CHAPTER ONE

Introduction: High Altitude Irrigation

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Irrigation is crucial to life in the Andes. This need for water has always been obvious on the coastal plain, one of the driest deserts in the world. In this region, any human settlement beyond the barest minimum requires irrigation, essential to both household and farm, throughout the year. Pre-Columbian populations built some of the largest and most complex irrigation systems of the premodern era in this zone. They constructed canal systems that united entire valleys and sometimes connected the watersheds of more than one valley (see Kosok 1965). These irrigation systems were so prominent and important that they provided Wittfogel (1957) and Steward (1949, 1955) evidence to support their models of hydraulic society and the evolution of ancient states.

Highland irrigation is no less vital. Its importance to agriculture, however, has been masked by the semimoist environment and the modest size of the canal systems. Because it rains torrentially in most areas during the major growing season of crops, farmers irrigate only briefly, a brevity that can leave the impression

that irrigation is unimportant. This limited water, however, is necessary for the cultivation of most crops, especially maize, the single most important food in both ancient and modern diets (Mitchell 1976, 1991a; Murra 1960). These systems, moreover, provide potable water for households and livestock during much of the year.

Irrigation in the mountains is found in two distinct ecological zones: valley bottoms and highland slopes. Water for slope irrigation usually comes from small streams, springs, and the runoff from high altitude seeps, glaciers, and permanent ice caps. Because this water is scarce, its use is regulated, and farmers are unable to irrigate year-round. Valley bottom systems normally rely on small rivers, which have enough water to allow farmers to irrigate whenever they want. Taking advantage of favorable thermal conditions, most farmers in these valleys are thereby able to grow two crops a year, one in the rainy season and another in the dry season. Valley bottom systems have been studied less extensively than those on the slopes, an emphasis that is reflected in the chapters of this book.

Unlike those on the coast, highland irrigation systems (both on the slopes and in the valleys) are normally small and decentralized. Water is transmitted to fields by means of open canals either directly from the water source or indirectly via small reservoirs. Canal and reservoir construction and maintenance, water allocation and distribution, and the resolution of conflicts are often managed at the village or interhamlet level. The small size of the systems, however, does not mean that they lack complexity. Many highland irrigation structures are engineering marvels, as Seligmann and Bunker demonstrate in this volume.

Local management of irrigation does not always ensure the egalitarian distribution of water. The control of water is a key element in local stratification, and the battle over water rights is a major theme in many communities (see Gelles and Mitchell *intra*). Hacendados and powerful townspeople have often dominated the distribution of water, frequently giving water to peasants only in return for labor.

Even in those systems controlled by peasants, farmers often fight over water, and sometimes resort to force, especially when water is distributed on a first come/first served basis. Since only powerful peasants are able to mobilize significant support, they are able to obtain more water for themselves and their allies. At times of heavy demand, however, peasants use formalized distribution mechanisms that assign water to plots of land (not persons) in an organized sequence, thereby alleviating most disputes (see Gelles and Mitchell *intra*). This distribution is still not egalitarian, however. Since farmers control different amounts of land, they also control different amounts of water.

The wide geographic range of highland irrigation systems is impressive. In a 1977 survey of 99 percent of the officially recognized peasant communities in Peru, 59 percent (1,589) reported that they employed irrigation, and of these, 61 percent (970) distributed the water communally.[1] The greatest number of communities with irrigation (DCCN 1980: table 36) were in the departments of Cuzco (321), Lima (226), and Ayacucho (214). To these systems of canal irrigation should be added other forms of water control, including raised fields, sunken fields, and drained fields that had been and still are used to manage moisture and raise productivity.

Along valley bottoms many communities construct flood-control devices to prevent rainy season inundation of their fields (Mitchell 1976). Recent evidence also indicates at least one post-Columbian use of a filtration gallery, or *qanat*, in the highlands (Paucartambo), as well as a number of others on the coast (Barnes and Fleming 1991).

Variation in Andean drainage and irrigation systems is as great as that in any area of the world. Water flow patterns, physical irrigation infrastructure, and irrigation management differ greatly from village to village, even within the same drainage basin.[2] Such system diversity suggests complex interactions of environment, technology, economy, and sociopolitical organization. Nonetheless, the Andes are united by a remarkable homogeneity of culture and society, especially when compared to the diversity found in the other great mountain habitat of the world, the Himalayas (Orlove and Guillet 1985).

Since the prefarming period, Andean communities have drawn on comparable cultural and evolutionary roots. They have also had parallel conquest histories, first by local states, then by the Huari, Inca, and Spanish empires (see Sherbondy *intra*). In consequence, even though the central Andean cultural region extends through three nation-states (Bolivia, Ecuador, and Peru) and is partly found in two others (Argentina and Chile), only two indigenous languages (Quechua and Aymara) and Spanish are commonly spoken.[3] In addition, despite social and cultural differences, most highland communities share similar concepts of kinship, community organization, and religion. These resemblances extend to many of their beliefs and practices relating to irrigation. The ideology and performance of the irrigation cleaning and blessing (known as *yarqa aspiy* or *yarqa ruway*), for example, are remarkably alike in those communities where they have been described.

Variation among irrigation systems in a setting of relative cultural homogeneity allows unique opportunities for carefully controlled ecological and social comparisons (Eggan 1954; Ragin 1987). Although the authors in this volume have not deliberately set out to make such comparisons, they all consider the relationship between environment and social organization. They maintain this focus even though they also reflect their differing theoretical perspectives.

Four of the papers (those of Gelles, Guillet, Paerregaard, and Treacy) concern the Colca Valley in the department of Arequipa. Another four (those of Bolin, Seligmann and Bunker, Sherbondy, and Zimmerer) pertain to the Department of Cuzco. The paper by Mitchell examines a valley in the department of Ayacucho, an area to the north and west of these two zones, and Winterhalder's paper covers a region encompassed by a northeast-southwest transect through the Andean cordillera of southern Peru (through the departments of Cuzco, Puno, and Arequipa). This geographic distribution reflects fortuitous patterns of research during the last twenty years, rather than any methodological design. More scholars have worked in Cuzco than other areas of highland Peru. In recent years, attention has shifted to the Colca Valley. It would be useful to have additional material from the north, the eastern escarpment, the arid highland valleys of the western escarpment outside the Colca Valley, and the valley bottom areas of the inter-Andean valleys. We hope this volume will stimulate such comparative research.[4]

We have organized this volume not on the basis of geography but on thematic coherence. Winterhalder's discussion of Andean environmental variation (Chapter 2) and Sherbondy's analysis of the hydraulic organization of the Inca (Chapter 3) set the climatic and historical stage for the succeeding articles. Treacy's and Zimmerer's studies (Chapters 4-5) add to Winterhalder's discussion by providing material on the hydraulic technology used on the western and eastern escarpments of the Andes. The majority of the remaining papers deal with the political economy of irrigation. Bolin, Guillet, and Gelles (Chapters 6, 7, and 10) emphasize the relationship between the state and the local polity. Paerregaard (Chapter 8) focuses on the importance of ritual in unifying an extremely decentralized irrigation system. Seligmann and Bunker, Gelles, and Mitchell (Chapters 9, 10, and 11) consider the forces (ecological, economic, political, and social) favoring and militating against the maintenance and expansion of contemporary Andean irrigation.

