From Columbus to Acosta: Science, Geography, and the New World

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Abstract. What is called the Age of Discovery evokes images of voyages, nautical skills, and maps. Yet the European encounter with the Americas also led to an intellectual confrontation with the natural history and ethnography of a "new" world. Contrary to the prevailing view of intellectual stasis, this confrontation provoked novel methods of empirical description, organization, analysis, and synthesis as Medieval deductivism and Classical ontogenies proved to be inadequate. This essay demonstrates how the agents of that encounter—sailors, soldiers, government officials, and missionaries—made sense of these new lands and peoples; it highlights seven methodological spheres, by examining the work of exemplary individuals who illustrate the diverse backgrounds, abilities, and interests characteristic of the period. These examples include the observational skills of Columbus in 1492, the landscape taxonomy of his son Fernando, the biotic taxonomy of Oviedo, the cultural recording of Sahagún, the regional geography of Cieza, the pervasive role of Velasco in both geographical synthesis and town planning at the government level, and finally, the overarching scientific framework for the natural history and peoples of the New World proposed by Acosta in 1590. The evidence rehabilitates the reputation of Columbus who, like so many others with little or no formal education, had a spontaneous capacity to observe and describe. The origins of Native American stereotypes are identified, but there also were remarkable "insider" studies that, in the case of Sahagún, touched upon the semiotics of culture and landscape. Although Sahagún and Acosta had scholarly training, the confrontation with new environments and unfamiliar peoples probably put observers with rural backgrounds on an equal footing with those steeped in traditional academic curricula. Last but not least, the essay points up the enormity of the primary documentation, compiled by these Spanish contributors during the century after 1492, most of it awaiting geographical reappraisal.

Key Words: Acosta, Columbus, ethnography, geographical planning, gridiron towns, history of science, landforms, López de Velasco, natural history, New World landscapes, Oviedo, *relaciones geográficas,* Renaissance, Sahagún, Spanish geography.

> The world is so vast and beautiful, and contains so many things, each different from the other . . .
>
> —Francisco López de Gómara (1552)

Renaissance Science

THE European encounter with the Americas in 1492 falls within what Western historians call the Age of Discovery. Humanists have long been fascinated with that encounter as a source of myths and images (Green 1968, III, pt. 1; Gerbi 1985; Greenblatt 1991). Historians of science in general and of geography in particular are preoccupied with navigation and cartography (Kimble 1938, chaps. 5, 9–10; Parry 1981; James and Martin 1981, 63–95; Nebenzahl 1990; Harley 1990; Buisseret 1992). The thesis of this essay is that the Spanish encounter with the New World also had a far-ranging impact on environmental and cultural understanding.

The boundless enthusiasm with which the first writers described the landscapes and biota of the New World was integral to the Renais-

sance, or reawakening of Western civilization. That Renaissance marked an uneasy transition from the Medieval to the modern world, characterized by many cross-currents of thought and expression. One hallmark of the Renaissance was the rediscovery of Classical writings during the fourteenth and fifteenth centuries and their translation from Greek into Latin, as a new source of information, ideas, and esthetic prototypes. But the resulting humanistic resurgence did not immediately lead to more critical analysis, let alone philosophical reassessment. The deference once given to the Bible or Christian theological authority shifted to that of leading Classical scholars, but empirical contradictions to "new" authorities such as Aristotle were only offered with hesitation. At its worst, the rediscovery of Antiquity led to an unproductive antiquarianism that took precedence over new observations and stifled intellectual progress.

Medieval science had already included a component of empirical, practical observation, but was dominated by scholastic discussions or the excerpting of older texts, seldom introducing materials derived from personal observation. The three realms of natural history, consisting of animals, plants, and minerals, had been studied in a compartmentalized fashion, without a grasp of fundamental interconnections, except as an expression of a divine plan. In many ways it was a period of introverted reflection on the self-sufficient truths provided by theology, and the individual was part of an ahistorical cycle of life and death, of suffering in the present and anticipated reward in the hereafter.

The rediscovery of Antiquity provided a new sense of history, identifying new role models of scholars—not only soldiers or kings—who had made their mark in a secular world of the living. Renaissance scholarship included individuals who were motivated and willing to embark on a new search, with a fresh curiosity. Only a minority of these had both the talent and boldness to emphasize the empirical and the inductive, to reexamine deductive theories critically, and to draw conclusions from direct observation or experiment. Although time-honored religious beliefs set constraints to discussion, the Renaissance was the beginning of a spirit of free enquiry, with renewed interest in verification, accuracy, and systematic understanding.

It can be debated whether Renaissance geography was the revitalization of a Classical tradition or the spontaneous product of a new intellectual climate. Two personalities of the later Middle Ages illustrate the problem. In 1410, the French Cardinal d'Ailly (1948) wrote a world description based almost exclusively on Classical sources; it begins with a series of interesting figures for the astronomical subdivision of the globe, but his regional chapters are a mix of old fables and obsolete toponyms, for which endless fictional or mythological explanations are offered. Quite unaffected by such ballast from Antiquity, the Venetian merchant-traveler Marco Polo (1958) left a remarkable account of his travels in Asia (1271–95) that includes vivid descriptions of landscapes and cultural patterns.[1] Pierre D'Ailly and Marco Polo represent two extremes among precursors of the Renaissance, but the pattern remained.[2] My point is not that intellectual roots are unimportant, but that the prevalent Renaissance paradigm overemphasizes the significance of Classical antiquity, to the degree that it obscures the acuity and originality of Renaissance observational skills and comprehension.

The discoverers, explorers, and observational scientists of the Renaissance were at best familiar with a very limited selection of Classical works, that were frequently cited only for effect, sometimes in the final stages of revision (see Cieza de León 1984, xxxiii, n. 12). Strabo, an available and obvious source, was barely used, and Columbus's consultation appears to have been very selective and from a derivative digest in his possession (see Broc 1980, 18, 200; Harley 1990, 37, 42). More influential was Pliny's *Natural History* (1940–56), the *de facto* encyclopedia of the Renaissance (Broc 1980, 15). For cartography and navigation, the tables of geographical coordinates by Ptolemy (1932), and the maps attributed to him, provided a direct or indirect datum for most large-scale charts from the mid-1300s to the early 1500s.[3]

Geography during this period was a part of what was called *cosmography* (Waldseemüller 1966), which included astronomy and nautical science, particularly as applied to cartography. But between Waldseemüller writing in 1507 and Münster (1968) in 1550, cosmography also began to include what today would be called physical and cultural geography.

The present paper is directed to the origins, rapid growth, and crystallization of physical

and cultural geography as a consequence of the Columbian Encounter. My argument is that the European discovery of the New World required new observational and descriptive skills, as well as explicit discussion of environmental and cultural phenomena that could no longer be taken for granted: things were either different or similar on the other side of the ocean. Geomorphology soon received a degree of attention that it had never been accorded in Antiquity, and biogeography was reinvigorated. Ethnographic observations gradually added greater depth to the appreciation of cultural phenomena, and these several geographical strands were integrated into what could be called regional geography. All of this was abetted by the Spanish government's official role in normative urban planning.

The study focuses on Spain and the New World, rather than on research developments in other parts of Europe. Renaissance geography in Italy, Germany, and France has received some attention (e.g., Baker 1963; Beck 1973; Broc 1980), but the originality and quality of Spanish geography during the period has been underappreciated, even by Spanish authors (see Becker 1917; Martínez 1945; Aríja 1972, versus Menéndez Pidal 1944), The emphasis is necessarily selective, and several key authors have been chosen for closer examination. This focus on individuals is not an attempt to create new icons; it is essential to elucidate the interests, abilities, and limitations of the period. The differences among the individuals selected also reveal the degree to which the evolution of sixteenth-century Spanish geography was multilinear, not unilinear. Geography itself was the unifying theme, rather than a by-product of this scientific evolution.

