DIGGING STICKS OR DAGGERBOARDS? A FUNCTIONAL ANALYSIS OF WOODEN BOARDS FROM THE ICA REGION

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Introduction

A current debate exists over the function of a class of carved wooden boards found in tombs and middens of sites in the Ica region of southern Peru. Two principal interpretations exist: (1) the objects were digging tools, (2) the objects were daggerboards used in balsa raft navigation. A review of the literature indicates that argument by analogy has been the basis for supporting these functional identifications. The following paper reviews these positions and presents new data to support one of the two alternatives.

Max Uhle's excavations in the Ica valley in 1901 uncovered a range of burial objects that were later interpreted as the symbols of prestige of the nobles of Ica (Menzel 1977). Among the recovered objects are a number of tall, carved wooden boards that were found standing upright in the sandy clay floor of deep graves. Many of the objects are long (up to 2.3 meters) and ornamented with carved three-dimensional figures, low relief surface carving, painting in several colors, sheathing in gold and silver, cloth wrapping, and feather appliqué (Figure 1). Objects of similar form were recovered from midden context at sites in the Ica valley (Menzel 1977; Alejandro Pezzia, personal communication). These objects are smaller in size, lack elaborate ornamentation, and are often heavily worn on their lower edges (Figure 2). Both types are carved from the hardwoods of the dry coastal regions: algarrobo (*Prosopis chilensis*), guarango (*Prosopis juliflora*), espino (*Acacia macracantha*), and Calato (*Bulnesia retama*). The wood is well preserved in the dry and hot climate of the Ica region, but changes in the burial microenvironment have caused cracking and warping of the wood in many cases.

As stated above, two different functions have been suggested for these enigmatic objects. The interpretation most recently favored describes the objects as daggerboards or centerboards used to navigate balsa log rafts (Eisleb 1962; Gretzer 1914; Heyerdahl 1952a, 1952b, 1955, 1957; Horkheimer 1960; Johnstone 1980; Lothrop 1932; Urteaga 1978[1919]). The position taken is a functional argument substantiated by formal analogies. The authors argue that several physical traits of the objects negate their utility as digging implements: the boards are long and heavy, their blades are asymmetrical, and their handles are off-center and often carved. However, this conclusion is based on a subjective determination of the formal attributes of a digging implement which is neither described nor compared with documented digging sticks. Formal similarities with boards from the historically documented large balsa log rafts of southern Ecuador and northern Peru, the smaller Sechura log rafts, and the small rafts or *jangadas* from the lower Amazon, provide comparisons to support this suggested interpretation. However, analogy is a source of hypothesis generation and not a basis for evaluating an hypothesis. Independent sources of data such as spatial and temporal context, use-wear analysis, and iconographic associations are needed to evaluate critically these hypotheses.

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The digging implement interpretation (Horkheimer 1960; Menzel 1977; Ryden 1958) is also based on weak analogical reasoning. Menzel (1977) argues that the tools were symbols of prestige related to agricultural production. Her basis for this interpretation is a comparison with "real digging tools" found in the agricultural refuse layers of small settlements in the south coast valleys. Unfortunately, a formal and/or functional definition of the tools is never presented. How is a real digging tool defined or used and later identified? What kind of similarities does it share with an ornamented form?[1]

These two positions are the alternative hypotheses to be tested with independent sources of data in this paper. In the analysis, two major working assumptions will be made that apply to both possible interpretations:

1. Regardless of inherent symbolic function, all of the objects were used in some form of mechanical task, or patterned after utilitarian objects used in such a task.
2. The two hypotheses under investigation are mutually exclusive when considering primary function.[2]

Data

A total of 104 wooden implements were examined by the author from collections in the following museums: Museo Nacional de Antropología y Arqueología (Lima). Museo Regional de Ica, Lowie Museum of Anthropology (Berkeley), Museum of the American Indian, American Museum of Natural History, and the British Museum. All of the objects with specific provenience were from the Ica-Pisco region on the south coast of Peru. Heyerdahl (1957: 134, 136) states that the carved wooden boards are among the most familiar artifacts found in graves on the Peruvian coast, but the Pisco-Paracas-Ica region is the only specific locality he cites. Although most of the tools in this study lack site provenience, all of the studied objects have a single regional provenience, the south coast of Peru.

For organizational purposes, a formal typology will be used which closely follows the Eisleb (1962) typology. My revisions consist of a redefinition of existing types to account for more variation and the introduction of two additional types, 4 and 5 (see Figure 3).

Type 1 (Figure 3: 1A, 1B)

Defined by Eisleb as "a long broad board with a horizontal half round cut-out handle, upon whose lateral parts there is decoration". The board has an asymmetrical cross section, similar to that of an airplane wing. One end is always thicker and gradually tapers to a point on the opposite side, like the blade of a knife. This type is usually decorated on some portion of the upper blade (upper lateral edge, upper board face and upper handle; see Figure 3: 1A for a key to board morphology).

Type 2 (Figure 3: 2A-2D)

This type is characterized by a long, wide blade identical to Type 1, but has a half round cut-out handle which is open on one side. The open end of the handle is terminated by a blunt point. The closed end terminates in a short solid platform, which is usually aligned parallel to the width of the board. Ornamentation occurs on the same parts of the board as Type 1 (Figure 3: 2A). A variant of Type 2 retains the same form, but has no ornamentation. The upper handle is often heavy and blocky and the level of workmanship is generally crude (Figure 3: 2B). Eisleb (1962) suggests that some of the heavy upper handles are preforms or blanks for subsequent carving. Another variant is a board whose blade terminates in a long narrow peg and whose width is one fifth that of the blade (Figure 3: 2C). A final variant has a rectangular notch cut into one edge of the blade at a point midway down the length of the blade (Figure 3: 2D).

Type 3 (Figure 3: 3A-3C)

Type 3 is characterized by a short, broad blade and a long, shaft-like handle terminating in a carved wooden block. The lower board blade is shorter in proportion to total length than Types 1 and 2, but identical in cross-section view. When present, ornamentation is on the upper handle, the lateral edges of the shaft, or the upper edge of the blade. The shaft always meets the blade at a point that is slightly off center (Figure 3: 3A). A variant of this type is identical in general form, but the upper handle is a solid block, round knob, or a solid cross bar. No ornamentation exists anywhere on the implement and the workmanship is generally crude (Figure 3: 3B). One unusual variant of this type has a normal blade, a gradually widening shaft, carved step blocks on the lateral edges, and a closed semi-circular handle. The workmanship is rough and the piece is extremely heavy (Figure 3: 3C).

Type 4 (Figure 3: 4)

Type 4 is characterized by a short blade which gradually widens, a very short shaft-like handle, and an undecorated thick wooden knob on the upper end. The average total length of this type is shorter than Types 1-3, but the blades share the same formal characteristics.

Type 5 (Figure 3: 5)

Type 5 is characterized by a blade with no rounded shaft or handle. The blade is loaf-shaped in plan view and tapers to a point at either end. Some examples have a center band of low relief carved decoration.

Use-wear analysis

The surfaces of all blades were closely inspected and use-wear patterns were recorded in an effort to document activity or material specific function. Eisleb (1962) discusses the role of use-wear patterns in his earlier study of these blades, but never presents a complete description of his observations. Use-wear analysis has received considerable attention in lithic studies and the results have yielded patterns of surface alterations that can be linked to activity and

material specific tasks. The poor preservation and burial alteration of wood has prevented similar kinds of in-depth, microscopic studies on these boards. We are therefore limited to the use-wear patterns observable without magnification on the surfaces of the boards; these patterns will be compared with the patterns seen on utilized wooden implements of known function and analogous patterns on stone tools.