VARIATION IN HIGHLAND ANDEAN WATER CONTROL SYSTEMS

Winterhalder presents data on precipitation, temperature, and the onset of thermal and rainy seasons from 69 weather stations on a cross-Andes transect, oriented northeast to southwest, perpendicular to the axis of the cordilleras. He provides an indispensable data set: precise information on the environmental variation across the Andes, quantifying the more qualitative classifications previously available to us. He demonstrates that the predictability of rainfall and minimum temperatures decreases with increased altitude; temperatures and rainfall are less predictable at higher altitudes, than they are at lower altitudes. His data illuminate the reasons for the geographic distribution of Andean irrigation systems, and he provides us with two case studies, using his environmental data to show why one community irrigates and the other does not. The importance of Winterhalder's material extends beyond the study of irrigation systems, as it illuminates the reasons for the distribution of Andean agropastoral adaptations in general, as well as the consequent patterning of population and settlements.

He groups his data into three zones: the eastern escarpment, the altiplano (we prefer the term "inter-Andean valleys"), and the western escarpment. Annual precipitation, greatest in the eastern escarpment, decreases to between 400 and 800 millimeters in the inter-Andean valleys and drops to a range of 200 to 400 millimeters in the valleys that descend the western slopes of the cordillera. The rainy season declines from 5-6 to 3-4 months as one moves from the high slopes of the eastern escarpment across the altiplano to the high slopes of the western escarpment.

Winterhalder derives several propositions from his analysis. In the inter-Andean valleys and the slopes of the western escarpment, irrigation extends the growing season and helps stabilize the irregular and often late-arriving rainfall. In the western escarpment, irrigation also augments the moisture available to crops during the growing season. In both areas, soils dampened by irrigation lower the frost risk caused by low minimum temperatures. In the eastern escarpment, where

rainfall is higher because of rising air masses from the adjacent humid Amazon basin, the role of irrigation in modifying the timing and quantity of water for agriculture is of less importance. Technology to provide drainage, however, is needed in the moist areas of this zone.[5]

These broad generalizations do not preclude substantial variation caused by local geomorphology and topography. The different exposures of the eastern escarpment, for example, create a multiplicity of microareas that vary with respect to sunlight and rain. One region may be in a rain shadow and require irrigation, whereas another, only a short distance away, has too much moisture and demands drainage. Similar variation, although perhaps less extreme, is found in the inter-Andean area and in the western escarpment. Nonetheless, the broad generalizations apply: communities located in the eastern escarpment are more likely to need drainage than those located in any of the other zones (Bruce Winterhalder, personal communication, February 20, 1992).

The papers in this volume portray areas in all three of Winterhalder's zones. Bolin and Zimmerer deal with communities in the eastern escarpment; Gelles, Guillet, Paerregaard, and Treacy consider towns in the western escarpment (all from the Colca Valley). Cuzco, described by Sherbondy, is located in the inter-Andean area. Huanoquite, the village discussed by Seligmann and Bunker, is found on the border between the inter-Andean valleys and the eastern escarpment. Mitchell's contribution from Ayacucho deals with an inter-Andean valley outside of Winterhalder's research zone, one that is farther west than all the other areas and probably much drier for that reason.

ETHNOHISTORIC MODELS OF IRRIGATION ORGANIZATION

Sherbondy's discussion of the valley of Cuzco provides striking insight into the importance of water and irrigation not only in the social organization of the Incas but also as found in social organization throughout the Andes today. The Inca drew on preexisting social forms to create their institutions of empire (Aveni and Silverman 1991; Murra 1986; Zuidema 1967). They, in turn, used these reworked institutions to reorganize the local societies that they conquered, employing the organization of the Inca capital of Cuzco as a model (Zuidema 1964). Consequently, even though the Inca empire was of short duration, lasting less than one hundred years before its conquest by the Spanish in 1532, the patterns described by Sherbondy for the Inca had (and still have) widespread applicability.

Sherbondy demonstrates that irrigation constituted an important aspect of local Inca administrative organization (see also Zuidema 1986). In the Valley of Cuzco, irrigation was fundamental to the division of the valley into two moieties, or *saya,*[6] as well as to the system of *ceque* lines (Sherbondy 1982) and the organization of the local groups known as *ayllus* and *panacas*. Except for the *ceque* system and the *panacas,* these social units have persisted (albeit with many changes).[7]

Of special importance is Sherbondy's demonstration of the hydrographic foundation of the dual divisions, or *saya,* so basic to Andean social organization.

These divisions, which are prominent in ceremonial and political organization, have close ties to irrigation. In the valley of Cuzco, the Huatanay River divided the land into two social units (*saya*): Hanan Cuzco, the right bank, faced upriver, higher in sociopolitical rank than Hurin Cuzco, the left bank. Each unit had a separate irrigation system and its own water official assigned to monitor boundaries and oversee the system. Many contemporary communities maintain a similar pattern. In the village of Quinua in the department of Ayacucho, for example, the dual division into Hanan Sayoc and Lurin Sayoc is based on the hydrography of the mountain slope, and each division uses a different drainage and irrigation system (Mitchell 1976).

The importance of irrigation to Andean social organization is demonstrated by Sherbondy's analysis of the social changes introduced by the Spanish. Although the Spanish dismembered the highest levels of Inca political organization, they retained much of the local structure associated with irrigation, native production, and access to native labor (see also Rowe 1980:94). As expediency governed the transition to colonial administration, the Spanish continued to use traditional water officials, water distribution procedures, and the irrigation calendar. The Inca *ayllus* and royal *panacas* were incorporated into the colonial parishes as social groups with corporate rights to land and water, even as they were stripped of their power as independent state institutions.