Observation: Christopher Columbus

The discovery of the New World initiated an unprecedented interest in geography and natural history. Somehow, earlier maritime discoveries by Europeans had failed to generate evocative reports of new lands and peoples. Even the exploration of West Africa instigated by Portugal's Prince Henry "the Navigator" (see Fernández Armesto 1987, 185–200) led to such dreary works as the *Crónica da Guiné* (Beazley and Prestage 1896–98), a leaden saga of seafaring and slave hunting activities from 1434–48, punctuated by incidental comments on indigenous customs; only its commercial prospects stirred interest in Portugal. To the credit of Columbus (Cristóbal Colón), his voyage of 1492 inspired much more than additional coastlines on the portolan charts. Even though he thought he was in East Asia, Columbus recognized the novelty of the landscapes, flora, and people on the other side of the ocean. However observant were other captains or ship's pilots of the period, they lacked his ability to describe the novel in ways that would excite academic and lay curiosity in Europe.[4]

Columbus's credentials as a scientific figure have long seemed unimpressive to his critics. Born 1451 in Genoa under modest circumstances (his father was a weaver), he went to sea as early as age fourteen. During the mid-1470s he sailed the Mediterranean, perhaps on a galley in the service of France; about 1476–84 he was based in Lisbon and the Madeiras, sailing to West Africa, probably with slavers.[5] All we have to attest to his learning are the surviving letters in his handwriting (see facsimiles reproduced in Thacher 1967, III, 84–490; with discussion in Varela 1982, li–lvii); his script was bold and sophisticated, varying in execution according to the formality of the occasion, and comparable to that of educated scribes and notaries of the time.[6] Any doubts about Columbus's ability as a cartographer and geometer are laid to rest by one of his diagrams showing a three-dimensional projection, converted from a sphere to a plane (see Harley 1990, 42, Fig. 36), which is found among his annotated copies of Ptolemy, Marco Polo, and D'Ailly (see Taviani 1985, 446–55; Harley 1990, 34–43). His report on the Third Voyage (1498–1500) also makes numerous references to Classical authors then only available in Latin (see Las Casas 1965, I, 482–96).

Columbus was essentially self-taught, as he admitted in a letter of 1501 to the monarchs of Spain:

> In navigation [God] endowed me generously, of astronomy he gave me what was needed, and the same of geometry and arithmetic, with the talent of mind and hand to draw this globe and upon it the cities, rivers and mountains, islands and ports, all in their proper place (Varela 1982, 251; Las Casas 1965, I, 31) (all translations by author).

Accordingly, he hewed to a pragmatic, cartographic tradition of the period, one concerned

with the making of geographically realistic maps intended for the practical world of navigation (see Campbell 1987).[7]

Columbus's insight and intellectual impact deserve more sympathy than has been accorded him by Carl Sauer (1966, chap. 2) and Kirkpatrick Sale (1990, chap. 5), Whatever his motives and however annoying his use of hyperbole, Columbus attempted to inform about the new lands he saw. His descriptions of the people and their lifeways, incidental to his narratives about encounters with the indigenous inhabitants, contain much useful ethnographic information (see Sauer 1966, chap. 3) and novel insights on the physical environments of the New World.

Columbus was untutored in the sciences, and his lack of botanical knowledge frustrated him: "I believe there are many plants and trees (in the Bahamas) worth much in Spain as dyes or medicinals but I do not recognize them, which I greatly regret" (see Spanish transcription of the First Voyage diary, by Dunn and Kelley [1988, folio 15 recto, lines 25–28]). But his lack of formal training did not prevent his from venturing comparisons of the New World palms with those of West Africa or the Mediterranean: "They have a great number of palms of a different kind than those of Guinea or our own, of medium height, with smooth trunks and very large fronds" (Dunn and Kelley 1988, folio 18 recto, 13–16), nor from recognizing six to eight different classes of palms (1493 letter in Varela 1982, 141). He also noted the distinctiveness of the trees, fruits, and plants of Cuba and of Hispaniola (see Varela 1983, 141). And he commented on the unusual association of pines and palms growing in one river valley (*vega*), whose surface alternated between level hills (*montes llanos*) and low plains (*baxos*) (Dunn and Kelley 1988, folio 29 recto, 26–28; see also Humboldt 1845–47, II, 56).

He likewise demonstrated an intuitive grasp of geomorphology. He found it remarkable that the steep slopes of tall mountains were densely vegetated and not rocky (Nov. 14 and 26, 1492), and that broad rivers debouching into the sea lacked sand or gravel bars (Nov. 27), both phenomena that we would now attribute to deep tropical weathering. On another occasion he defined a *cala* (a local term for drowned valleys of the Balearic Islands and Sardinia; see Butzer 1962) as "a narrow inlet where sea water enters the land" (Dunn and Kelley 1988, folio 24 vuelto 45–25 recto 1). Two sources derived from the lost diary of the Second Voyage (1493–96) offer the first description of a mangrove coast on the southern shores of Cuba; it was replete with *ciénegas* and swamps for two leagues inland, with almost impenetrable thickets of plants and trees (F. Colón 1984, 189). "According to Columbus this region is completely submerged and covered with water and its coasts are marshy and full of trees" (Martyr 1964, 139).

Finally, there are Columbus's instructive, if debatable, climatological ideas. He explained the great heat of the Bahamas by their low elevation and the prevailing easterly winds (Oct. 29). On the daily tropical showers, he noted that late in every day a cloud bank formed on the western part of Jamaica, resulting in rain for an hour or less; this he attributed to the great forests of the island, with reference to his previous experience on the Canaries, Madeiras, and Azores (July 1494, F. Colón 1984, 193–94). He appended a remarkable ecological note. On those Atlantic islands, "they have cut so much forest and trees that hindered them [from expanding cultivation] that such clouds and rains no longer form as they once used to." The observation is telling because it shows that Columbus was aware of and concerned about environmental degradation on the recently-settled Madeira islands.

Much in the manner of more recent field observers, Columbus repeatedly drew analogies between the Old World and the New: a similar tree but with larger leaves than a counterpart on an Aegean Island (Nov. 12); live oaks and arbutus (*madroños*) as in Castile (Dec. 7), healthy river waters as compared with pestilential ones of Guinea (Nov. 27), finely cultivated lands recalling the plains of Córdoba (Dec. 14), weather like April in Castile (Dec. 13), or mountains like those of Sicily (Oct. 28).

Some of the comparisons were motivated by natural curiosity, others by economics, and others still by sheer aesthetics. They give point to his verbal paintings of an exuberant tropical vegetation, nourished by an eternally spring-like climate, and inhabited by peaceful and naked innocents. Columbus thus created an image of an Edenic land that was at once primitive yet familiar, and in so doing his rhetorical analogies delineated a powerful theme in European humanistic thought. He demonstrated an ability to observe, compare, and describe, and

there are suggestions of partial comprehension.[8] It was his articulation and dissemination of his ideas, his way of putting words together, and his rhetoric that provoked scientific interest in a New World that he himself refused to believe was new. Columbus, though at times a medieval visionary and mystic and given to Biblical metaphors and prophecies, demonstrated tenacity as an explorer and a longing for greatness and discovery that mark him as typically modern and, in thought, action, and results, unlike other of the great personages of the Middle Ages (Gerbi 1985, 13).

Landscape Taxonomy: Fernando Colón

Fernando, born out of wedlock in Córdoba in 1488, was the son of Columbus who had intellectual ambitions, and who had a profound, if little-known, impact on Spanish geography for a century. At the age of five he saw his father off at the docks of Sevilla, and aboard the Fourth Voyage he served as chronicler in 1502–04 (F. Colón 1984, 162, 288). In between, he was a page at the royal court and privately tutored, in part by a key historian of the voyages, the Italian humanist Peter Martyr (c. 1458–1526). At least some of the natural history observations on the Central American coasts were probably made by Fernando, including the first description of pineapples (F. Colón 1984, 317). He was on Hispaniola in 1509, after which he was sent to Castile to study, "because he was inclined to the sciences and had many books" (Las Casas 1965, II, 370). Indeed, he spent much of 1512–16 studying at the Spanish Franciscan monastery in Rome, under the humanist Pedro de Salamanca (De la Rosa 1906; Ponsot and Drain 1966).

Fernando was precocious by any standards. He was captain-general of the fleet sailing back from Hispaniola in 1509; a year later he began the complex lawsuits against the crown, in regard to the titles and New World revenues due to the heirs of Columbus, who had died wealthy but frustrated in 1506; he proposed a circumnavigation of the globe a decade before Magellan; and in 1517 he began what was probably the most ambitious national project yet conceived for Spain, a countrywide geographical survey.