Among the surface patterns observed, moisture-induced warpage, drying, and surface cracking were noted on many of the wooden boards. Waterlogged wood undergoes a chemical reaction known as hydrolysis which weakens the strength of cell walls. When the cell walls have been severely weakened and the wood object is dried, the resulting surface tension force may collapse these walls and severe cracking may follow (Tarkow 1976). Warpage occurs when pressure is applied to wood in this weakened or waterlogged condition; subsequent drying may preserve this distortion. Daggerboards used on sailing rafts can be expected to become waterlogged and warped after prolonged immersion in water. However, Menzel (1977) reports that some boards were found imbedded in the moist subsurface soils of deep graves. This constant moisture can cause similar warpage and surface decay of the wood. The wood surface often acquires a crazed or tightly fissured surface appearance (cf. Tarkow 1976: 114). When present on the studied specimens, this alteration is almost always on the lower portion of the blades, while the upper blade is intact. Blades that were inserted upright into soils with subsurface moisture would be expected to have water-induced damage on their lower blades. Massive wooden posts from the Ica region, thought to be tomb posts, show the same kind of decay on lower edges (Hauspfahl 1984: 355). Several boards were noted with surface cracking along the entire length of one side. It is possible that these boards may have been laid flat inside deep tombs rather than inserted upright, causing decay of the entire downward facing side. Many blades have no moisture-induced alteration and were probably excavated from shallower, dry graves or middens.

The role of sailing boards used in navigation requires them to be immersed in water for long periods of time mixed with intervals of at least partial drying and re-use. This degree of exposure to water can cause severe structural damage unless the wood is protected with a suitable paint, varnish, or other type of sealant. When used in the sea, the salts that accumulate in the wood can cause further damage, depending on the surrounding environment. Despite these two factors, none of the studied boards had extensive salt accumulations on their surfaces and most had localized water damage relative to total blade area. In contrast, digging boards may receive little exposure to standing water during use, especially when farming is based on controlled irrigation and water table irrigation. The variability of the observed moisture damage (presence/absence, location on object, and degree) does not support the sailing board hypothesis. The use of these objects as digging boards would not be expected to result in this water damage either. Therefore, the moisture level in burial or depositional context appears to be the primary factor in causing this particular form of damage.

The remaining use-wear traits that were observed include: degree of surface finish, surface smoothing from abrasion, striations in the surface of the wood, altered blade morphology, and surface inclusions.

1. The degree of finishing of the wood surface of the objects varies from being highly smoothed and flat to roughly hewn with distinct axe or adz marks. Eisleb (1962) correctly points out that Types 2B and 3B have a greater percentage of roughly worked and heavy variants. Some Type 2 boards have a smooth surface finish on the upper blade portions and a roughly worked lower blade with use-smoothed lower edges. It appears that the lower blades of these tools were resharpened without subsequent surface smoothing and re-used, resulting in the observed lower edge smoothing. All blades showed some evidence of use and some appear to have been resharpened regularly and re-used.

2. The smoothing always occurs on the bottom edge of the blade, extends across the entire width, and is variable in height, though generally not exceeding 20 cm. In plan view, the zone is crescentic, being widest at the center of the blade and tapering to either side (Figure 4). Edge-smoothing was also observed on the thick lower lateral edges of many blades, but was rare on the thinner lateral edges and on upper surfaces.

3. Randomly oriented striations occur in and around this area of smoothing. Patterned striations were observed on upper blade surfaces and on lower blade surfaces with little associated smoothing. These are probably tool marks resulting from final shaping of the artifacts during manufacture and not from final activity-related wear.

4. The lower portion of the blade is usually asymmetrical in plan view. The maximum length always occurs at the thick-edged side of the blade and gradually diminishes in a gentle curve to the opposite, thin edged side (see Figure 3: 2B, 3B, 4). The boards are generally more fragmentary along the thinner and shorter edge, where they are more fragile. This variation in thickness and fragility often results in chunks of the thin lower blade edge falling out, leaving little intact bottom edge for study.

5. Many blades have small gold mica inclusions on their lower surfaces. Gold mica is a component of the soils in the Ica region and is a characteristic inclusion in the locally produced ceramics. Two possible interpretations for this observation can be offered. Sand or soil may have been used as an abrasive for manual smoothing of the surface of the implements. This action would implant mica inclusions over the entire smoothed surface of the tool. Alternatively, the mica may have been implanted by repeated insertion into soil, as might be expected for a digging stick. This action would leave mica inclusions on the lower blade zone only, as observed in the study collection.

6. A final observation concerns wear patterns on the upper handles of Type 4 tools. The handles are solid wooden knobs that were battered, showing many deep cracks and fissures. This kind of wear is typical of hammers or tools used in direct percussion work, such as clodbreakers used to break up hard earth. The wear patterns are not related to tool manufacture because shaping was accomplished by rough cutting, carving, and smoothing.

Iconography of the boards

Many of the tools have carved figurative ornamentation on different parts of the blade. Several different iconographic themes are depicted which have been

used to support functional interpretations (Eisleb 1962; Menzel 1977). There are several recurring themes which appear on the decorated Types 1, 2, and 3 boards. A seabird, often with a fish in its beak, is the most common (see Schmidt 1929: 426, 432). The birds may represent the cormorant, the gannet, or the pelican, marine species common to the Peruvian coast and the offshore islands. The fish are highly stylized and usually unidentifiable, but they are also commonly represented on Ica style ceramics, textiles, gourds, and adobe reliefs. On the boards, the fish always appear in association with birds. Similar kinds of figures appear on the ends of carved bone weaving implements from the Ica region (ibid.: 444).

A second frequent category is human figures wearing caps or headdresses, tunics, and often holding hands (see Schmidt 1929: 428-433). The figures are often painted in red, yellow, and green resin-based paints, with only traces of the paint remaining on most. There is a great deal of variability in the fine details of these figures (details of dress, posture, number, orientation, associated objects), and a careful study of these associations may provide important clues for both the functional interpretation of these objects and their ceremonial context (cf. Cook 1986).

Additional iconographic themes occur with much less frequency than seabirds and humans. They include parrots, foxes, men carrying foxes, mice eating corn, and a human sacrificial scene. Carvings were often further embellished with metal sheathing, painting, feather appliqué, and at least one example of cloth covering.

Discussion

At this point, let us review the different categories of data which we have collected, in order to proceed with the testing of the two suggested functions.

Category	Data
Distribution	South coast of Peru, centering around the Ica valley.
Use-Wear	Localized water induced damage. No heavy salt encrustations. Variable surface finish, sometimes on the same object. Use-smoothing on lower edges of blades. Random striations over surface probably resulting from object manufacture. Outline form of lower blade is asymmetrical. Gold mica inclusions on surface of lower blade ends. Heavy mechanical damage to undecorated wooden knobs of type 4 objects.
Iconography	Primary theme is a seabird with or without fish. Other themes include: humans in standard posture and costume, parrots, foxes, men carrying foxes, mice eating corn, human sacrifice.

We will now turn to an in-depth consideration of the functional roles of daggerboards and digging sticks in an Andean context. The implications of the use and contextual roles of the tools, completely independent from our lab analyses of the archaeological specimens, will provide a reference point for comparison with our observations study collection.