VARIATION IN HIGHLAND WATER CONTROL SYSTEMS

The remaining papers in the volume concern contemporary communities. In most of the Andes irrigation is crucial to maize cultivation, although this may not be the case in the wetter areas of the eastern escarpment.[8] In many areas, especially the Colca and Cuzco Valleys, this intensive system of cultivation is associated with terracing, a technology that we refer to as the irrigation-terracing-maize complex.

Not only is maize the premier ceremonial crop in the Andes (Murra 1960), but it also provides more protein and nearly twice the calories per unit of land than do potatoes, the second most important crop (Mitchell 1991a:80). Peasants eat maize at most meals, consuming it in fresh, parched, and milled forms. They also prepare maize beer to serve at fiestas and ceremonial work groups (Mitchell 1991b). Intrinsic to the system of social stratification, this beer is a critical prestation; the wealthy use it to get labor, and the poor demand it as an entitlement. Because maize is also easily stored and transported, its cultivation is of critical importance to the welfare of the Andean people.

Maize, however, grows only in very restricted altitude zones, ones that are not too high and cold or too low and dry. In most zones, moreover, maize requires irrigation. The same variety of maize can take six to nine months to mature, depending on altitude, but the rainy season at most altitudes of the interandean valleys and western escarpment is considerably shorter. Farmers also consider the thermal season in calculating when to plant maize. If they plant at the beginning of the rainy season (November, December, or January depending on area), maize

would still be growing in June, when cold nights can cause frost damage. This risk is lessened, and maize can mature before the frosts begin, by advancing the sowing to the relatively dry month of September by means of irrigation (Mitchell 1976, and *intra*).

The importance of seeding maize at the right time–not so early that it will dry out, and not so late that it risks late season frost–encouraged the native peoples of the Andes to create an elaborate agrarian and ritual calendar so important that it has survived the conquest largely intact (Villanueva and Sherbondy 1979: ix; Sherbondy *intra*).

Irrigation is also used to plant maize and other foods (especially cash crop potatoes) a month or so before the main planting. This dry season planting, often called the *michka,* has a limited distribution (Mitchell *intra*) because it must be irrigated every week or so, a much greater need for water than in the rainy season crop cycle (see Mitchell, Winterhalder, and Zimmerer *intra*). Few slopes in the inter-Andean Valleys or on the western escarpment have enough water to plant this crop, so that dry season foods are usually grown only in valley bottoms with abundant irrigation water (Mitchell *intra,* and n.d.).

Terracing is not always found with slope irrigation, but where it is found, it facilitates the irrigation of maize by providing a field platform onto which water can be led (see Donkin 1979; Guillet 1987; Treacy *intra*; Winterhalder *intra*). In addition to inhibiting erosion, terraces also promote the downward flow of cold air, thereby reducing the risk of frost and permitting the cultivation of maize on otherwise frost-susceptible slopes (Guillet 1987).[9]

Although maize cultivation had been widespread in the Andes before the Inca, the Inca intensified maize production by expanding irrigation and the associated system of terraces (see Murra 1960; Rowe 1946; and Wachtel 1982). In conjunction with the cultivation of potatoes and edible chenopods (Troll 1968; Guillet 1983:565), this irrigation-terracing-maize regime achieved remarkable levels of productivity, doing so in an unpredictable and otherwise low-yielding mountainous environment. The Inca introduced their system of intensive maize farming into the areas they conquered. In the Mantaro Valley, for example, local peoples moved to lower altitudes after the Inca conquest, where they began both to produce and consume more maize (Hastorf 1990; Hastorf and Earle 1985). Preliminary results of research from northwest Argentina similarly indicate that the Inca conquest initiated increased irrigation and maize production (Terence N. D'Altroy, personal communication, October 31, 1991).

The papers on the Colca Valley, found in the western escarpment in the department of Arequipa, are particularly useful in providing information on the irrigation-terracing-maize complex. Treacy, in his contribution to the volume, analyzes the interaction of irrigation and terracing in the Colca Valley village of Coporaque, focusing on the landscape engineering employed to extract and conserve available moisture. His description of this irrigation technology is one of the few available and is a notable contribution on that basis alone.[10] He also addresses several theoretical issues, making his paper an even more substantial contribution.

In Coporaque, farmers employ a metaphor of "teaching water" to describe the

process of hydraulic management. To them, water is untutored and elusive and in need of training to make it behave correctly. They do so by employing an impressive technology that ranges from the hydraulic features (both temporary and permanent) found in individual fields to permanent terraces, feeder canals, control valves, secondary distribution canals, and reservoirs that extend over a wide territory. Of these, agricultural terracing is by far the most important because of its role in the irrigation-terracing-maize complex.

Treacy emphasizes the role of terraces in controlling water flow, a consideration that leads him to broaden the definition of "terrace" to include any field that has been artificially flattened to retard the flow of water. Most scholars and development agencies have focused on the spectacular bench terraces of worked stone found in the Cuzco Valley, the Colca Valley, and elsewhere. Treacy argues, however, that these structures are not the only type of terrace, a point that Mitchell (1985) has also made for the Ayacucho valley, where even informants had overlooked the plain and rough terraces found in the village. As we have argued above, and as Winterhalder (*intra*) shows, terraces do more than slow the flow of water (see Guillet 1987), but Treacy's point is well taken. There is more to a terrace than spectacular walls.

Treacy's contribution also sheds light on the issue of the skills needed for the construction of Andean canal systems. Were the builders of the complex irrigation system in Coporaque the equivalent of hydraulic engineers with specialized knowledge? Treacy concludes they were not. The basic skills for such construction are shared by all farmers, although some are better at it than others. Canal building is the responsibility of local people who use patient "teaching" methods, perhaps organized by someone who is most skilled at managing flows, but not necessarily a specialist. He concludes that ordinary farmers were probably the builders of irrigation systems in pre-Colombian times as well.