Although this project was designed for and executed in Spain, it later had great impact on physical observation in the Americas. As reconstructed from the surviving materials (F. Colón 1908–15), its purpose was to:

(a) Inventory all settlements, their dependencies or abandoned sites, any castles or monasteries, the distance to the municipal boundaries in different quadrants, and the jurisdiction (royal, aristocratic, monastic) to which they belonged.
(b) Determine the number of resident households (*vecinos*), presumably as based on local tax rolls and provided by the town councils.
(c) Record the quality of land in each territory (*casco*); this included location with respect to rivers and mountains, types of land use, and over 15 more-or-less standardized categories of topography and natural or spontaneous vegetations (Table 1). These characteristics were recorded along all roads in all directions, specifying rough distances to each change of land use or landscape, hence the designation of the project as an *Itinerario* (Itinerary).

This effort was funded by the crown, with salaries paid to a team of assistants who traveled around the country, following explicit but lost guidelines, presumably issued by Fernando.

Close to 10,000 settlements (perhaps 80 percent of those in Spain at the time) were inventoried before the project was terminated by royal decree in 1523, possibly in retaliation for a renewed round of litigation against the government initiated by Fernando in that year (De la Rosa 1906; Ponsot and Drain 1966; Arranz, in F. Colón 1984, 17). Incomplete and lacking official sanction, the results were never collated into the planned, alphabetical gazetteer (*Vocabulario*), from which a land use and physical map of Spain apparently was to be constructed. The notebooks of raw data were left to gather dust in the remarkable private library of 15,300 volumes and manuscripts that Fernando left behind at his death in 1539. When that library was rescued, at the end of the nineteenth century, only 4,400 of the town inventories and 5,000 of Fernando's books had survived.

Nothing like the Itinerary had ever been conceived before. However abortive or premature it may have been, this sophisticated geograph-

ical survey represents the first attempt to develop and implement a comprehensive field approach to the cultural and physical landscape.

Without questioning the pivotal role of Fernando in conceptualizing his geographical survey, the concepts and terminology used (Table 1) do not seem to have been his own. In his biography of Columbus, Fernando Colón (1984) employed a fairly sophisticated geomorphologic vocabulary, including terms such as *montaña, collado* (hill), *peña* (hilltop, cliff), *llanura* (plain), *planicie* (plane), *ciénega* (marsh), *fango* (swamp), *arroyo, espalda* (high slope, mountain crest), *peñascosa* (cliffed), *pedregosa* (rocky) and *quebrada* (broken topography), none of which are used in the Itinerary (Table 1). Only *llano, cerro,* and *aspera* are common to both, while *sierra, loma, cuesta, derribadero,* and *doblado* are exclusively found in the Itinerary. Most important, *monte* in the Itinerary is exclusively used in the traditional Spanish sense of scrub or woodland vegetation, whereas for Fernando it was a hill or low mountain, equivalent to *cerro*. This suggests that the vocabulary and possibly also the systematic approach should be credited to unidentified Spanish collaborators. Certainly the vegetation categories are those of Spaniards with rural backgrounds and, not surprisingly, none of these terms are used by Colón (1984) in his Caribbean accounts.

The only potential consultants of Fernando that can be identified are Pedro de Salamanca, whom he met in Madrid in June 1517, or Antonio de Nebríja, whom he consulted at the University of Alcalá at about the same time, six weeks before he began the Itinerary (De la Rosa 1906).[9] Nebríja (died 1522), is better known for first attempting to standardize Castilian Spanish as a written language (Green 1968, III, 11–18), but he also had geographical interests: he wrote on atmospheric pressure, worked on navigational instrumentation, and assembled an ambitious chart for the longitudes of Spanish cities, based on true time differences between them (Becker 1917, 96, 122; López Piñero 1979, 213–14). He may have stimulated or encouraged Fernando to attempt a national project, but he had no evident background in geomorphology or botany. One must assume that pragmatic Spanish rural experience was critical in developing the biophysical criteria central to Fernando's conception.

Table 1. Land Use and Landscape Classes Utilized for the Geographical Survey of Spain (1517) by Fernando Colón[a]

Arable land
Wheat cultivation (*tierra de pan* or *labores, labranza*)
Olive groves (*olivares*)
Vineyards (*viñas*)
Irrigated tracts (*huertas*)
Minor categories, including almond, fig, citrus, apple, etc. orchards or groves
Grazing land and degraded woodland (*monte bajo*)
Designated pastures (*dehesa*)
Rough grass and shrub (*espartinas, monte de atocha*)
Sclerophyllous scrub (*lentiscales, romerales, matorrales*)
Thorny scrub (*montes jarales*)
Scrub oak (*chaparrales, marañales, carrascojas*)
Palmetto scrub, possibly abandoned farm land (*palmares*)
Rocky surfaces with shrubs (*berrocales*)
Primary or secondary forest (*monte alto*)
Deciduous oak (*robledal*)
Live oak (*encinal, carrascal*)
Cork oak (*alcornocal*)
Pine (*pinal, pinar*)
Topography and landforms
Floodplain (*llano de ribera del rio, vega*)
Level plain (*llano, tierra llana, campiña*)
Irregular plain (*tierra doblada*)
Rough, dissected topography (*tierra aspera* or *derribadera*)
Flat-topped hill (*loma*)
Hill or peak (*cerro*)
Mountain and valley country (*sierras y valles*)
Escarpment (*cuesta*)

[a]Derived from F. Colón (1908–15); see also De la Rosa (1906); Ponsot and Drain (1966); Butzer (1988).

Fernando's project, probably conceived within a broader Spanish interest in the basic geography of the New World colonies (see Jiménez 1965, I, 11–37, 267–77), was closely replicated in New Spain in 1547–51 when emissaries were sent out from Mexico City to assemble detailed information on each Indian settlement for taxation purposes. Some 940 such reports, consisting of a paragraph or two of compact data, are preserved and known as the *Suma de Visitas* (Paso y Troncoso 1905a; also Borah and Cook 1960). No dated decree or official explanation is known.

Most of the *Suma* accounts gave the number of taxable households, the dimensions of the

lands belonging to the town, and the nature of Indian agriculture and handicrafts (as liable for taxes in kind), together with a description of the topographic setting—*llano, espalda, sierra,* and *fragosa* (rugged) are common terms. Vegetation was characterized by such words as *sabana* (open parkland) or *monte* (woodland); when trees were suitable for timber or firewood, the accounts may specify oak, pine, or key tropical forms. Other features noted include potential pastures for livestock, the presence of wet lowlands (*ciénegas*), and springs or rivers suitable for irrigation. The similarities with Fernando's project are too close to be coincidental, demonstrating that the idea of the geographical survey was by no means forgotten in the deliberations of government at the highest level. Surprising, too, is the implication that lower-placed officials had the competence to make reliable observations of great value for the landscape reconstruction of sixteenth-century Mexico (see Butzer and Butzer forthcoming).

Biotic Taxonomy: Oviedo

Scientific research only began in the New World thirty years after Columbus's fateful voyage, and it was initiated by an unlikely source. Gonzalo Fernández de Oviedo (1478–1557) was a royal official with humanistic credentials who once translated a novel of chivalrous love into Spanish. Raised at the Spanish court, he spent three years as a soldier in Italy, where he became an aficionado of the arts before settling in as a retainer and notary. But at age thirty-five, he was sent to Panama as royal inspector for the gold foundries, and from 1513–47, he spent twenty years in the New World, working in Central America, Hispaniola, and Colombia (Pérez, in Fernández de Oviedo 1959, I, xvi–ccxxxvi). From 1522 onward he devoted a dozen years preoccupied with natural history,[10] for which he lacked any formal training. While in Madrid in 1525, without his records in hand, he wrote a "summary" volume on the natural history of the Indies (Fernández de Oviedo 1950), and in 1535 this was republished in expanded form as the cornerstone of his massive study (410 of 1,900 printed pages, Fernández de Oviedo 1959). Oviedo completed the whole work at age 71. But he clashed repeatedly with Bishop Las Casas over the character of the New World Indians, whom he had refused to idealize, and Las Casas intervened to effectively stop publication of the remaining volumes (see Hanke, in Las Casas 1965, I, xxii–xxiii), which were not printed until the 1850s.