Navigational Aids

Centerboards, leeboards, and daggerboards are three distinct types of steering aids used on flat-bottomed sailing rafts. Although they are generally similar in form, their function is quite distinct. A centerboard is a single board extending through the hull of a boat, which is centered midships and may be well back to the stern. If the board is truly centered, it acts much as a keel, providing stability and resistance to lateral drift. When located towards the stern, the board acts much as a steering rudder and provides directional control and propulsion when used as a sculling board. Centerboards/rudders were observed on balsa log rafts in Sechura (Edwards 1960) and on modern jangadas off the coast of Brazil (Cascudo 1957). Leeboards are thin broad planks that extend through the hull of a sailing craft to reduce lateral drift and provide stability. They are most often used in combination with a vertical rudder and are not primarily used for directional control (cf. Greenhill 1976: 100-101). Daggerboards combine the functions of centerboards/rudders and leeboards. They are inserted through the hull in pairs: two in the bow and two in the stern. Raising and lowering the boards in different combinations with the set of the sail permits one to steer a sailing raft and to reduce lateral drift (cf. Heyerdahl 1957: 141). This sailing technique was reported by Juan and Ulloa (1978[1748]) on rafts off the west coast of South America and was later tested by Heyerdahl on the voyage of the Kon Tiki. Different combinations of boards and vertical rudders are reported on rafts from Vietnam, Formosa, the Coromandel coast, Brazil, Sechura, and ancient Egypt (Doran 1971; Edwards 1960, 1965; Hornell 1970; Johnstone 1980; Urteaga 1978[1919]).

Regardless of the precise functional specificity of these boards (hereafter referred to as sailing boards), their reported size falls within a normal range of variation. The "centerboard planks" on the Sechura rafts are 2.5 cm. thick, 30-45 cm. wide, and 180-244 cm. long (Edwards 1960). Juan and Ulloa (1978[1748]) describe the sailing boards as being 274-366 cm. long and 46 cm. wide. The boards used on the Kon Tiki were 180 cm. long and 61 cm. wide (Heyerdahl 1950). From this information, we can hypothesize a minimal size for the boards of 150 cm. length and 30 cm. width. The study collection of 104 boards has 75 boards whose length falls below this minimum (69%). Furthermore, many boards appear to have been reworked or resharpened, which substantially diminishes the length of the blade. This type of tool curation would, of course, be detrimental rather than beneficial to the intended task. The length and width of a sailing board represents the total area of effective resistance and are the most critical dimensions of these boards. Many of the boards from the study collection do not meet minimum size criteria for these dimensions.

Sailing boards are only reported to be used on flat-bottomed rafts, most often constructed of wooden logs or bamboo. The flatness of the hull requires the use of vertical structural additions for navigational control. Therefore, the distribution area of flat-bottomed log rafts on the west coast of South America

should subsume the distribution of archaeological sailing boards. The distribution of balsa log rafts during the historic period stretched from the Guayas basin of Ecuador in the north, to as far south as Lima, Peru (Edwards 1965; Heyerdahl 1955). A second type of log raft was built along the forested coasts of Chile. The raft was constructed of three logs, with the center log longer in the prow than the other two, and was propelled with a double-bladed paddle (Bird 1943). However, this type of raft did not use a keel or sailing boards, so we may omit modern day Chile from our estimation of the distribution area of sailing rafts using sailing boards for navigational control.

The documented distribution of the archaeological wooden boards discussed in this study centers around the Ica-Pisco region on the south coast of Peru. To the author's knowledge, none of the board types covered in this study have been found within the area of balsa log raft occurrences. This spatial discontinuity between the two distributions is of primary importance, but it must be interpreted carefully. First of all, there is a considerable temporal gap between the two forms of data. The boards have been found in burials that date from Late Intermediate Period 3 to the Late Horizon (Menzel, personal communication), while the raft descriptions are from the early historic period. It is difficult to determine the full range of balsa log rafts in the Pre-Columbian era, when the wooden boards were made and used. Preservation of waterlogged balsa wood is very poor along the exposed shorelines of coastal Peru.[3] One small flat-bottomed raft was excavated in 1979 in Chayhuac, a fishing settlement close to and contemporary with the occupation of Chan Chan (Segundo Vasquez, personal communication). However, this raft may be one of the few remaining evidences of a once well-established method of marine transport.

Alternatively, let us review the kinds of sea craft recorded for the Ica region during historic times. Totora reed rafts, constructed of wrapped bundles of reeds lashed together in a manner analogous to balsa log raft construction, have been recorded for the south coast region (Edwards 1965). These were reported by Cobo (1956[1653]) to have up to a 10-12 foot beam. A hardwood or cane chafing strip was attached to the sides of some, but the hull construction was entirely reed. Expected preservation of these rafts is very poor because the reeds eventually become waterlogged and lose their buoyancy. On the north coast of Peru today, the fishermen of Huanchaco unwrap the reed bundles of their *caballitos* when waterlogged and abandon the reed or reuse it for house thatch. The wrapping cord is saved and used in the construction of the next caballito. Similar practices in earlier periods would suggest a low potential for encountering intact reed rafts or raft building material. The remains of one reed raft were excavated near the mouth of the Ica river (Pueblo 40) and is of the wrapped bundle construction (Engel 1980). No boards were found associated with the raft.

The final data we have on Pre-Columbian raft distributions comes from ethnohistoric sources published by Rostworowski (1977) on the merchants of Chincha, Peru, just to the north of Pisco. The lord or *curaca* of Chincha was thought to have maintained an important role in the Inka political hierarchy because of the great economic wealth he amassed by having over 100,000 "balsas" at his disposal. These rafts were the means of mobilizing goods in a maritime transport system that stretched from at least Guayaquil, Ecuador to

Chincha, Peru. If true, this information would extend the southern range of balsa rafts to include the south coast Ica region. However, the documents are unclear as regards the specific type of "balsa" in use and offer no details about navigation systems. Without these crucial data it is difficult to extend with confidence the range of flat-bottomed, log-constructed sailing rafts any farther south than Lima, Peru.

Sealskin rafts were reported in the Ica region by Acosta (1954[1590]), in Valparaiso in 1834 (Lothrop 1932), and were still constructed in the Atacama province in 1958 (Niemeyer 1965). No archaeological evidence of these rafts or their paddles has been found in the Ica region. The sealskin rafts and the reed rafts were both propelled with double-bladed paddles. Totora reed rafts on the north coast of Peru were probably propelled with split cane paddles, if the depictions on Moche and Chimu ceramics are correct (Lothrop 1932: plate XIX). Similar paddles are still used today by the fishermen of Huanchaco. The Lake Titicaca reed rafts are propelled with thin poles (some have scrap-wood blades attached) and reed sails. Keels or sailing boards are not reported from any reed rafts in the world, nor is there any indication that they were used in the Pre-Columbian era in Peru.[4] The reed hull may not provide the rigid yet flexible support necessary for lashing the hardwood boards.

All of the existing evidence for sailing rafts and the wooden boards under study presentssites like us with two non-contiguous distribution zones. Although the current evidence is meager, distribution zones do not support the sailing board explanation for the function of the wooden objects in this study.