As we will see below, Seligmann and Bunker take a different approach in their paper. They conclude that the people of Huanoquite (department of Cuzco) would have required specialists to construct their irrigation system. Perhaps the two views are not as divergent as they seem. The irrigation system in the Colca Valley is not as complex as that described by Seligmann and Bunker in Huanoquite, which entailed moving water long distances over different drainage systems and around mountains. Even bench terraces, although spectacular, do not seem to require specialized skills available only to specialists, a point that can be made not only for Peru but also for the dramatic terraces of the mountain provinces of the Philippines (Bacdayan 1974).[11] The largely tacit skills of an entire social group may transcend the skills of a single person (Bruce Winterhalder, personal communication, March 3, 1992). Consequently, we conclude that specialized engineering skills were sometimes required in the Andes, but probably infrequently.

Irrigation in Tapay, at the other end of the Colca Valley, is organized very differently from that found in surrounding communities. Instead of elaborate bench terraces and common canals, Tapay is characterized by a decentralized collection of fourteen very small irrigation systems. Each system services a small cluster of fields, each with its own separate source of water and other infrastructure. The local irrigation group also distributes water and resolves conflicts independently without

any recourse to a hierarchical or centralized organization of power.

Paerregaard argues that this acephalous collection of irrigation structures is unified by means of a complex schedule of ritual offerings (*pagos*). These offerings are proffered to water spirits at the levels of the hamlet, moiety, and village, in a repetitive cycle. The ceremonies progress along the system, advancing toward the same geographical location on Seprigina Mountain, where the critical rituals of the separate groups are celebrated at the same time. Different irrigation groups thereby come together, unifying an otherwise decentralized system. The attempt of a small group of evangelical Protestants to challenge these celebrations is used by Paerregaard to demonstrate the importance of water ceremonial in creating Tapay unity.

In this analysis, Paerregaard concurs with Treacy's conclusions about the irrigation cleaning and celebration in Coporaque. In Coporaque, during the annual cleaning of the irrigation system, the entire population ascends to the headwaters of the canal system. Splitting into moiety halves, the farmers of Urinsaya clean one branch, and those of Anansaya, the other. They descend, working as they proceed, and meet to rest and celebrate at the point where the two canals join. Then, united, they clean the main canal. For Treacy, this event symbolically represents the principle of *chu'llay,* the melding and subsuming of two sources of water into a unitary flow. The canal cleaning and ritual in Coporaque thus acts in much the same way as in Tapay: it helps create a sense of communal unity.

Environmentally very different from the Colca Valley, the eastern escarpment is characterized (according to Winterhalder) by a thermal season in the higher elevations of 8 to 12 months and a rainy season of 4 to 6 months. Absolute amounts of precipitation are significantly greater than in the inter-Andean valleys or the western escarpment. These patterns suggest that irrigation would not always be useful for extending the growing season or for augmenting available moisture. Rather, in the wet areas of this zone, one would expect to find landscape modifications and water control systems designed to drain water, especially for the cultivation of tuber crops. Recent discoveries of a host of indigenous drainage technologies to cultivate fertile but waterlogged soils support this expectation. Unfortunately, most of these drainage systems are represented only by abandoned archeological remains (Denevan et al. 1987; Erickson 1983; but see Flores Ochoa and Paz Flores 1984).

In his contribution, Zimmerer provides one of the few accounts of a functioning drained field system. Zimmerer analyzes a drained field complex in Colquepata, a community located in the intermediate altitudes of the Paucartambo highlands of southern Peru. His contribution is a significant description of wetland farming and of the role of social organization in the adoption of new technology. His paper also includes a meticulous–and thereby important–description of agricultural labor.

Colquepata cultivators drain swales (low marshy areas) to grow potatoes and other cultivars. They reduce excess moisture to agriculturally appropriate levels by draining water from the fields into gullies and rivulets through a network of canals. Household and reciprocal labor is sufficient for construction and maintenance of the fields; conflicts are few, and the system requires no centralized scheduling or

coordination. The small-scale labor organization of these drained fields approximates that found in simple canal systems, such as that of Tapay (Paerregaard *intra*).

Zimmerer's paper specifically describes the social context of technological innovation. In Colquepata, farmers use drained field cultivation to grow potatoes as a cash crop. However, the economic gain of high potato prices was not in itself sufficient to develop this new technology. Colquepata farmers were able to use preexisting agricultural skills and patterns of labor organization. They obtained the workers needed for this labor-intensive innovation through already-existing reciprocal-labor (*ayni*) and wage-labor (*jornal*) networks. These labor systems not only provided workers but also created the social conditions necessary for common patterns of construction and the rapid diffusion of the new technology throughout the community.

It is the social and physical environment, however, that explains why the people of Colquepata (but not other communities) were able to adopt the new farming methods. Unlike farmers in surrounding communities, those in Colquepata controlled their own land and labor. They were thereby free to innovate, and they were probably more willing to undertake the capital investments such innovation requires. Colquepata is also closer than surrounding communities to the Cuzco market, which significantly reduces their transport costs, further encouraging them to direct their efforts to creating new fields for cash cropping.

The lands of Colquepata also benefitted from a suitably wet habitat that allowed potato production during the dry season with a relatively simple technology. This contrasts with Mitchell's data from Ayacucho, where peasants have been unwilling to build new dams and expanded canal systems. The differences in the two areas may partly be the result of the differential labor costs (in construction, maintenance, and use) of drained field cultivation versus irrigated cultivation. Irrigated cultivation in the very dry Ayacucho Valley is more labor intensive than drainage systems, or even irrigation, in moister areas of the Andes.

IRRIGATION SYSTEMS AND THE STATE

One of the most notable processes of this century has been the general expansion of state power. Faced with the need to feed growing populations, states have increasingly attempted to improve the use of water by codifying and updating water management law and by creating improved extension services to acquaint farmers with new laws and procedures. As part of this effort, they have expanded agricultural ministries to implement the new laws and have encouraged agricultural universities and research stations to develop better methods of water transport, water distribution, and conflict resolution. The efficacy of these managerial innovations is a much discussed aspect of contemporary irrigation (Hunt 1989; Sampath and Nobe 1986; Utton and Teclaff 1978).

Peru is an excellent place to analyze the impact of state intervention on locally organized irrigation. At the beginning of this century, irrigation management had been left largely in local hands. The peasant political leadership known as the

varayoc were responsible for organizing peasant corvée labor and often supervised local irrigation systems (Mitchell 1976). Although part of the local prestige hierarchy, these leaders also served the interests of the municipality and powerful townspeople. Used as a police force in a form of indirect rule, the *varayoc* obtained labor and other resources for elites (Mitchell 1991a:149-155). In the latter half of this century, the *varayoc* have been disappearing at a rapid rate, many of their functions (including those associated with irrigation) being directly assumed by the state (Mitchell 1991a:149-155, 163-177).