The bulk of Oviedo's work is devoted to the history of Spanish exploration and conquest, but even his derivative accounts single out important geographic and biotic data, such as the comparison of the cold-temperate biota of Patagonia and Newfoundland (Alvarez 1957). For areas Oviedo knew first hand, his accounts are substantive as well as evocative; they teem with nostalgic, comparative images of townscapes and landscapes in Spain or Italy (Gerbi 1985, 188–94). In an era when academics wrote in restrained Latin, Oviedo deliberately presented his materials in Spanish, salting his text with vignettes of Spanish abuse of the Indians, quips about greedy clerics or armchair historians, and candid personal anecdotes. His enthusiasm for the natural world is illustrated by an incident from his travels between Panama and Nicaragua (August 1527). Spotting what he thought were live oaks, in the mountains above the Gulf of Nicoya, he noted that the trees had no acorns. So he stopped his party and had his companions search the ground around the trees until they found a dozen acorns:

> And I ate them, though they were somewhat dry; and they were no more nor less than in Spain—live oaks in terms of the tree and the leaf, as well as the fruit (Fernández de Oviedo 1959, I, 298).

It is probably fair to say that Oviedo possessed modest abilities for synthetic interpretation, and that his primary contribution in natural history was analytical and systematic. Several broad themes preoccupied him:

(a) Domesticated indigenous plants and their utilization by the Indians (book 7);
(b) Wild food or fiber plants, manipulated and exploited by the Indians (book 8);
(c) Taxonomic comparison of neotropical trees and plants with those of the Mediterranean realm, according to physiognomy, leaf arrangements, leaf morphology, and fruits (books 9 and 11);
(d) Recognition of those genera or families with European counterparts, e.g., cherries, grapes, nut trees, pines, oaks, palms;
(e) Inventories of the neotropical fauna, organ-

ized under the categories of quadrupeds (book 12), fishes (book 13), birds (book 14), and insects (book 15), with the recognition that most, but not all, of these diverse animals belonged to families represented in the Old World.

Oviedo was the first to confront the dazzling profusion of unfamiliar plants and animals that made New World biogeography so daunting a subject. Excited but unperturbed, he imposed order through a taxonomy which organized life forms into morphological classes and delineated commonalities and differences with Old World forms. For unfamiliar genera or families, he applied indigenous names that, at the time, were rapidly acquiring an almost universal currency in the tropical colonies of Spain (J. D. Sauer 1976)—the "folk taxonomy" that was generally practiced before the binomial Linnaean classification. His natural history was published promptly, translated into several European languages, and had a profound scientific impact.

Oviedo modeled his taxonomy on Pliny (1940–56), with whom he was familiar, rather than on Theophrastus's more sophisticated conception of plant morphology and ecology, which he did not know. But unlike Pliny, Oviedo's descriptions and organization were based on years of empirical observation, guided by two firm principles: accuracy and inductive approach.[11] By virtue of his lack of formal training, Oviedo broke the mold of Medieval herbalists, who organized their plants alphabetically, not comparatively (Alvarez 1957).[12] In consequence, he offered a bold, biological macro-framework for the New World as well as the first systematic study of natural history since the time of Pliny (first century A.D.).

Although Oviedo seems not to have understood the principles of ecology, his work is filled with suggestions of ecological association that elevate it from taxonomy to biogeography. His is the only document we have that describes the circum-Caribbean region in a relatively unmodified biotic state (Alvarez 1957).

Equally important, Oviedo offered a detailed and focused account of economic botany that remains unique, and that retains its importance for the cultural geography of peoples in the region who have become extinct. In reading these sections, one repeatedly has the impression that Oviedo relied heavily on Native American informants, although he did not admit it. Oviedo's general contributions to understanding the aboriginal inhabitants and their customs also have value. He had no illusions about human nature, and was impartial in his criticisms of Spaniards and Indians and their foibles (see also Gerbi 1985, chap. 19). He heaped sarcastic abuse on Pedrarias, De Soto, and certain other conquistadors noted for their brutality (see also Salas 1954), and he blamed the Indian demographic collapse on Hispaniola squarely on the Spaniards: forced labor and other gross abuses, the resulting suicides, and on smallpox (Fernández de Oviedo 1959, I, 67). His comparative analysis of Spanish exploration or conquest of different parts of the Americas not only convinced him of the common nature of humanity in both world hemispheres, but he was the first to recognize that indigenous peoples of southeastern North America, the Caribbean, and South America had varying forms and levels of human culture (i.e., cultural complexity, a concept later explicated by Acosta [1962, 6.19]). Ballesteros (1957) further detects an implicit recognition of an historical progression of culture.

Like Columbus, Oviedo came to the New World as an amateur and was promptly filled with wonder by what he saw. But unlike Columbus, Oviedo became a dedicated scholar who produced the first great scientific work on the New World. No less an authority than Humboldt (1845–47, II, 298) believed that the foundations of modern physical geography were laid in the studies of Oviedo and Acosta (see below).

Cultural Landscapes: Sahagún

The biggest challenge for the first European observers in the New World was the encounter with new peoples possessed of unfamiliar and puzzling languages, lifeways, beliefs, and values. The problem, then, has been to grasp the indigenous vision of an indigenous world, to move from description to understanding. That vision was elusive because Native American reading of the landscape was set in a different cosmological perspective (see Licate 1980), one which cast the supernatural, the individual, and the community in unaccustomed interrelationships, and lent different meaning to concepts

or material phenomena such as property, labor, dwelling, food, or technology.

In the unhappy tradition of European ethnocentrism, while some enlightened individuals sought to understand, many others recklessly destroyed the cultural diversity that they encountered in the "New" World. Not surprisingly, perhaps, some of the most explicit acknowledgments of Native American creative capacity and achievement come from some of the men who knew them best—the conquistadors. Hernán Cortés, in his letter of 1520 to the emperor, expressed wonder at the splendors of Tenochtitlan (later, Mexico City), its markets, and the great temple in a classic description, expanded in 1552 by his biographer, López de Gómara (1966, II 147–58; see the prose of Simpson 1964, 156–67). Indeed, most of the ethnographic materials synthesized by Fernández de Oviedo (1959) came from the chronicles of minor conquistadors or their more articulate rank-and-file. Among the latter is Cieza de León (1985), who assembled the first history of the Inca from oral testimony given by Indian informants.

The most successful students of cultural phenomena are found among the ranks of the missionaries. The first of these came to the Americas with Columbus on the Second Voyage. Although working with little christianizing success on Hispaniola 1493–96, the obscure Jeronymite friar Ramon Pané (Panet) evidently listened with great care. He was able to recount the origin myth, beliefs in the hereafter, and ritual medical practices, as well as observations on ethnic and linguistic distributions of the Taíno people (as in F. Colón 1984, 205–29; see Wilson 1990 on their culture). Even by modern anthropological standards, this account is remarkably objective, and qualifies as a first effort to record the self-perspective of another people. Pané's account is complemented by the descriptive ethnography of the Sevillano physician for the expedition, Diego Alvarez Chanca (Jane 1988, I, 20–73; Gerbi 1985, 23–26). Although Las Casas (1967, II, 178) maliciously described Pané as a Catalan who spoke Castilian poorly and was a bit simple-minded, Las Casas himself fares poorly by comparison.

Las Casas (1967) assembled a massive corpus of information during the 1540s–50s on the rituals and customs of various New World peoples in order "to demonstrate the rational capacity of the Indians." The seemingly strange behaviors can be explained, he argued, by different beliefs and world views, and in this relativist context, the New World peoples did not merit the pejorative connotation of "barbaric." But his ethnographic materials are so highly selected and sanitized that they retain little value.[13] His dogmatic conclusions that human sacrifice and cannibalism once were universal traits and that this demonstrated "a higher concept of God" among "the most religious peoples" (Las Casas 1967, II, chaps. 157, 185) are particularly disturbing.