The expected water-induced wear on sailing boards is problematic (as stated before) due to depositional environment. However, the repeated raising and lowering of the boards between the logs of the hull would be expected to leave a pattern of linear striations along the wide surfaces of the blades. No such pattern was observed. The one consistent pattern seen on the boards in the study collection is the edge-smoothing of the base of the board which develops from repeated abrasion. This kind of wear could develop if the boards were regularly used in helping to cast off from the beach by insertion into the abrasive beach sand. However, Edwards (1960) describes the method of casting off the Sechura log rafts in great detail. The rafts are pushed down the beach on log rollers and when the sand is soft, sailing boards are placed under the rollers to provide a firm support. Once in the water, the boards are used to scull the raft through the surf. When beaching the raft, the boards are again used to scull the raft through the surf. The support function of the boards would cause a random pattern of aligned linear striations to form from contact with the log rollers. No such pattern was observed. In summary, the apparent absence of all expected use-wear traits does not support the sailing board functional model.

The iconography on sailing boards may be expected to have a maritime association. Among the earlier-named types of figurative ornamentation, only the seabird/fish association meets this expectation. Murphy (1920-1922) noted the vast flocks of seabirds which were seen to fly back to their nesting grounds on the guano islands or the mainland coast after a day of feeding on the offshore fishing grounds. Undoubtedly, ancient mariners were aware of this pattern and could navigate towards land by following the flight of birds. The sighting of

flocks of feeding birds would also have indicated the locations of dense schools of fish close to the surface of the water. Therefore, we can suggest the importance of these birds to ancient mariners and their regular depiction on sailing boards would not be unexpected. However, the remaining figures that regularly appear on the decorated boards (humans, parrots, foxes, mice with corn) do not appear to have a distinctly maritime association. We would expect to identify a single theme which relates to all of the iconographic elements observed, assuming a single function emphasis for the objects. Many of the figures are also painted with a resin-based pigment that is water-soluble. The use of these pigments on objects continually exposed to sea water would require regular repainting. Alternatively, the boards may have been painted only prior to burial or were never used on sea going rafts.

In summary, a formal analogy between the larger Ica wooden boards and the documented sailing boards of log rafts, and the appearance of marine birds as ornamentation, offer the only suggestive basis for a daggerboard interpretation. I suggest that an alternative functional identification is needed.

Digging Implements

Despite the amount of detailed work conducted on agricultural systems and techniques in the Andean region, little analysis has been directed towards the material technology behind the construction and maintenance of these systems. Donkin (1970), Ravines (1978), Rowe (1946), and Soldi (1982) review the known types of digging implements from the Andean region. The most common tool is the foot plow, known as the *taclla* in Quechua. The tool consists of a pointed wooden shaft, around 1.8 m. long, with a hardwood or socketed metal point, a footrest attached to the lower blade, and a hand grip on the upper blade (see Waman Puma, 1980[1615]: 224, 1050, 1053). The tool was used with two hands and a foot and jabbed into the earth with force (Rowe 1946: 211).

During the Colonial Period, socketed points made of bronze or iron were attached to the digging end of such tools. Although no complete pre-Spanish foot plows have been found, many socketed copper-arsenic bronze blades have been recovered from the north coast of Peru (Lechtman 1980, 1981). Most of the tools are socketed but their distal ends vary in form from a slender point to a wide, flaring blade. Use-wear analysis on these tools is difficult because of the buildup of an enveloping layer of copper corrosion products on the surface. Gordon (1985) has employed use-wear analysis to test the premise that some bronze tools were used for stonecutting. Heavy mechanical damage to tool edges as expected for stoneworking may be observed, but the edge-smoothing, surface striations, and occasional nicking expected to develop from repeated insertion into soil would be difficult to observe.

The form of use-wear developed from digging can be predicted by comparisons with documented wear on stone blades. Keeley (1980: 79-81) identifies the typical wear pattern as: severe abrasion "polish" at the tip of the tool, striations (aligned and random) and edge-crushing. He feels that these traits are easily identified by the naked eye. Observations on the stone blades of shovels from Chuquicamata, Chile (AMNH collections) also show this pattern of use-wear. I am suggesting that a very dense hardwood, like algarrobo, would develop a similar kind of surface smoothing. Less dense woods would tend to

crumble or crush at the point of contact. Fortunately, the preservation of organic materials in the Ica region allows us to study these patterns on wooden tools.

The copper alloy points are primarily from the north coast region of Peru and have not been found on the south coast near the Ica region. In the absence of metal points, foot plows with wooden blades, perhaps fire hardened, were probably used (Figure 5). The blade is long and relatively narrow, in cross section it tapers to a point at the basal edge, and the blade form is asymmetrical in plan view. The blade alone would appear to be a rather unwieldy implement. However, the attachment of a projecting footrest on the lower blade and a projecting hand rest on the upper body greatly increases the ease with which it can be handled. When used as a foot plow, the blade would develop use-wear on its lower edge. This type of foot plow shows a clear formal similarity with board Types 1 and 2 from the study collection. The attachment of a lower footrest on these Ica boards would facilitate their use as digging tools and improve the formal similarities. No boards have been found with such attachments, but the 2C variant has a rectangular notch cut into the side of the blade that would serve the same function (Heyerdahl 1952a: plate LXXIII). While the board edges could have been notched to serve as a gripping point for the cord wrapping, no such marks have been found. Unfortunately, fiber impressions or pseudomorphs are rarely formed on wood surfaces, so this potential bit of information is lacking.[5] The semi-circular notches at the upper ends of the studied objects may have functioned as hand grips, since they are in the correct position and have the right size. For those tools with no upper notches, a separate hand grip may have been cord wrapped to the upper body of the objects. Finally, the regularly observed zone of lower edge-smoothing is exactly what we would predict to find on the lower ends of digging blades.

A second type of Andean digging implement is similar in design to a modern garden hoe. It consists of a straight wooden handle with a sharply angled upper body to which a chisel-shaped digging blade is attached (Fernandez Baca 1980: 18). The blades are made of stone in the Cajamarca region (Ravines 1978) and the Mantaro Basin (Russell 1985), and were fashioned of metal in the Inka Period (Rowe 1946: 211). Waman Puma shows one of these implements being used for cultivating fields of corn and potatoes (1980[1615]: 1029, 1032, 1044). On the south coast, large stone blades were used in the Initial Period at sites such as Hacha in the Acarí valley (Robinson 1986), but are not found in later period sites. In the absence of suitable stone, the blade portion of the tool could have been made of a dense hardwood. The valleys of the Ica and Nazca rivers once supported dense stands of algarrobo (Cobo 1956[1653]), so hardwood was a locally available material that could have been used for tool manufacture. The expected dimensions of a wooden blade of this type can be estimated from the graphic depictions of the tools in use (ca. 30-75 cm.). This is comparable with the smaller size range of the Type 2 boards. Menzel (personal communication) reports finding blades of this type and size (ca. 60-120 cm.) in the south coast valleys. The lack of a recognizable hand grip on these short boards suggests that they may have been lashed to a handle. The ends of these boards also show the characteristic edge-smoothing seen on longer tools.

Another type of agricultural implement in the Andes is the clodbreaker. The form usually consists of a wooden shaft with a large protruding knob at one end, which may be part of the wooden shaft or an attached stone head. The

tool is used to break up solid chunks of earth, usually after groundbreaking with footplows (Waman Puma 1980[1615]: 102). In Quechua, these tools are called *huyppus* or *tacanas* (Ravines 1978: 100). Type 4 boards show formal and functional similarities to this type of tool. The upper handle is a solid wooden knob that shows evidence of heavy battering. The lower portion of the tool consists of a flaring thin blade, similar to Type 1 and 2 blades. This may be a multi-purpose tool which combines the functions of a clodbreaker and a hoe, perhaps suited to the less compacted soils of the Ica region. The combination of the knob-like head and the flaring blade strengthens the argument for a digging stick function for these tools, because both forms are independently documented as being used for agricultural activities.

