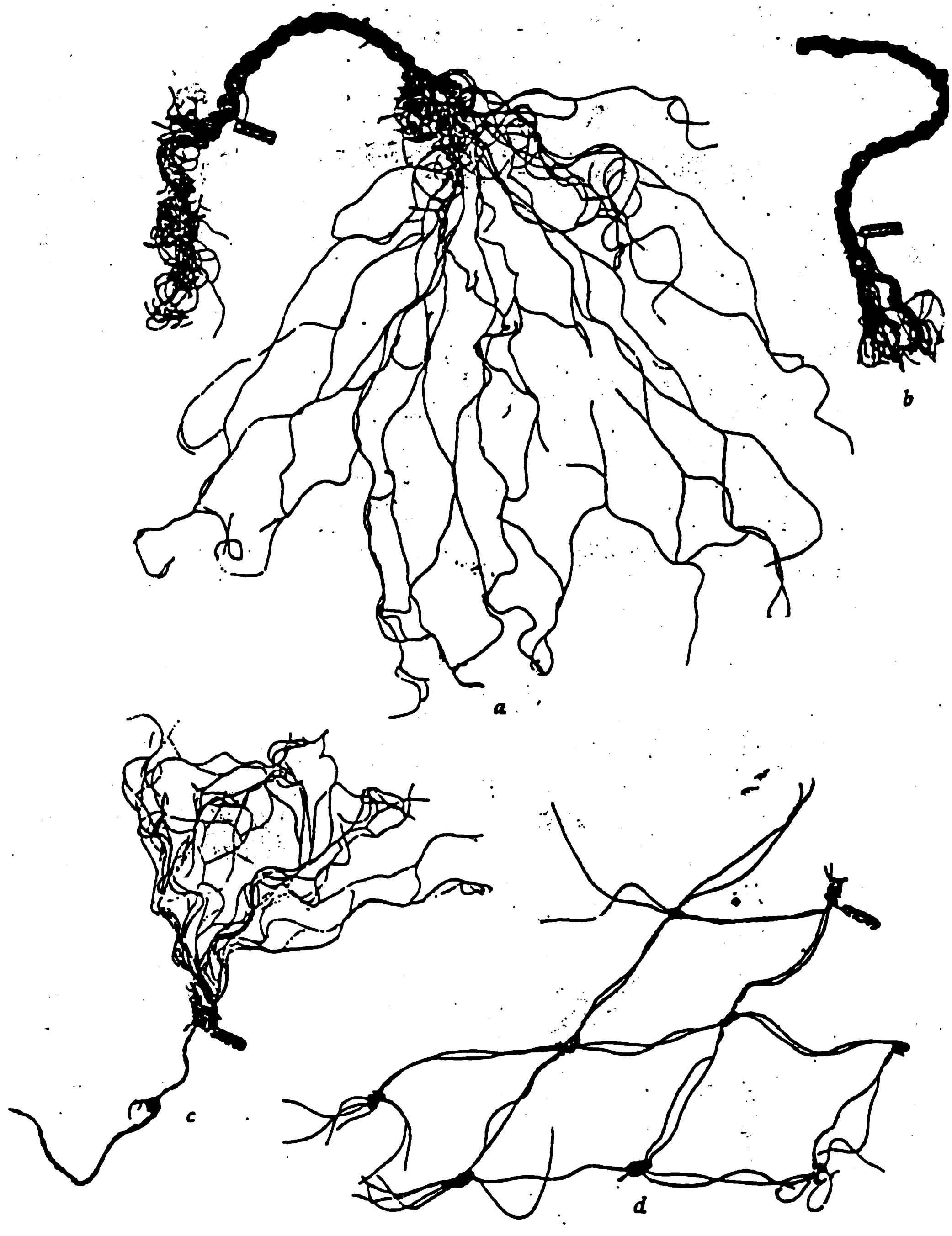


Figure 37. Fish nets from Lovelock Cave, Nevada (from Loud and Harrington 1929)

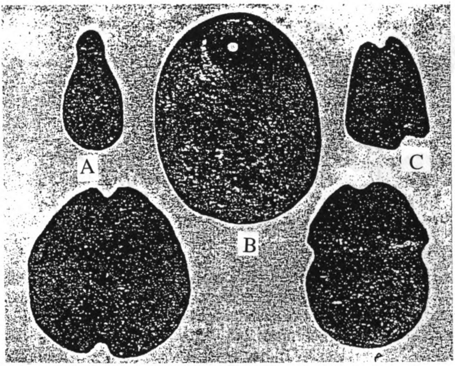
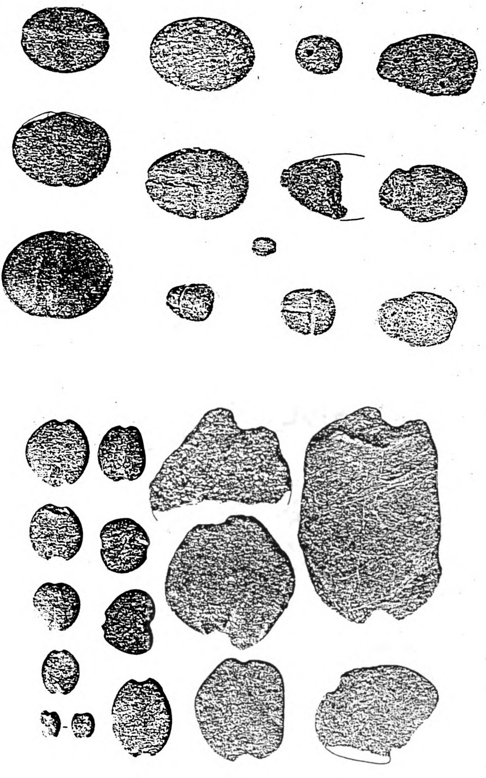
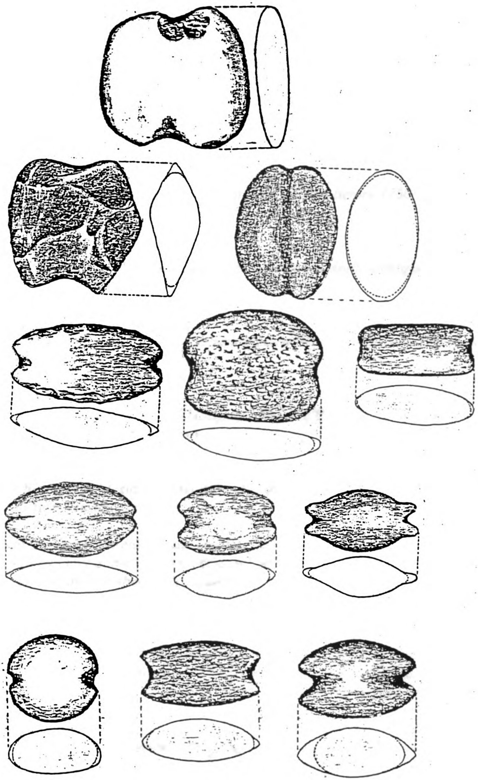


Figure 38. Net sinkers from Port Moller, Alaska (from Weyer 1930)



Figures 39a-b. Notched stones from Cook Inlet, Alaska (from De Laguna 1934)



Figures 40a-b. Notched stones from central Texas (from Watt 1938)

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