More solid contributions to understanding New World cultures were advanced by the early Franciscans in Mexico. Diego de Landa controlled missionary activities in the Yucatan 1549–79, and although he was responsible for burning countless Mayan documents (see Lovell 1991), he also assembled an invaluable account of ancient Maya ethnography, history, and religion. Based on his own experiences as well as oral and written information, this account included "the first accurate knowledge of the hieroglyphic writing" (Tozzer, in Landa 1941, vii). Toribio de Benavente Motolinía (1969, 1971), one of the "first twelve" missionaries to arrive in Mexico in 1524, also authored works which include a wealth of ethnographic description on the pre-Contact Aztecs and some of their archaeological sites. Yet unlike Pané, who slips at times into an "insider" presentation, Motolinía's mode remains that of an "outsider."

The main Dominican contribution, completed in 1581 by Diego Durán (1967), reconstructed Aztec historical annals and their ritual calendar, based on indigenous informants and manuscript sources. His writings are interlinked with those of his Jesuit relative, Juan de Tovar. A specialist in three indigenous languages, Tovar was commissioned in 1576 by the Viceroy of New Spain to write the history of the indigenous people he was to govern, "with the assistance of the native historians and their books" (Warren 1973, 80). Although this work was lost, it was used extensively in another Jesuit study (Acosta 1962) of the indigenous civilizations of the New World. These investigations, encouraged by the government, signal a period of genuine and sensitive scholarly activity devoted to Aztec social history, one which presupposes the existence of indigenous documentation which, like many of the missionary

writings, has been destroyed or "lost" in private collections.

The finest cultural research of the sixteenth century, the great Florentine Codex, was accomplished by the Franciscan friar Bernadino de Sahagún (1499–1590). Born in a small town of León, Sahagún came in 1529 to Mexico, where he occupied his next forty years with Aztec linguistic and cultural studies, materials that have attracted the attention of a century of international scholarship. Completed in final form in 1579, the thirteen-volume work (Sahagún 1950–69) constitutes an encyclopedia of Aztec culture, recorded in their Nahuatl language with abbreviated Spanish translations. Ranging across cosmology, philosophy, society, natural history, economic botany, and the artifactual realm, the materials stem from decades of in-depth interviewing of indigenous informants in several towns, whose responses to a structured questionnaire were transcribed in Nahuatl and in the cultural style of the informants. Of particular interest to geography are parts 10–12, dealing primarily with crafts and trades, markets and economy, architecture and construction methods, medicinal plants, and the Aztec perception and classification of the environment. These sections contain almost two-thirds of the 1846 indigenous illustrations (see Quiñones 1988) found in the work, but which so far have only been published as simplified sketches (Glass and Robertson 1975, 190–92).

An example best illustrates the complexity of cultural information encoded in what to European perception is merely a material object. In explaining the term *tecpancalli,* a pre-Contact palace, Aztec respondents unraveled multiple levels of meaning as they connected function with physical description:

> It means the house of the ruler, or the government house, where the ruler is, where he lives, or where the rulers of the townsmen, the householders, assemble. It is a good place, a fine place, a palace; a place of honor, a place of dignity . . . . It is a fearful place, a place of fear, of glory . . . . There is bragging, there is boasting; there are haughtiness, presumption, pride, arrogance. There is self-praise, there is a state of gaudiness . . . . It is a center of knowledge, of wisdom . . . . It is something embellished, a product of care, made with caution, a product of caution, a deliberated thing made with deliberation; well made, the product of carved stone, of sculptured stone, plastered . . . , It is a red house, an obsidian serpent house . . . , It has a deep footing, a deep foundation . . . . It has an entrance, vaulted, with cross beams, with a covering . . . (Sahagún 1969, XII, 270–71).

Klor (1988) regards Sahagún as "the father of modern ethnography," and he offers an insightful discussion of Sahagún's methodology and the problems of relating indigenous conceptions to European categories. Entering Aztec culture as a participant observer, Sahagún saw the native cultures as equal and, in some ways, superior to imported European cultures. He grasped what is now called cultural relativism, that each culture is rich in human information, and that the values embraced by the people who share that culture have merit. He "remained convinced that the conquest of the New World brought only one arguable gain: religion" (Nicolau and Cline 1973, 207; Nicolau 1987).

The Florentine Codex marks the close of sensitive research into Native American cultures in Hispanic America. In 1577 the Inquisition and the Council of the Indies barred or suppressed works in native languages by the missionaries. They ordered Sahagún's manuscripts to be turned over, but fortunately they were saved by the Inquisition's censor in Mexico who held different views (Nicolau and Cline 1973). This reversal of policy, directed from Rome, entailed fundamental changes in missionary strategies which the Archbishop of Mexico and the mendicant orders in New Spain strenuously but vainly resisted. From Motolinía in the 1520s to Sahagún in the 1580s, the goal had been conversion, not assimilation. When, in the 1590s, that benevolent Indian policy was set aside, particularly by the Franciscans, a steady erosion of cultural integrity ensued.

The Spanish observers of the sixteenth century had great difficulty in finding a model with which to view and understand the diversity of Native American cultures. Through the widely disseminated elaborations of Martyr (1964), Columbus's account of the Taíno of Hispaniola as generous, guileless, and backward fostered the stereotype of the American Noble Savage. In Mexico, Cortés and his soldiers stumbled upon a great civilization and created a different stereotype, a Clever and Discreet Indian gifted in art and industry (Keen 1971, 60). Las Casas blindly idealized the Indians. Motolinía accented the social inequalities and the poverty of Aztec Mexico, while Durán praised the hierarchical, class-conscious spirit of Aztec society (Keen 1971, 119–20). It remained for Sahagún to

recognize the linkages between the world of appearances and the cognitive structures beneath it that influence individual and group actions, a discovery made possible by his linguistic analyses. But Sahagún himself was only rediscovered in the 1880s, and his semiotic conceptualization of culture and landscape should attract postmodern cultural geographers today (see Rowntree, et al. 1989, 213–14).

Regional and Synthetic Geography: Cieza de León

The talent to integrate environmental and cultural information in spatial and logical terms may be inborn rather than learned, at least if Pedro Cieza de León is taken as an example. Cieza (1984) was raised in Llerena, an Extremaduran town of 5000 inhabitants when he and his parents embarked at Seville for Colombia in 1535. At the time he was either thirteen or seventeen years old (his books give two versions), but within a year he was campaigning up and down the Andes as a common soldier. In describing the hardships, he complained of the exorbitant price of a piece of paper, implying that he was taking notes. His terse, informative, and evocative prose indicates an educated man; but that education must have been largely informal, acquired on his own and on-the-go. He died young, in 1554, just as his introductory volume to a four-tomed history of Peru was published. This first book, which relates a district-by-district geography of the Andean world from Panama to Bolivia (Cieza 1984), is of particular interest here.

Again and again he describes the dramatic physical environment, its diversity, and the cultural landscapes and subsistence forms of its various ecozones. In one paragraph he sweeps the reader from the mangrove coasts and rain forests of the Pacific slope into the snow-topped high ranges, describing the semiarid intermontane valleys in between. He directs attention to variations in rainfall and vegetation, windward and lee slopes, habitable and uninhabited regions, and the tortuous roads that bind them together. His superb account of the environs of Quito (Cieza 1984, chap. 40), with its descriptions of planted crops, Indian populations, livestock economy, and the surrounding network of towns, is too long to excerpt. The cogent report on Lake Titicaca is also exemplary and can be reproduced in translation:

> The region of Collao has many snow-capped wastes and mountains, as well as plains covered with good pastures that serve the domestic livestock wandering across them. In the middle is a lake, possibly the largest and widest in [South America], and most of the towns of Collao lie next to it. The cultivated land [and anything of value] is found on large islands within the lake, because these are deemed safer than the towns, which lie along the roads.
>
> This region is so cold that not only does it lack fruit orchards, but maize is not grown because it will not ripen, for the same reason. There are great numbers of birds of many kinds in the reed marshes of this lake, including large ducks and other fowl, and two or three kinds of tasty fish . . . .
>
> The lake is so large that its circumference is 330 km and its depth [according to Captain Juan Ladrillero, going out with his brigs] 25 fathoms or so, more in some parts, less in others. This size, and the waves raised when the wind blows, suggests an embayment of the ocean. It is not known why so much water is held in this lake or where that water comes from: although there are many streams and arroyos flowing into it, this seems inadequate, mainly because the lake is also drained [by a deep river that flows strongly] . . . Possibly the Deluge left this water behind because, as I see it, it should be salty rather than fresh if it had been part of the ocean, and furthermore the sea is 300 km away . . . .
>
> The great lake of Collao is called Titicaca, after the temple built on it . . . (Cieza 1984, chap. 103).