Waman Puma illustrates a double-pointed implement used in cultivation (1980[1615]: 1053). The tool is being held in two hands, but its precise function is unclear. Type 5 tools are identical in form to the tool in this illustration. The predominant wear on these tools is on the lower tip of the tapered blade. The tool was probably used in a hoe-like motion, with the pointed tip repeatedly inserted into the ground. Some may have been hand-held, while others could have been hafted to larger handles.

The final agricultural tool considered is a type that is formally similar to a modern shovel. Archaeological examples are known from the Rio Loa and Chuquicamata regions in northern Chile (Bird 1979; Bennett 1946; Montell 1926; Ryden 1944). Some of these types were probably used as shovels in mining activities. Their form consists of a wooden handle with a hafted blade of wood or stone. The stone blade is often round or ovoid and has a well-smoothed lower edge. The wood blades have a projecting shaft at one end for hafting and a rounded, but asymmetrically worn basal edge. The asymmetry of the blade edge is identical to that seen on most of the board ends from the study collection. These digging tools all have basal zones of edge-smoothing, as do the formally similar tools in the study collection. This tool appears on a painted textile from Pachacamac (Disselhoff 1967: 30) as it is being used to cultivate around a tuber-bearing plant. The tool is identical to the Type 3B form. Another similarity is seen in a digging stick collected from the Champa tribe on the Tambo river in the Amazonian region of Peru. It is made from a single piece of carved chonta palm wood and has a cord-attached footrest (Figure 6). Without the footrest, the tool is nearly identical to the Type 3 objects and it exhibits the same edge-smoothing seen on the study samples. Finally, digging sticks used by the Otovalo Indians are made of carved eucalyptus wood and bear strong resemblance to the Type 3 study tools (Murra 1946: plate 161).

The occurrence of wear patterns on the ends of blades with heavily ornamented upper handles was a surprise, as it was originally assumed that these ceremonial tools received little use. However, Zuidema (1977) describes an agricultural ceremony known as the ritual of the first plowing, during which Inka dignitaries would plow a field with golden digging sticks. If we interpret this description correctly, it suggests that ritual sticks may have been used regularly in a limited ceremonial context. These sticks would not show the heavy edge damage or edge attrition seen on the more utilitarian tools, but they should show basal edge-smoothing. This is precisely the kind of observation made on the decorated objects in the study collections.

Many different functions can be suggested for digging sticks in the Andean region, including ground breaking, soil preparation, cultivation/weeding, excavation and maintenance of irrigation canals, raised and sunken fields, guano extraction, and mining. These activities should provide a contextual background which we can use to interpret the iconography associated with digging sticks. The most common theme observed is a marine bird with or without a fish. The importance of these two figures in native agricultural systems stems from the use of marine bird guano and/or fish as rich organic fertilizers. The practice of placing fish heads with corn seeds in first plantings is documented by Cieza (1947[1550]: 42). The use of guano or animal excrement is similarly suggested (Julien 1985; Rowe 1946: 216; Winterhalder et al. 1974), but the archaeological verification of this practice is elusive. One of the richest guano stations in Peruvian history was the Chincha Islands, located off the Peruvian south coast. Archaeological materials have been found in the guano deposits (Kubler 1948), providing evidence that the islands were visited during the Pre-Columbian era, but we know little of their economic and/or religious importance. The available evidence does show that the maintenance, collection, transport, and use of this resource was of considerable importance during the early historic period (Julien 1985). The islands are also known to have had special ritual importance to the peoples of the Andean coast (Rostworowski 1981: 122-135).

Further evidence associating the boards with marine birds and fish comes from Ica style ceramic bowls. Several bowls in the Museo Nacional in Lima have Type 2B boards painted on their inner surface and a pattern of stylized birds and fish painted on the exterior walls. This regular association of marine birds and fish with the wooden boards is consistent with the use of these objects in agricultural activities, particularly in the south coast region of Peru.

Some of the secondary iconographic themes are also directly related to agricultural activities. The stylized fox, parrot (Eisleb 1962), and mice eating corn (Sawyer 1968: 100) are depicted stealing and/or eating corn in other contexts. Parrots are seen on Chimu-Inka ceramics being fed corn (Figure 7), where they appear to be captive. Naturally mummified parrots have also been found in Pre-Columbian burials and parrot and macaw feathers were extensively used in textiles (Rowe 1984). These contexts suggest that the birds may have been semi-domesticated, as reported for many ethnographic groups in Amazonia. Among the Bororo (Crocker 1985), macaws, parrots, and parakeets are domesticated pets. The birds are considered to be a vehicle of the spirit, neither wholly animal nor human, and they are an important source of highly valued feathers used for ritual goods. This comparison can offer us a potential role for these birds in earlier Andean cultures. Parrots were also considered as agricultural pests and were hunted, as illustrated in Waman Puma (1980[1615]: 859, 1138). The resulting dichotomy between a wild bird/pest and a semi-domesticated/pet (source of feathers) probably resulted in many symbolic associations with this bird. Suffice it to say that the parrot was linked to agricultural crops on two levels: as a raider of crops and as a valued semi-domesticated animal that was fed corn.

The fox also appears to have had a dichotomous association with agriculture, but of a different nature than the parrot. In addition to appearing as a single or multiple figure, the fox appears in association with humans on one of the boards from Uhle's excavations in the Ica valley (Lowie Museum #45384) and on

several boards published by Schmidt (1929: 428, 433). The carved upper handle of the boards have seated or standing men, one behind the other, wearing fox pelts on their heads and down their backs. I suggest that these figures are *ararihua*, young men who are responsible for protecting agricultural fields (Urton 1985; Zuidema 1985). The evidence for this interpretation comes from two sources at least 1000 years apart. In the months of March and October, Waman Puma (1980[1615]: 1138, 1159) shows an ararihua or protector of the field wearing a fox skin on his head and back, holding a staff with rattles and tassels and a sling. According to Zuidema (1985: 187), "The ararihua derives his distinctive dress from that animal which is specifically associated with the forces he is to combat." This description establishes a destructive association between foxes and cultivated plants. A Nasca style painted textile published by Sawyer (1979: 142) shows a harvest festival scene in which several of the participants hold food plants and wear a fox skin in the style of the ararihua. A Nasca style ceramic illustrated by Sawyer (ibid.: 143) shows a similarly dressed figure. Finally, a Paracas style headdress ornament from the Ica valley (AMNH #41.2/6610), constructed from the head of a fox with macaw feathers fixed to the surface was reported to have been attached to the head of a mummy bundle. These Paracas and Nasca depictions are strongly suggestive of the historically documented ararihua. Further inspection of historical and contemporary data reveals the double meaning of foxes. According to Urton (1985) and Zuidema (1985), foxes are used to predict the outcomes of upcoming agricultural seasons in highland communities today. These animals predict the yield of the harvest, the favored ecological zone for planting, and the amount of rain. Furthermore, Urton (1985: 262) records a myth that presents the fox as the bearer of cultivated plants to the earth.

The human figures that form a major iconographic theme on ornamented boards do not appear to have a clear association with agriculture, nor with seafaring. The elaborate headdresses and painted tunics may symbolize high status individuals, but further interpretation is difficult.