Efforts in modern Peru to improve water management date from the enactment of a national water code in 1902. Designed in response to upstream-downstream problems endemic to the large-scale river-based irrigation systems of the coast, the law had a limited impact in the highlands. This isolation of the highlands from national water control was to change. In 1969, the reformist government of President Velasco enacted by decree a Water Law creating special-purpose local irrigation associations linked to a larger water management hierarchy. This law took the control of irrigation systems from local municipal bodies and transferred that control to the water users themselves, reversing a trend of town domination over water that had begun with the Spanish conquest (Guillet 1989).

The papers of Bolin, Gelles, and Guillet consider the implementation of the 1969 Water Law in highland communities. Bolin deals with the impact of the water law and of development schemes on irrigation along three canal systems in the Vilcanota Valley. Her data demonstrate the disparate responses of highland peasants to the irrigation law. Only the people along one of the canal systems that she studied have implemented the required "Regulations for Water Users" to any great extent, and even that was done incompletely. The communities along another of her canal systems have complied with the rules in a minor way, and the people along the third canal system have ignored the rules altogether.

Bolin finds that, contrary to common assumptions, governmental agencies in the Vilcanota Valley have had some positive influences on local irrigation systems. The communities along the three canal systems vary in the extent of their control–that is, autonomy–over irrigation and in the success of their irrigation management. Using Weber's model of autonomy, she concludes that, "although autonomy is essential to the organization of irrigation at the local level, irrigation management does not necessarily improve in proportion to increasing autonomy." The adequacy of the water supply and the nature of outside control are additional variables that determine such success. If water is scarce, state intervention may be crucial to provide irrigators with resources necessary to act autonomously. In Bolin's study, the community with the most local control over irrigation was also the community with the greatest amount of conflict over water; here, the important variable was adequacy of the water supply, not local control of the irrigation system.

Bolin finds that irrigators must be involved in the planning of any irrigation scheme if it is to be successful. Intervention works best when local people request development and are incorporated into the decision-making process early on, a conclusion that Gelles also reaches in his paper.

Guillet devotes his entire paper to the 1969 law and the variation in its

implementation in five communities of the Colca Valley. Although the state has successfully reorganized and reinvigorated irrigation associations in many of the agricultural villages of the valley, traditional systems of water management persist, from heavily "Incaic" Yanque (where the local irrigation systems are integrated with moiety and supramoiety organization) to the acephalous Tapay, which lacks management levels above the local irrigation groups.

Guillet suggests that the persistence of traditional irrigation organization in the Colca Valley is best explained as a rational response to farming in a stressful environment. These traditional strategies have allowed the people of the area to maintain a productive agricultural system for more than a millennium. Consequently, these arrangements should not be seen as mechanisms to combat capitalist penetration of the area (or only as this), but as systems that are valid in their own right.

By focusing on the adaptive aspect of irrigation, Guillet finds that variation in irrigation structure is in part explained by the characteristics of local water sources. Communities with moiety irrigation systems are adapting to local hydrography, a pattern like that described by Mitchell (1976) for the Ayacucho Valley. Similarly, the many springs that provide water in Tapay help explain the acephalous organization of irrigation in that community.

Guillet's and Bolin's analyses concur in several respects. In finding that the state has been unable to implement fully the management forms dictated by the Water Law, they suggest that the success of state intervention depends on its compatibility with local ecological and social needs. In effect, the state negotiates with, rather than dictates to, highland communities in the process of "rationalizing" their irrigation systems. Even following state intervention, most water management decisions remain local. Upper levels of the state-imposed hierarchy are weak and ephemeral in comparison with the viability and endurance of the community and local irrigation group.

They both conclude that the 1969 Water Law has had a beneficial effect on irrigation management by strengthening special-purpose irrigation associations. These associations now have the autonomy to elect their own authorities, officials who control water allocation, resolve disputes, and organize infrastructural improvements and maintenance. Mitchell's paper supports their contention that under certain circumstances state intervention empowers local communities. In the department of Ayacucho he found that peasants had used earlier law to wrest control of water from haciendas and to place it in the hands of an elected water board. The peasants were effective in their struggle because of the political alliances they had forged with the elected government of President Belaunde.

THE DEGRADATION AND REJUVENATION OF HIGHLAND IRRIGATION SYSTEMS

It has become clear that peasants respond not only to local pressures but also to those emanating from beyond the local social system. In many areas of the Andes

and elsewhere, local food production has declined. Understanding the reasons for this decline is of paramount importance in this period of food shortages and growing population. The contributions of Seligmann and Bunker, Gelles, and Mitchell illuminate the reasons why various communities in the Andes have had difficulty in creating and repairing their irrigation infrastructure.

In their contribution, Seligmann and Bunker analyze the degradation of the irrigation system of Huanoquite in the department of Cuzco. They demonstrate that the original construction of this canal system required much greater knowledge and labor than is available today. This technologically sophisticated irrigation system is one of the most complex ones described in the Andean literature, and its construction was an impressive achievement. Today the people of Huanoquite can no longer maintain their elaborate canal system, much less reconstruct it. Not only are they unable to field an effective labor force for canal work, but they have also lost much of the environmental knowledge and many of the skills necessary for practical repairs. Continued losses of such abilities can only lead to further degradation of the system.

Seligmann and Bunker attribute these shortcomings to political fragmentation caused by the Spanish conquest and subsequent domination of the region by haciendas. The Agrarian Reform further fragmented Huanoquite by creating competing communities and by ignoring the need to create mechanisms to recruit communal labor. Unlike irrigation systems in the Colca Valley that get water from high altitude springs and snowmelts, the Huanoquite system draws its water directly from a river. Because communities tap into the flow along the way, upstream and downstream users cannot have access to water at the same time, a situation that creates potential conflict.

Like many other communities throughout Peru and the Third World, Huanoquite has shifted from communal to individual productive strategies. Peasants expend their time and energy in market production, migration, and the education needed for cash production. They have little time to work on the irrigation system or even to learn how to make the repairs. Mitchell reaches comparable conclusions for peasants in Ayacucho, and we suspect that analogous processes are undermining rural production generally.