Cieza's account rivals the regional geographies of the nineteenth century, which is all the more remarkable because Cieza was untrained and had no mentors or role models. Although Classical geographers like Strabo provided good regional descriptions, they lacked the ability to shift the scale of vision, to gather so much hard observational data, to analyze interrelationships, or to systematically treat a large region according to a particular set of criteria.

A very different type of regional geography, embracing most of the New World, was attempted 1571–74 by López de Velasco (1971), whose similar lack of formal education is discussed below in relation to government geography. The *Geografía y descripción universal de las Indias* was assembled from reports and maps on the New World and East Indies in the office of the Council of the Indies. Dedicated to the king, and evidently intended to inform the government, Velasco tallied a total of 200 Spanish settlements in the Americas, with 32,000 Spanish households and 4000 other settlers and miners; there also were 8000 Indian

towns and 1.7 million Indian "tributaries" liable to tax or work demands as well as 40,000 African slaves, not counting people of partial black ancestry.

Velasco's is a classic regional geography, a coherent work of synthesis. First the coastlines of a region are described, much in the manner of a navigational chart, followed by an outline of the topography, a description of the environment, a summary of the main cultural phenomena, and a systematic account of towns and agricultural activities. Miscellaneous points cover topics such as climatic constraints to settlement or agriculture. Historical digressions or travelers' "tales" are few. Unlike Cieza, who wrote spontaneously on the basis of direct observation, Velasco presented a more "academic" synthesis.

The work's rigor and systematics make it a volume of lasting historical scientific interest, as is shown by Menéndez Pidal's (1944) reconstruction of a New World geography for about 1570, based primarily on Velasco. The modernity of his secular and empirical synthesis, conceived at a global level through its inclusion of oceanic navigation and East Asia (López de Velasco 1971, 29–49, 273–309), contrasts with the continuing use of an obsolete Ptolemaean framework and a theological paradigm to the end of the century for presenting new geographic information in Central Europe (Menéndez Pidal 1944, 4; see also Ptolemy 1966; Münster 1968, Büttner and Burmeister 1979). Unfortunately, Velasco's prototype for synthetic geography remained unpublished until the fourth centenary of Columbus's voyage. Although Velasco's work had no impact on geographical scholarship, it deserves to be considered as a precursor to Carl Ritter and Elisé Reclus.

This first epoch of Spanish geographical inquiry aptly concludes with another compendium of a New World regional geography, that falls a little beyond our period of examination. The Carmelite friar Antonio Vázquez de Espinosa (c. 1570–1630) traveled through most of Hispanic America for fourteen years (1608–22), perhaps to evaluate possibilities for his order to engage in missionary work. Doubtless Vázquez (1969) had important backers because he had full freedom of movement, access to privileged information (such as the salaries of high church officials), and disposition over reams of municipal and economic statistics, which he put to good use. In the course of his travel and sojourns, he compiled a wealth of papers, maps, reports, and first-hand observations.

Vázquez came from a poor, rural background in the olive-growing country just west of Sevilla. Equipped with a primarily religious education, and lacking the conceptual rigor or analytical skills of Velasco, Vázquez compensated for his shortcomings by a ready appreciation for complex landscapes and a lively interest in the rural economy. He provides, for example, unique quantitative data on wine and olive oil production in Peru; he also remains a key source for demographic data. The Compendium spans the Hispanic dominions, and his regional descriptions brim with quality, systematic information. He was unsparingly critical of what he regarded as short-sighted and abusive administration of the indigenous peoples, by both church and state; yet his own attitude was paternalistic, and unrelieved by sophistication for other cultures. At the time of his sudden death, his manuscript was in press, and like so many others, it remained unpublished.

To the works of Cieza, Velasco, and Vázquez can be added a variety of other travel reports or regional histories, with enlightening geographical introductions. Collectively they show that synthetic as well as analytical geography was an integral part of what would now be described as scientific thinking in sixteenth-century Spain. That normative geography was espoused in government circles should therefore come as no surprise.

Government Geography and Town Planning: López de Velasco

The role of Spanish government policy in urban planning is relatively well known (see Stanislawski 1947), but disagreement continues on the relation of theory and practice and the origin of the Spanish gridiron plan.

The first unambiguous government decree in regard to town location and morphology dates to November 1513 (CDI 1883, vol. 39, 284–85, 295–97); it instructed Pedrarias, the governor of Panama, to choose a town site on the coast or along a river to facilitate transport, making certain that the location was healthy, near woodland (for fuel) and good soil (to cultivate), and

not liable to flooding; once the site was selected, the streets, plaza, church, and house lots were to be laid out in an explicitly "regular" (*ordenado*) manner, from the very beginning. A geometric grid is evidently meant, but no particular arrangements are specified for the various components. Cortés (1963, 589–90) received almost identical instructions in 1523, that added the caveat to avoid locations that were excessively windy, foggy, or steep.

But the details for the gridiron format were only specified in the "laws for settlement," proclaimed in 1573 (Ordenanzas 1973, 112–25). These ordinances called for towns to be organized along four main streets running at right angles to a central plaza and opening to four external gates; eight additional streets should diverge from the cardinal directions at the corners of the plaza. Diagonal alignment of the square and axial streets was thought to avoid direct exposure to unpleasant winds. The town square was to be rectangular, with a ratio of 1:1.5, varying from 60 by 90 m to 240 by 460 m, depending on the initial and expected size of the town. One ordinance specified that, according to Mediterranean custom, the church should be on the highest point and not necessarily on the plaza, with the public buildings located between the two (Ordenanzas 1973, 124). Where possible, location on a river or coast was recommended, with sanitation dictating that craft centers be located near the water.

These ordinances are remarkable in that they dictate norms for urban planning more than two centuries before the rectangular survey began to create checkerboard town plans in the U.S. The approximate grid plan for Santo Domingo (1502) was laid out without instructions to that effect (see CDI 1879, vol. 31, 17). The 1522 foundation document for Nata, Panama specified a *traza* ("trace"), implying a regular layout, and informs us that the principal streets of Nata converged on the church and public buildings "according to and because of the order and manner that the *traza* is identified [on the ground]" (Domínguez 1977, 36). Mexico City-Tenochtitlan was first rebuilt in 1523—in a location notorious for flooding and an unhealthy environment; it was then drastically remodeled according to a strict grid plan after 1538, not in response to special instructions, but according to the plan of Viceroy Mendoza (Tovar 1985). The new city of Puebla, begun in 1531, also conforms to the ideal type of grid layout (Yáñez 1991), and many other examples in various parts of Hispanic America predate 1573.

The ordinances merely articulated and legalized a system already well established and in common use (Hardoy 1978). But the prescribed model was not always followed. Most such grid towns are more or less axially oriented to the cardinal points, not at 45° to them, while the church and public buildings were always on the plaza (or on one of two plazas). Hardoy (1975) examined 292 maps for 134 Spanish Colonial towns, only 22 of which were founded before 1600; he found that only 42 percent had been planned from the outset, another 32 percent were gradually modified to conform to a regular plan, and 26 percent evolved spontaneously. In short, the ordinances were not very effective after 1600.

Some authors argue that the Hispanic American grid plan was influenced by (or even grounded in) the Roman architect Vitruvius or Classical town models, and Mendoza's remodeling of Mexico City was indeed influenced by the Italian architect and planner, Leon Battista Alberti (1404–72), who drew many ideas from Vitruvius (Tovar 1985). But most new towns in Europe founded after about 1200 already had some form of regular layout long before the delayed publication of Alberti's book in 1485 (e.g., Hardoy 1975; Kubler 1978; Benevolo 1980).[14] Considering the inordinate role of leading conquistadors or administrators in determining the actual forms of the first planned towns in the New World, it seems more reasonable to attribute urban evolution to adaptation of already familiar Spanish prototypes to new opportunities and requirements: the availability of abundant space; the need to quickly establish a few dozen initial settlers; the priority of economic over defensive strategies, favoring level terrain and the conjunction of kitchen gardens with dwellings on a single lot; and proximity to vital Colonial institutions: the government buildings, the church, and various shops (see also Hardoy 1978). Instead of an endless and inconclusive search for specific intellectualized antecedents, it seems more productive to explicate particular urban histories (e.g., Butzer 1989), and to explore the function of the city as an instrument of colonization (Hardoy 1978; Morse 1987).