Conclusion

Functional and formal analogies support a confirmation of the digging stick hypothesis. The use-wear traits, including abrasion zones, blade asymmetry, and mica inclusions, match our expectations for digging implements. The lengths of the boards are close to the documented size for tacllas (Rowe 1946: 211) and the sizes suggested from drawings (Waman Puma 1980[1615]) and painted textiles (Sawyer 1979). Formal analogies with known digging tools, in combination with use-wear evidence from the same classes of implements, offers further support.

The iconography seen on the boards shows a consistent association with agricultural activities in all but one example. The elaborate and finely detailed work seen on many of these implements may be expected on tools used during agricultural ceremonies such as ritual groundbreaking and planting. Their common occurrence in burials and middens is to be expected when agriculture formed a large part of the economic basis of a group and played an important role in ritual activities.

The data presented in this paper suggest that the digging implement hypothesis offers a better explanation for a wider range of the traits and variation observed on the Ica boards than does the sailing board hypothesis. The restricted and sharply focused distribution of the boards may be a function of availability of wood as a raw material, the lack of alternative materials and an established historical tradition or cultural preference for wood tools, and a favorable environment for the preservation of wood. The rejection of the daggerboard hypothesis rests on mutually exclusive distribution patterns and the lack of expected associational evidence. This conclusion does not imply the lack of a well-developed maritime transport system on the south coast. Instead, it suggests that a re-consideration of documented sea-going vessels from this region would help to focus the search for their elusive remains in the future.

Endnotes

1. Menzel (1977) offers a comparison with tools depicted in several Waman Puma drawings which are formally distinct from the tools she publishes. However, the Waman Puma tools do correspond with Type 5 tools in this study, also reported by Menzel to have been found in the Nasca, Acarí, and Yauca valleys.

2. "The close relationship between the agricultural and fishing community is illustrated in some curious ways; for example, the favorite tool for scraping hulls and collecting certain shellfish at Laguna Grande is the farmer's lampa (spade) for collecting other shellfish, a rake" (Hammel and Haase 1962: 213). Although this observation suggests dual functions for farming implements, there is an implied functional primacy seen by the choice of terms (farmer's spade and rake).

3. It appears that log raft construction may be a highly expedient technology. Dampier (1703) reports seagoing log rafts on the west coast of South America that were regularly broken up at their final destination and sold for timber. The crew then booked passage home on a Spanish ship. Indians near the Iquitos region currently use log rafts to transport cargos of roof thatching on down-stream trips. The rafts are loaded at upriver locations and floated to the market in Iquitos. Two long stern paddles are used on the rafts for steering and to provide some propulsion. The paddles are constructed of long wooden posts with a short and wide wooden blade that is cord-hafted to the end. Upon arrival at the market, the cargo is unloaded, the cord lashing of the log raft is unwound and saved and the logs are abandoned. The paddle blades are also untied and saved for later use.

4. Gene Savoy (1974) employed sailing boards on a reed raft journey along the west coast of South America. His interpretation of rafts depicted on Moche V ceramics suggests the use of sailing boards, but it is equally possible that long paddles are depicted. This slim and inconclusive evidence is insufficient to warrant consideration of sailing board navigation on reed rafts in this paper.

5. It is equally possible that the sandy and generally loose soils of the Ica region did not require digging tools with such leverage points. For example, sunken fields are often dug into dry, loose soil which is then mounded around the perimeter of the field to prevent wind redeposition (Soldi 1982). Foot plows

used on the harder highland soils would require a greater leverage point and hence, a footrest.

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Figure 1. Wooden board with carved and resin painted ornamentation. Traces of copper alloy sheathing remain on the upper handle (see Figure 3: 1A for definition of board morphology). American Museum of Natural History 41.2/638.

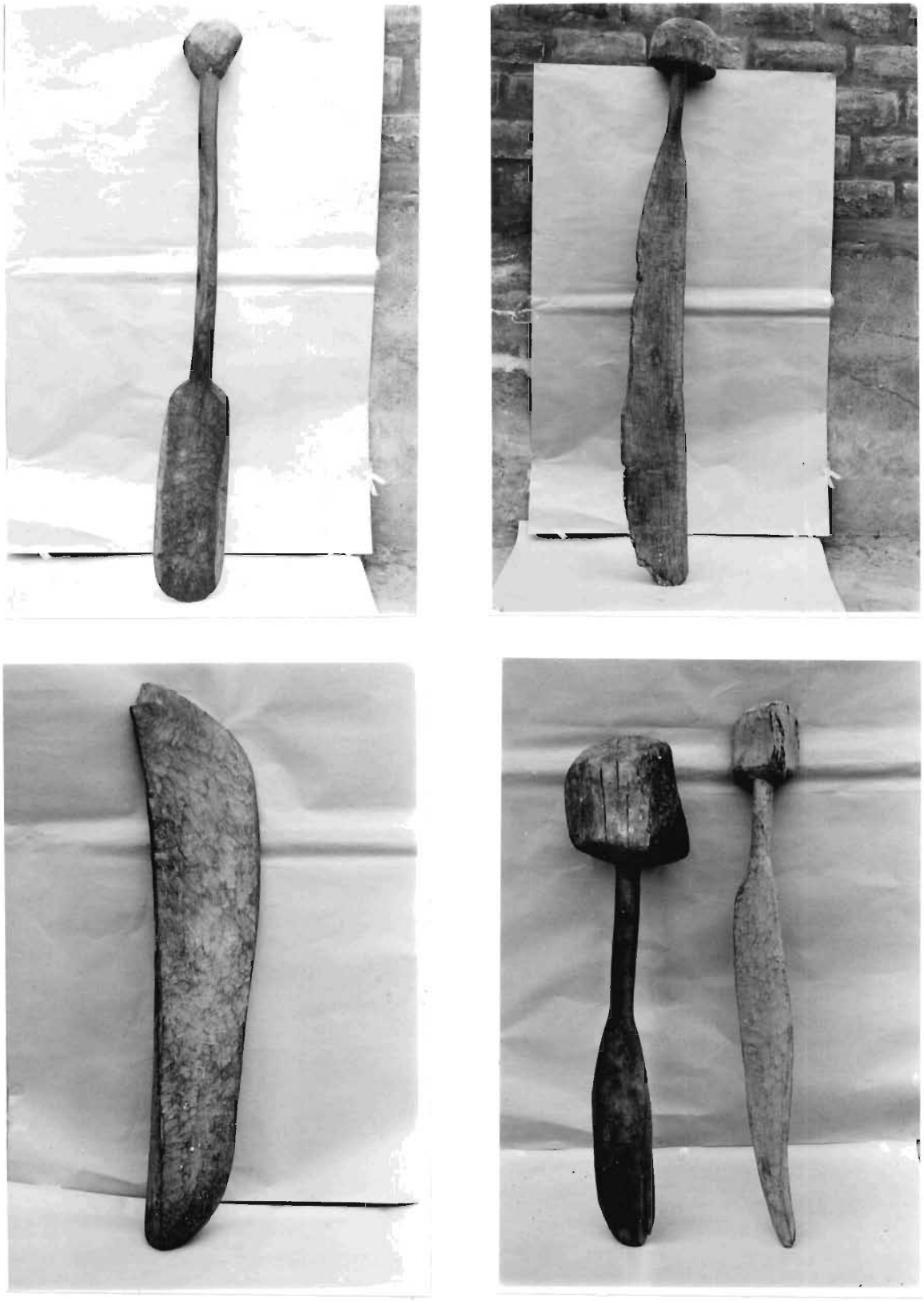


Figure 2. Wooden implements from the Ica region, Peru. All show evidence of use on lower blade edges. Museo Regional de Ica.