Seligmann and Bunker also explore the impact of oral traditions in creating and sustaining the sense of hopelessness that inhibits the ability of Huanoquiteños to maintain their irrigation system. According to these traditions, the ancient people constructed the irrigation system with the aid of supernatural power. Since the contemporary residents of Huanoquite do not have this supernatural power, they are–realistically, from the point of view of the myths–unable to rebuild it. This is an interesting account of the way in which mythology helps sustain the effects of ecological, economic, and political forces. Myth provides positive reinforcement so long as the myths reflect real processes. When they do not, when myth loses its link to social reality, the reinforcement is negative.

Gelles tells us a story that is both similar and different, for the people of the Colca Valley community of Cabanaconde have experienced both failure and success in expanding their irrigation system. They have failed in those efforts in which local

and regional elites have dominated the process, with resulting inter-class conflict. They have succeeded in those cases where the peasantry has been able to mobilize to advance its own interests without effective opposition from other communities or from elites.

The people of Cabanaconde have tried to reclaim lands since at least 1916. The local rich had made many of the earliest attempts to reclaim fallow land, but they did so through seizure rather than through purchase, a familiar story in the Andes. The peasantry successfully opposed these usurpations by refusing to irrigate the reclaimed lands. Other attempts, in this case by the peasantry, to obtain more water to reclaim abandoned land were impeded by regional politics. Competing claims over water–a rather common Andean problem–prevented the people of Cabanaconde from reconstructing an abandoned Inca canal. A proposed source of water used by a neighboring village and regional elites was effectively denied to Cabanaconde through intimidation and court action.

The picture changed in the 1980s, when Cabanaconde farmers, threatened by severe drought, illegally and forcefully linked into the Majes canal. This canal was an international development project that was designed not to provide water for the highlands, but to bring highland water to the politically powerful coast. This allocation of development funds to the export sector on the coast instead of to the peasant sector in the highlands is routine in Peru and must be seen as one of the problems obstructing highland agriculture (Mitchell 1991a:97-101).

After the people of Cabanaconde seized the initiative, the Majes personnel acquiesced and assigned water to Cabanaconde to avoid any further confrontation. Cabanaconde has used this water to reclaim abandoned terraces and other lands. Although most of this land reclamation has succeeded, some has failed. The continuing conflict between rich and poor over the land seizures earlier in the century has prevented the people of Cabanaconde from bringing all of their potentially reclaimable lands into production.

Gelles also portrays the role of the peasant method of water distribution (what he calls "the local model") in creating peasant identity and power. This system not only has important ritual meaning but is also controlled by the peasants, a control that facilitated peasant resistance to the land seizures of the local rich earlier in the century. The peasantry has opposed the full implementation of the 1969 Water Law, fearing they would lose their control of water allocation. It is one of the ironies of invented tradition (Hobsbawm and Ranger 1983), however, that this "local model" has historical roots in the hegemonic institutions imposed on Cabanaconde by the Inca and Spanish empires.

Gelles affirms–as Bolin, Guillet, Mitchell, and Seligmann and Bunker also do–that the expansion of the water supply must be seen not only as a technical problem but also as a political and social one. He concludes his paper by suggesting that the success of a land and water reclamation project depends on its appeal to the interests of the local majority instead of the local rich. Development efforts, therefore, must use the institutions and beliefs of that majority, especially the recognized peasant community and the local model of water distribution.

Although we find the notion that the majority should determine its own destiny

congenial, it would be interesting to determine the limits of Gelles's proposition. It is conceivable that under certain circumstances the majority may be unaware of its interests. The majority can also be manipulated, divided into groups acting at the behest of elite factions.

In his paper, Mitchell examines the ecology and political economy of irrigation. Like Seligmann and Bunker, he is perplexed by the seeming irrationality of underused farming resources where there is great poverty and hunger. His data show that peasants in the department of Ayacucho could produce more food if they expanded their irrigation systems, but they have not done so. The relatively arid Ayacucho Valley is one of the poorest departments in Peru (Banco Central de Reserva 1981; McClintock 1984, 1988; Mitchell 1991a:127). That the Sendero Luminoso guerilla movement had its start in this department in the early 1980s is only one of the many manifestations of the area's poverty.

Why have Ayacuchanos not expanded irrigation under conditions of economic stress? Mitchell proposes that to understand this apparent anomaly one must examine the ecology and political economy of production, which has encouraged nonfarm rather than farm work. He uses data from the District of Quinua, located about an hour by truck from the city of Ayacucho, to develop his thesis.

According to Mitchell, Quinuenos have been unable to expand irrigation because the energy investment to do so would be too costly in the dry conditions prevailing in the Ayacucho Valley, and because the relative returns on the investment would be lower than the returns on nonfarm work. Ayacucho peasants have also been constrained by the pressures of local population growth and by national and international economic conditions. Spurred by this population growth and the relative decline in the value of farm production since the 1940s, Quinuenos have migrated and entered nonfarm occupations (craft manufacture, petty trade, highway repair, and so forth) at an ever increasing rate. Since even expanded farm production would not provide them with enough food, farming has become increasingly supplemental to total household income.

Migration and nonfarm work have produced serious labor shortages, and Quinuenos are forced to choose among competing labor demands. Such labor stress, common in the Andes (Brush 1977; Collins 1988; Stadel 1989), further constrains local production. Quinuenos have responded to this strain on labor by constructing schools–the infrastructure for their new commercial roles–rather than by expanding irrigation–the infrastructure of farming. Like the rest of us, peasants must make choices apportioning scarce labor among competing demands.

Mitchell's analysis is supported by Dobyns' 1962 study of recognized communities (Dobyns 1964:57, 62, 92 and passim). In this study, only 21.2 percent of the communities had built new irrigation canals, whereas 83.6 percent of them had built new schools, and 44.7 percent of them had constructed new roads, in spite of the fact that the most frequent problem reported in the survey was aridity. The patterns Mitchell finds in Ayacucho appear to be widespread.

Mitchell's paper also highlights the impact of larger spheres on the local community. Many of the processes militating against irrigation in Ayacucho stem from decisions of national governments to favor export over local food production.

The International Monetary Fund, the World Bank, and other international bodies also tend to act in a context favoring exports over domestic food production (George 1990:96; Mitchell 1991a:98-101). Major agricultural exporters have also played a role, providing subsidies to Peru and other Third World countries to purchase their grains, thereby reducing demand for local production.