The driving force behind the formulation of

the 1573 ordinances and the role of government in marshalling geographical information was Juan López de Velasco (c. 1530–99). He came from the remote village of Vinuesa (Soria), where his family owned some houses and irrigated fields; checks of student enrollments at various institutions of higher education confirm that he lacked a formal education (Pérez-Rioja 1958). According to his last will, his sister in Vinuesa lived in poverty; some of his money went to her sons that they might go to America—something that he had been unable to do. Despite such impediments, Velasco wrote respectable works on astronomy, a navigation guide to the Atlantic Ocean, and a regional geography of the New World (see above); he also became a national authority on the spelling and pronunciation of the Castilian language. Velasco probably received a rudimentary education from the parish priest in Vinuesa, and then began to work as a young government clerk in Madrid. By 1565 it appears that he was an assistant, possibly responsible for legal work at the Council of the Indies. The proverbial self-made man, Velasco had no rank in his status-conscious society nor the opportunity to travel.

His profound influence on Spanish geographical planning and policy was exerted indirectly, through the authority of his patron, Juan de Ovando y Godoy, the distinguished jurist and statesman. Appointed to revamp the Council of the Indies in 1569–71, Ovando focused his reforms on improving geographical understanding and developing a coherent body of legislation (Cline 1972; González, in López de Velasco 1971, v–xxxvi). Velasco implemented this effort and was appointed cosmographer and chronicler to the Council to that end. After Ovando's death, Velasco was removed from a position of influence in 1577 as the policies of church and state shifted.

Ovando apparently served as a "front" for Velasco's precocious initiatives, which included: (1) reorganization and codification of the legislation applicable to the Americas (by 1571); (2) formulation of the comprehensive "laws of settlement" (in 1573); (3) solicitation of local reports from parishes in the New World, through the various bishops, to provide data on the Indian population, frequently amplified by geographical information (1571) (see Paso y Troncoso 1905b, c, for the Mexican series); (4) compilation of a New World regional geography, based in part on the parish reports; (5) development of a geographic and ethnographic questionnaire dispatched to all district magistrates in the New World (in final form 1577) (Edwards 1969; Cline 1972); (6) the questionnaire produced *relaciones geográficas* for some 500 communities (mainly 1577–86), now available in fourteen published volumes, covering parts of Mexico, the Antilles, and the wider Andean region (Acuña 1984–88; Latorre 1920; Jiménez 1965; Edwards 1980); and (7) a parallel set of questions directed to towns in Spain, which generated *relaciones topográficas* for another 636 communities (Nader 1990). In addition to these diversified and substantial initiatives in government geography and policy, Ovando and Velasco seem to have provided indirect support for the ethnographic research of Durán, Tovar, and Sahagún in Mexico.

The degree to which the Renaissance spirit of rationalization pervaded this effort can be judged by Velasco's thirty-eight questions (with twelve more for coastal locations) (see Cline 1972, 234–37). Question 4, for example, requested information as to whether land was plain or rough, open or forested; with many or few streams or springs, and abundant or deficient waters; fertile or lacking in pastures; abundant or sterile in crops and sustenance. Site and location of each town was to be specified; was the site high or low, level or sloping (question 10)? Other questions asked about distance to the nearest mountains; the nature of adjacent rivers and their sources; lakes or springs serving the town; volcanoes, caves, or other notable natural phenomena in the vicinity; native trees common to the district and their potential economic use; wild animals and birds; information on mineral resources, mines, or quarries; and, for coastal locations, data on shore topography, offshore reefs, tides, and storms. These biophysical questions were complemented by requests for information on crops, soils, livestock, town plans, and the like. Ethnographic questions covered Indian languages, pre-Contact government and religion, native dress, manner of warfare, and past and present means of subsistence.

The *relaciones* therefore solicited a broad corpus of information appropriate to the administrative needs of government policy. The reports submitted by the magistrates or clergy

were generally quite good since their accounts were based on interviews of long-term residents in Spanish towns and native elders in Indian towns. In addition, many of the *relaciones* included local pictorial maps, many drawn by Native Americans, that illustrate sixteenth-century cultural or symbolic landscapes, and sometimes include exquisite detail on vegetation. Collectively the *relaciones* provide an inestimable resource of analytical information on landscape change and indigenous cultural geography (see Edwards 1975; Bustos 1988; E. K. Butzer 1989). But that should not let us lose sight of the fundamental fact that the *relaciones,* like other efforts of Velasco as the first government geographer, were designed to facilitate imperial administration and policy at both the meso- and macroscales. In Madrid, by the 1570s, more complex modes of geographical understanding had begun to supersede maps as a tool of government.

Velasco's influence on sixteenth-century scientific observation thus was enormous. Not only did he play a catalytic role in government, but he also challenged others to follow similar norms. Indeed, Antonio de Ciudad Real (1976), a Franciscan friar traveling through Mexico in 1584–89 as secretary to a visiting inspector, seems to have modeled his account on parts of this questionnaire, noting the environments he traversed, land use around each town, and crops grown in the various monasteries. Similarly, requests for land deeds in Mexico increasingly incorporated environmental information, so much so that the land-grant documents can be used to reconstruct the vegetation of the sixteenth century (Butzer and Butzer forthcoming). Yet Velasco was indebted to the earlier efforts of Fernando Colón: in many ways he merely implemented the initiatives of Colón's *Itinerario,* a concept that finally bore rich fruit sixty years later.[15]

A Scientific Framework: Acosta

As the intellectual ferment of the sixteenth century began to diminish with growing religious orthodoxy and censorship (Kamen 1985, chap. 5), it remained for the Jesuit scholar Joseph de Acosta (c. 1540–1600) to place the New World into a new scientific framework. The son of a merchant family in Medina del Campo, a once-prosperous town of Old Castile, Acosta studied philosophy at the university of Alcalá de Henares 1559–67. The fifteen years 1572–87 were spent in the Americas, almost exclusively in Peru, but he had close contacts with Tovar and Durán in Mexico from whom he derived most of his ethnographic information.

In his *Historia natural,* Acosta made significant original observations on physical phenomena, e.g., the latitudinal organization of world climates in which he recognized that the rainy seasons of the tropics were linked to the zenith of the sun (high-sun rains) (Acosta 1962, 2.7), contrary to the opposite argument of Aristotle. He not only reaffirmed Columbus and Gómara to the effect that the torrid zone was quite habitable, but explained that equatorial climates were moderated by relatively short days and abundant rainfall, especially where complemented by coastal breezes (Acosta 1962, 2.10–11). He conceptualized the systematic decrease of temperature with elevation in tropical mountains (Acosta 1962, 2.12) and thus anticipated the montane ecozonation of Humboldt.

But his major contribution rests in his exposition of a scientific and ontological framework for the New World. The first half of his book focuses on the natural world, and there he makes two basic points (O'Gorman, in Acosta 1962, xliii–xlvii): (1) How the Americas form an integral part of the universe, in relation to the global distribution of seas and continents, and the habitable realm; (2) How the Americas are formed of the same four physical elements (earth, water, air, fire) and the same natural orders (mineral, vegetal, animal) as the other continents. The second half of his work, on the human world, is similarly structured according to two arguments (O'Gorman, in Acosta 1962): (1) That the New World peoples are an integral part of the supernatural world as well as of humankind, that is, spiritual, physical, feeling, and rational creatures; (2) That the New World peoples have their own history (in part oral), making them part of a universal history.

This all may seem self-evident today, but Acosta was the first European to explicitly recognize that New World phenomena existed in their own right. Building on ideas already expressed by López de Velasco (1971, 2), he attributed the divergence of the Old and New World peoples to migration, surmising that the

continents were connected or almost connected in unexplored Arctic latitudes:

> the one (world) and the other are joined and are continuous or at least approach each other and are very close . . . because the Arctic or North Pole has not been discovered and the full extent of the land is unknown . . . .
> the first settlers travelled to the Indies . . . without reflection, progressively shifting locations and territories, some occupying those already found, others looking for new ones, so that in the course of time they came to fill the lands of the Indies with so many groups, peoples, and languages (Acosta 1962, 1.20).