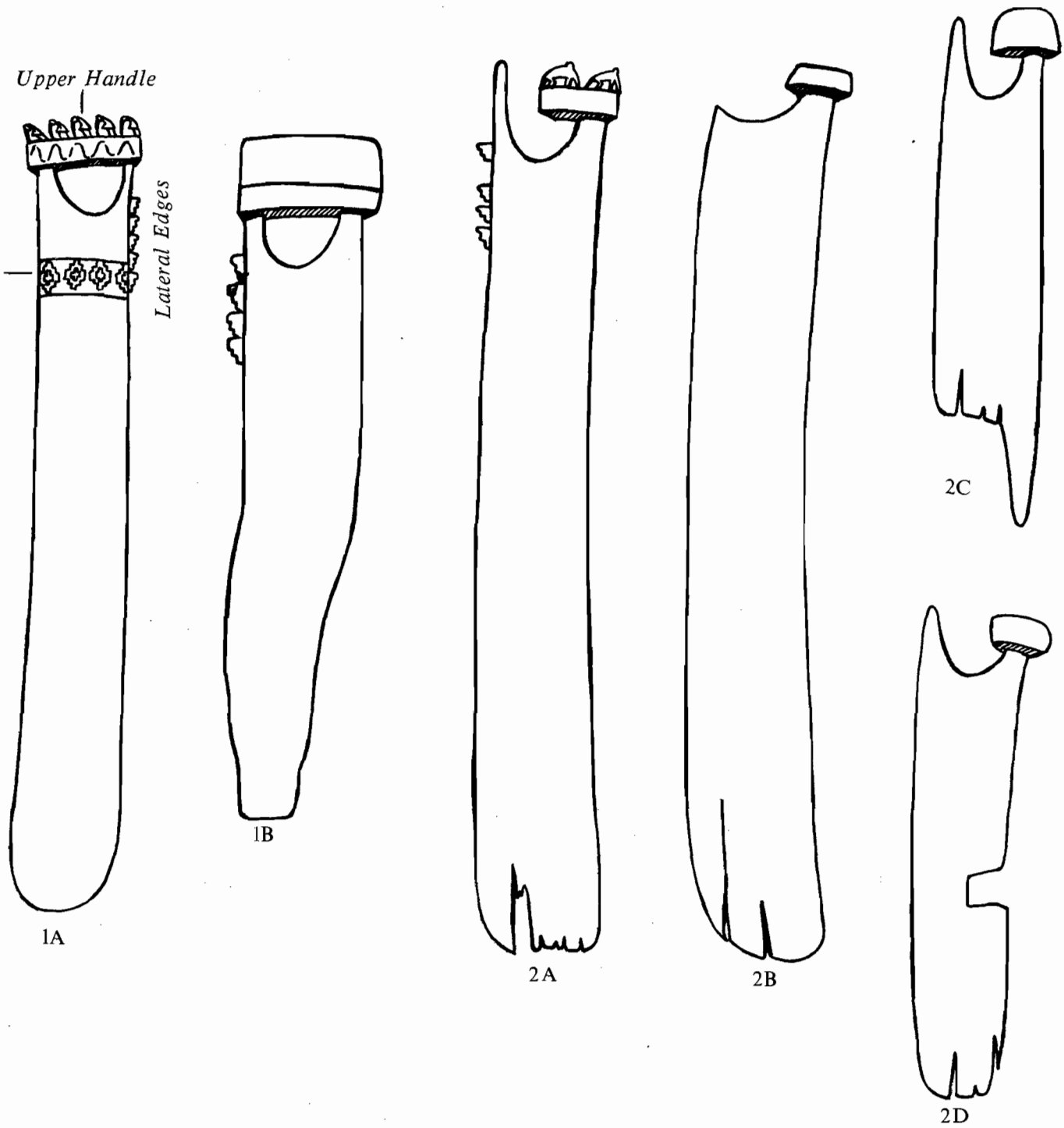


Figure 3. Range of formal variation in carved wooden implements from Peru. Types 1 and 2.

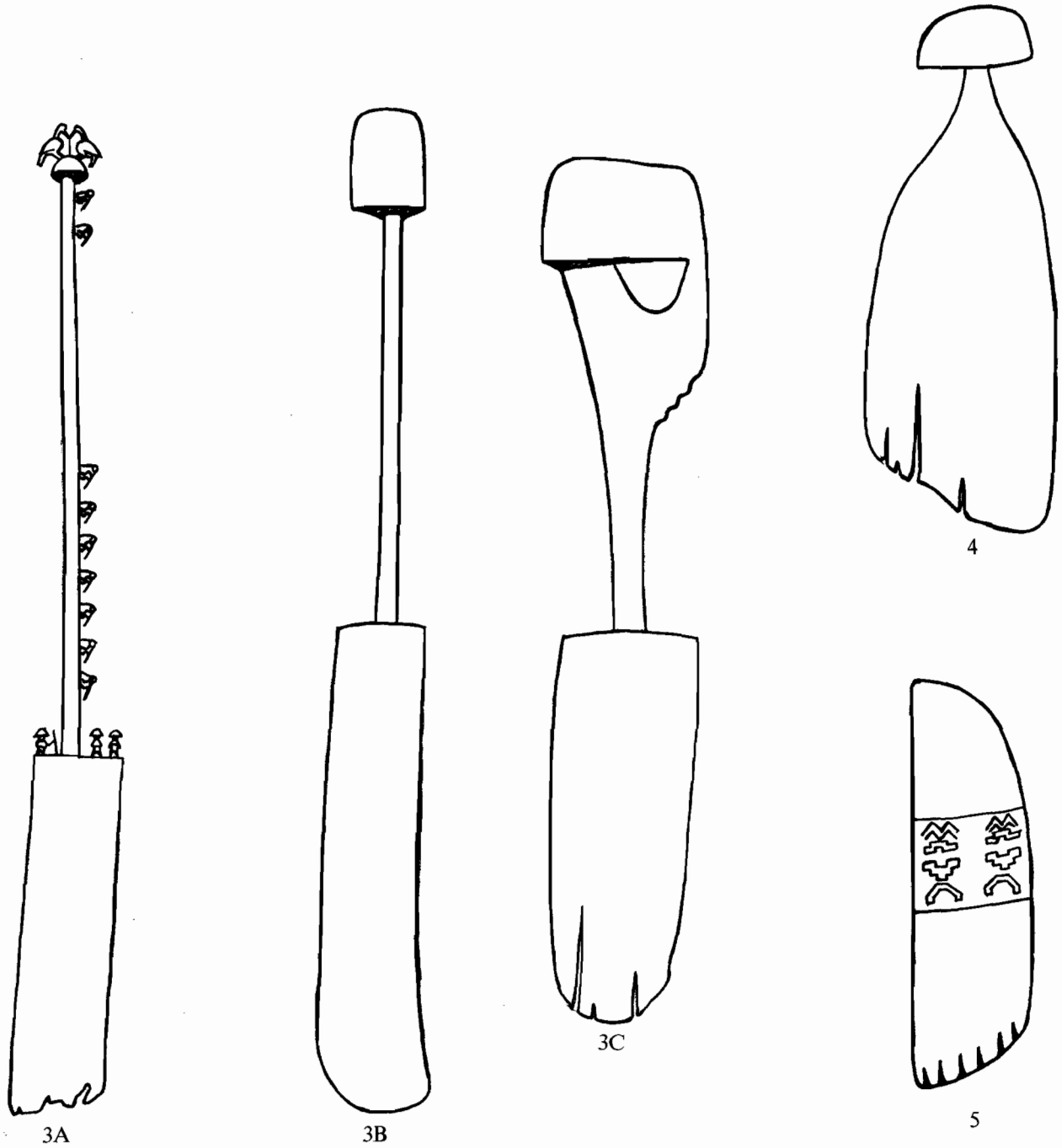


Figure 3, continued. Types 3, 4, and 5.