It is clear that local communities are woven into a global system that often constrains and buffets them. This world system has often fostered rural poverty, and in Peru it has encouraged the decline of rural farm production and the massive migration of peasants to Lima. The development of the Shining Path guerilla movement, the spread of cholera, and the strength of the drug trade are additional problems that can be attributed to the same processes. The losses are not Peru's alone, however. Violence and the diseases of poverty pay no heed to political boundaries. No nation is an island, and John Donne's bell tolls for us all. We write this in March 11, 1992, the month that passengers on a flight from South America to the United States were infected with cholera and on the day that the former editor of "El Diario" (New York) was gunned down in a New York restaurant, presumably by Colombian narco-gangs, in retaliation for his work in opposition to the drug trade.

Efforts to rejuvenate degraded systems of irrigation and water control must proceed on the basis of a firm understanding of the causes of degradation and a realistic appraisal of the factors that inhibit technical solutions to pressing problems of land and water. It is clear from the papers throughout the volume that technical issues are only part of the solution. Such social considerations as class relationships and the international economic system are equally important. Peasants make economic decisions that are more or less rational. They put effort into food production only when it pays them to do so.

The future success of Andean irrigation requires understanding of both peasant technologies and the ecological and economic forces constraining production. We hope this volume contributes to such knowledge, as well as to increased understanding of Andean society and irrigation in general.

NOTES

Acknowledgments. This volume began as a symposium organized for the International Congress of Americanists in 1988. The discussants at the symposium, Barbara Price and Robert Hunt, helped frame the papers with lively and illuminating comments. We also wish to thank the contributors to the volume for their efforts in the preparation of the papers and in their responses to the demands of editing.

We are very grateful to Jane Freed for her editorial assistance, to Cheryl Dake and David Syring for their help in assembling the manuscript, to Annelise Earley for preparing the figures, and to Jeffrey David Ehrenreich, General Editor of the Society for Latin American Anthropology Publication Series, for his patience and help.

Both Guillet and Mitchell have worked equally in the preparation of the conference on which the volume is based and, until the final editing, in the development of the book. In the final months of production, however, Guillet was in Spain, so that Mitchell took over major responsibility for the editing and consequently is listed first as volume editor, while Guillet is designated first author of the Introduction. Nonetheless, it is difficult to assign priority–the two editors are responsible for the overall shape of both the volume and the introduction.

We have dedicated this volume to the memory of John Treacy. His tragic death not only cut short the life of a productive and respected scholar but also left many who knew him with a great sense of loss.

We appreciate the thoughtful comments of Monica Barnes, Inge Bolin, Jane Freed, Paul Gelles, Barbara Jaye, and Bruce Winterhalder on earlier versions of this paper. The Monmouth College Grants and Sabbaticals Committee has helped in supporting some of the costs of preparing this manuscript.

1. Originally known as "indigenous communities" (*comunidades indígenas*) and later as "peasant communities" (*comunidades campesinas*), these communities are corporate entities established by law (Dobyns 1964). In 1962 there were 1,600 such communities, and in 1977 there were 2,728. The 1977 survey reached 2,716, or 99 percent of these registered communities (DCCN 1980).

2. For information on highland irrigation and drainage systems see Denevan et al. 1987; Donkin 1979; Guillet 1987; Lechtman and Soldi 1981; Mitchell 1976; Ravines 1978. In 1986 the Peruvian journal *Allpanchis* devoted two issues to highland irrigation (Nos. 27 and 28).

3. Some small groups also speak other aboriginal languages, such as Uru, Kauke, Tupe, and Chipaya. See volume 2 of *The Handbook of South American Indians* (Steward 1946) for descriptions of the various linguistic and cultural groups in the central Andes.

4. The Shining Path guerrilla movement, the military response, and the cocaine trade have made research increasingly difficult in Peru. We can only hope that the situation improves, not only for future research but for the sake of Peruvians themselves.

5. See Ravines (1978:107-188) for other descriptions of Andean irrigation technologies.

6. Although the term "moiety" is sometimes restricted to a division into two kin groupings, in the Andes scholars use the term to designate the frequent division of highland communities into two territorial groups, or *saya*. These units, pronounced differently throughout the Andes, are variously known as "Anan Cuzco" and "Urin Cuzco" in Cuzco, "Hanan Sayoc" and "Lurin Sayoc" in Ayacucho, and "Anansaya" and "Urinsaya" in the Colca Valley.

7. In their contribution to this volume, Seligmann and Bunker suggest that the *ceque* system served as a mnemonic device "for storing local environmental knowledge." In their analysis, the *ceque* system organized environmental features in a manner that "continues to provide spatial, historical, religious, and ecological orientation" to local populations, even though the Inca empire and the *ceque* system itself have long since disappeared.

8. Unfortunately, because there are very few ethnographies describing the communities of the eastern escarpment, we do not have enough information to make a clear statement about agriculture in this zone. It is likely, however, that the rainy areas of this zone may differ significantly from areas elsewhere in the Andes.

9. In the principality of Andorra and other nearby areas of the Pyrenees, Mitchell has observed nonirrigated terraces with stone retaining walls, some used for agriculture and others used for animal grazing. Both types function to prevent erosion, the animal terraces mitigating what would otherwise be substantial hoof erosion on the steep slopes. Terraces may also produce turbulence in the downward flow of air, mixing cold and warmer air and thereby reducing the risk of frost (Bruce Winterhalder, personal communication, March 3, 1992).

10. For comparable studies of western escarpment irrigation communities see Echeandía 1981; Gelles 1986; Guillet 1992; and Montoya et al. 1979.

11. Speaking of a western Bontoc group in the Philippines, Bacdayan describes the construction of a new dam and 25 kilometer canal "through the mountains with no sophisticated surveying equipment." The task was made possible only through the effective recruitment of labor and "the people's detailed familiarity with the territory from years of hunting and foraging" (1974:252).

REFERENCES CITED

Aveni, Anthony F., and Helaine Siverman

1991 "Between the Lines; Reading the Nazca Markings as Rituals Writ Large." *The Sciences* (July/August):36-42.

Bacdayan, Albert S.
1974 "Securing Water for Drying Rice Terraces: Irrigation, Community Organization, and Expanding Social Relationships in a Western Bontoc Group, Philippines." *Ethnology* 13:247-260.

Banco Central de Reserva
1981 *Mapa de pobreza del Perú 1981.* Lima: Banco Central de Reserva.

Barnes, Monica, and David Fleming
1991 "Filtration-Gallery Irrigation in the Spanish New World." *Latin American Antiquity* 2:48-68.