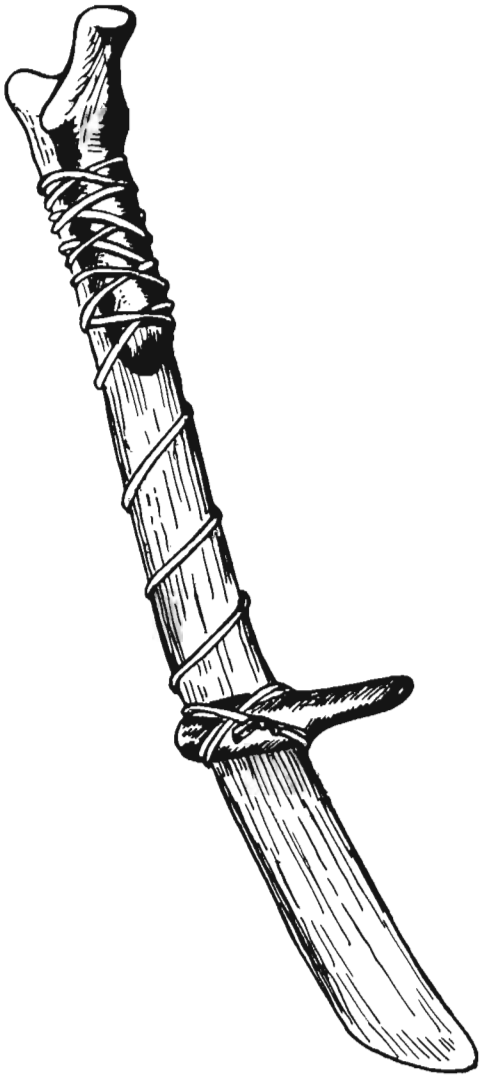
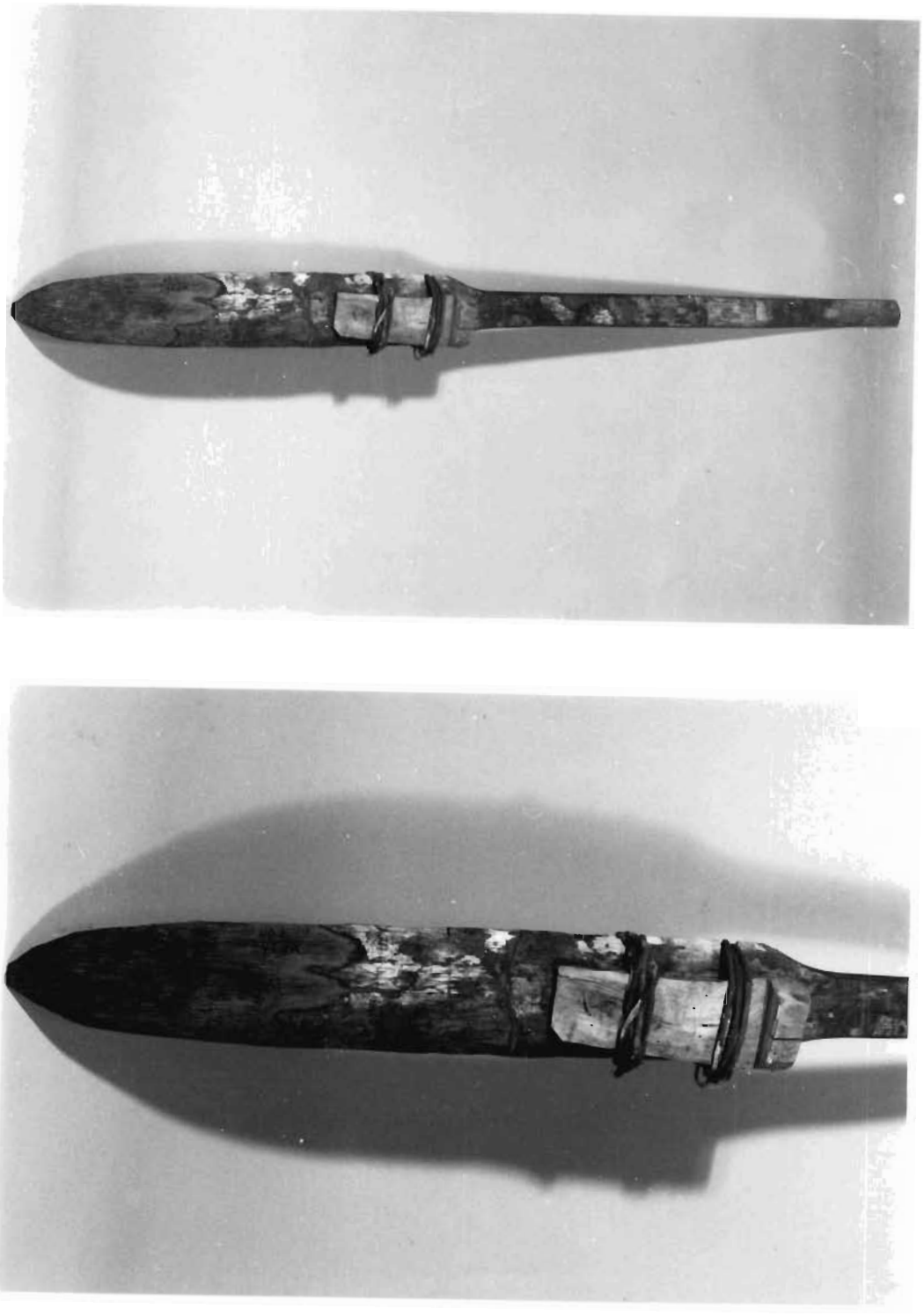


Figure 4 (upper and lower left). Close-up view of lower blade of a Type 3 board. The basal edge has a smoothened zone which lacks the rough tool marks seen elsewhere on the blade. Museo Regional de Ica.
Figure 5 (right). Wooden *taclla* or foot plow. Redrawn from Ravines 1978.



A

B

Figure 6. Champa digging stick. A: Complete stick made of carved palm wood with a vine-wrapped footrest at mid-section. B: Close-up of lower blade, frontal view. Note that the bark has only been stripped from the lower blade tip. American Museum of Natural History 40.1/2464A.

C

Figure 6, continued. Champa digging stick. C: Back view of the lower blade. American Museum of Natural History 40.1/2464A.

A B

Figure 7. Chimu-Inka ceramics. A: Pakcha or ceremonial drinking vessel, in form of a parrot perched on an ear of corn. American Museum of Natural History B/8773. B: Modeled detail from the whistling spout of a Chimu-Inka bottle. A seated individual feeds corn to a captive parrot. American Museum of Natural History 41.2/7522.