Brush, Stephen B.
1977 "The Myth of the Idle Peasant: Employment in a Subsistence Economy." In *Studies in Peasant Livelihood.* Rhoda Halperin and James Dow, editors, pp. 60-78. New York: St. Martin's Press.

Collins, Jane
1988 *Unseasonal Migrations: The Effects of Rural Labor Scarcity in Peru.* Princeton: Princeton University Press.

DCCN (Dirección de Comunidades Campesinas y Nativas)
1980 *Comunidades campesinas del Perú Información básica.* Lima: Dirección de Comunidades Campesinas y Nativas, Ministerio de Agricultura y Alimentación.

Denevan, William M., Kent Mathewson, and Gregory Knapp, editors.
1987 *Pre-Hispanic Agricultural Fields in the Andean Region.* International Series 359. Oxford: British Archaeological Reports (BAR).

Dobyns, Henry F.
1964 *The Social Matrix of Peruvian Indigenous Communities.* Cornell Peru Project Monograph. Ithaca: Department of Anthropology, Cornell University.

Donkin, Robin A.
1979 *Agricultural Terracing in the Aboriginal New World.* Tucson: University of Arizona Press.

Echeandía, Juan
1981 *Tecnología y cambios en la comunidad de San Pedro de Casta.* Lima: Universidad Nacional Mayor de San Marcos.

Eggan, Fred
1954 "Social Anthropology and the Method of Controlled Comparison." *American Anthropologist* 56:743-763.

Erickson, Clark L.
1983 *An Archaeological Investigation of Raised Field Agriculture in the Lake Titicaca Basin of Peru.* Ph.D dissertation, University of Illinois, Urbana.

Flores Ochoa, Jorge, and Percy Paz Flores
1984 "El cultivo en qocha en la puna sur andina." In *Contribuciones a los estudios de los andes centrales.* Shozo Masuda, editor, pp. 59-100. Tokyo: University of Tokyo Press.

Gelles, Paul
1986 "Sociedades hidraulicas en los Andes; algunas perspectivas desde Huarochirí." *Allpanchis* 27:99-147.

George, Susan
1990 *A Fate Worse than Debt* (revised edition). New York: Grove Weidenfeld.

Guillet, David
1983 "Toward a Cultural Ecology of Mountains: The Andes and the Himalayas Compared." *Current Anthropology* 24:561-574.
1987 "Terracing and Irrigation in the Peruvian Highlands." *Current Anthropology* 28(4):409-430.
1989 "The Struggle for Autonomy: Irrigation and Power in Highland Peru." In *Human Systems Ecology.* Sheldon Smith and Ed Reeves, editors, pp. 41-57. Boulder, CO: Westview Press.
1992 *Covering Ground: Communal Water Management and the State in Highland Peru.* Ann Arbor: University of Michigan Press.

Hastorf, Christine
1990 "The Effect of the Inka State on Sausa Agricultural Production and Crop Consumption." *American Antiquity* 55:262-290.

Hastorf, Christine, and Timothy Earle
1985 "Intensive Agriculture and the Geography of Political Change in the Upper Mantaro Region of Central Peru." In *Prehistoric Intensive Agriculture in the Tropics*. International Series 232. Ian Farrington, editor, pp. 569-595. Oxford: British Archaeological Reports (BAR).

Hobsbawm, Eric, and Terence Ranger, editors
1983 *The Invention of Tradition*. Cambridge: Cambridge University Press.

Hunt, Robert C.
1989 "Appropriate Social Organization? Water Users Associations in Bureaucratic Canal Irrigation Systems." *Human Organization* 48:79-90.

Kosok, Paul
1965 *Life, Land and Water in Ancient Peru*. New York: Long Island University Press.

Lechtman, Heather, and Ana María Soldi
1981 *Runakunap kawsayninkupaq rurasqankunaqa. La tecnología en el mundo andino*. Mexico, DF: Universidad Nacional Autonoma de Mexico.

McClintock, Cynthia
1984 "Why Peasants Rebel: The Case of Peru's Sendero Luminoso." *World Politics* 37:48-84.
1988 "Peru's Sendero Luminoso Rebellion: Origins and Trajectory." In *Power and Popular Protest: Latin American Social Movements*. Susan Eckstein, editor, pp. 61-101. Berkeley: University of California Press.

Mitchell, William P.
1976 "Irrigation and Community in the Central Peruvian Highlands." *American Anthropologist* 78:25-44.
1985 "On Terracing in the Andes." *Current Anthropology* 26:288-289.
1991a *Peasants on the Edge: Crop, Cult, and Crisis in the Andes*. Austin: University of Texas Press.
1991b "Some Are More Equal Than Others: Labor Supply, Reciprocity, and Redistribution in the Andes." *Research in Economic Anthropology* 13:191-219.
n.d. "Multizone Agriculture in an Andean Village." In *Ayacucho Archeological-Botanical Project*, Volume 1, Richard S. MacNeish, editor. Ann Arbor: University of Michigan Press. In press.

Montoya, Rodrigo, María J. Silveira, and Felipe J. Lindoso
1979 *Producción parcelaría y universo ideológico: el caso de Puquío*. Lima: Mosca Azul.

Murra, John V.
1960 "Rite and Crop in the Inca State." In *Culture and History: Essays in Honor of Paul Radin*. Stanley Diamond, editor, pp. 393-407. New York: Columbia University Press.
1986 "The Expansion of the Inka State: Armies, War, and Rebellions." In *Anthropological History of Andean Polities*. John V. Murra, Nathan Wachtel, and Jacques Revel, editors, pp. 49-58. Cambridge: Cambridge University Press.

Orlove, Benjamin S., and David W. Guillet
1985 "Theoretical and Methodological Considerations on the Study of Mountain Peoples: Reflections on the Idea of Subsistence Type and the Role of History in Human Ecology." *Mountain Research and Development* 5(1):3-18.

Ragin, Charles C.
1987 *The Comparative Method*. Berkeley: University of California Press.

Ravines, Rogger, editor
1978 *Tecnología andina*. Lima: Instituto de Estudios Peruanos.

Rowe, John Howland
1946 "Inca Culture at the Time of the Spanish Conquest." In *Handbook of South American Indians*, Volume 2. Julian Steward, editor, pp. 183-330. Washington, DC: Bureau of American Ethnology. Bulletin 143.