Other, popular fables such as the Lost Tribes or Atlantis were rejected. As a creationist he was puzzled by the different degrees of divergence between the Old and New World faunas, and the absence of large mammals on the Caribbean islands, suggesting that

> through natural instinct and divine providence different kinds (of animals) went to different regions, doing so well in some that they remained, or if they moved on, they did not survive or died out in time (Acosta 1962, 4.36).

It can be argued that this concept of diverging migration anticipates biogeography and even geographical speciation, but without its evolutionary implications.

A more satisfactory solution to the dilemmas of natural history noted by Acosta was not forthcoming until Darwin, while the origin of New World peoples has only been unraveled during the twentieth century. Although Acosta remained entrenched in Aristotelian thinking, his synthetic, ontological framework stands midway between Medieval attempts to construct a cosmological order and more modern efforts to lay out a new, scientific counterpart. Published in 1590, his ideas were disseminated by twenty-five foreign editions during the next two centuries (López Piñero 1979, 295).

Retrospect

It is evident that Columbus's encounter with what came to be called the New World had an immense intellectual impact on thoughtful Spaniards in many walks of life, with and without formal education. These included sailors and soldiers, clerks and clergymen, and a few men of letters. They were connected less by academic links or traditions than by a spontaneous capacity to observe and describe, to compare and classify. The authors and works singled out here, together with many others, represent a wealth of original and empirical observation and analysis of new environments and unfamiliar peoples, all within a span of three generations. Separately or in tentative forms of synthetic integration, they laid out the components of a scientific, geographical understanding of that "New" World. This was a veritable Renaissance or rebirth, that easily surpassed any Classical prototypes, and the challenge to deal with all that was novel put people with rural backgrounds on an equal footing with those steeped in academic curricula.

Given the exuberant environmental descriptions of a Columbus, an Oviedo, or a Cieza, or the love of nature exhibited by Acosta (1962, 1.3), it is difficult to understand how John Elliott can claim that:

> It is as if the American landscape is seen as no more than a back cloth against which the strange and perennially fascinating people of the New World are dutifully grouped. This apparent deficiency in naturalistic observation may reflect a lack of interest among sixteenth-century Europeans, and especially those of the Mediterranean world, in landscape and in nature (1970, 20).

For an influential historian of Spain, the ethnocentric dismissal of South European interest in the natural world is inexcusable. More important, the inability of such a fine humanist to grasp the intellectual excitement of geographical observation and perception of that new world is deeply disturbing.

Unfortunately, the Spanish contributions of the sixteenth century to geography and related scientific research had minimal impact on the German revival of the field during the early nineteenth century. Humboldt (1845–47, II, 298) readily acknowledged the importance of Oviedo and Acosta, but did not know Cieza. Furthermore, Fernando Colón, Sahagún, López de Velasco, Vázquez, and the *relaciones geográficas* remained unpublished and inaccessible, primarily as a result of official xenophobia or religious censorship. The curtain that began to close in 1577 stifled free inquiry, and the quality of Spanish research declined long before the precipitous fall in Spanish scholarly publication about 1640 (see López Piñero 1979, 377–86). The geography that reemerged in Spain during the mid-1700s stood in the shadow of the French Enlightenment (see

Capel 1982), and it did not regain its original vitality until well into the present century.

Acknowledgments

Development of the ideas discussed here was facilitated by free access to the library of Juan F. Mateu (Valencia), discussion with José M. López Piñero (Valencia), and Manual González Jiménez and Fernando Díaz del Olmo (Sevilla), and participation in the symposium "El Nuevo Mundo y los procesos de difusión de la ciencia y la técnica durante el período colonial" at the Universidad Internacional Menéndez Pelayo (Valencia), September 1991. James T. Abbott provided major assistance with the library search. Carville Earle (Baton Rouge), W. George Lovell (Kingston), Geoffrey J. Martin (New Haven), and Carla Rahn Phillips (Minneapolis) offered valuable, constructive criticism. Periodic Saturday breakfasts with Los Amigos de la Frontera in San Antonio and Austin offered a lively forum of discussion, especially with Adán Benavides, Robert Benavides, and Elizabeth John.

Notes

1. Marco Polo (1958) can be cited for descriptions of "Tartar" transhumance and the spring snow melt in Armenia (chap. 22), the landscapes he passed in the Pamir Mountains (chap. 47); moving sands covering tracks in the Lop Nor (chap. 56), the bustle of life and urban layouts of Peking and Hangchow (chaps. 85 and 153), and a series of well-tended Chinese landscapes (chaps. 107–58). Even data he obtained by hearsay for Zanzibar and Madagascar (chaps. 192–93) are remarkably accurate, such as a description of giraffes. The "chapters" refer to the Bennedetto subdivisions, used by some but not all of the many available editions. On the expanding geographical horizons of Medieval Europe, see J. Phillips (1988).
2. For example, the German cartographer Münzer (1952) gave a valuable and remarkably objective eyewitness account in 1494–95 of the Muslim towns and people of recently conquered Granada, without quoting a single Classical author or historical source. By comparison, a more erudite Portuguese traveler, Barreiros (1952), traveled through Spain in 1542, to fashion a self-styled chorography that was little more than a pretext to display his familiarity with Classical literature; observations become little more than incidental.
3. The Ptolemy (1932) edition, in English translation, has been criticized, but it is one of the very few that is accessible and not written in Latin or Greek. The fifteenth-century maps it reproduces presumably go back indirectly to third-century or earlier prototypes, to illustrate the regional information available in Antiquity. By contrast, Ptolemy (1966), in Latin with commentary and maps by Sebastian Münster, is a good example of how these principles were used to redraw the same maps during the early 1500s, using contemporary information. Münster (1968), Waters (1958), Harvey (1987), Campbell (1987), Harley (1990), and Nebenzahl (1990) are recommended for those readers interested in the cartography of the period. The unexpected death of Brian Harley will undoubtedly delay preparation of volume 3 of his and David Woodward's monumental *History of Cartography,* which will treat the Age of Discovery.
4. Questions persist whether the diary of the First Voyage is heavily edited, incomplete, or even a selective summary of Columbus's original by Bishop Las Casas (see Fuson 1983; Henige 1991). These issues do not affect the materials selected here, which clearly do not stem from Las Casas, who later paraphrased the same biophysical data in a singularly lifeless and inept manner (see Las Casas 1965, I).
5. Columbus's background, prior to his appearance at the Spanish court in the late 1480s, has been in hot dispute since 1517. The idealized biographical data for before 1488 all derive from Fernando Colón (1984) and Las Casas (1965), who used the same documentation, almost all of which has disappeared and thus cannot be authenticated. If the lost correspondence with the Florentine cartographer Paolo Toscanelli (1397–1482), as claimed by Colón (1984, 66–71) and Las Casas (1965, I, 62–66), were verifiable, it would date Columbus's interest in circumnavigation and, more important, his scholarly activities, back to before 1481. Las Casas (1965, I) refers to these letters on seven different occasions, implying that he had them in hand. For a lucid but critical analysis of Columbus's career, see Phillips and Phillips 1992; the authoritative biography is by Taviani (1985).
6. Letters securely attributed to Columbus are written in the script known as *humanística cursiva* (see Arribas 1965, I, 166–67 and plate 101), characteristic of the royal court in about 1500.
7. No maps by Columbus have been authenticated, but his younger brother Bartolomé is reputed to have been the author of several nautical charts (F. Colon 1984, 85–86; Las Casas 1965, I, 153–54). "Because Columbus dominates the documentary record, we know less about the other men on the voyage, but his observations . . . can stand as a general description of their experience" (Phillips and Phillips 1992, 157). The geographical competence of contemporary cartographers becomes apparent in the case of Andres de Morales (died 1517), a ship pilot on Columbus's Third Voyage. Morales was commissioned to make a map of Hispaniola in 1508 (see color copy in Milanich and Milbrath 1989, 68), and information from his report is preserved in Martyr (1964, 349–55), subsequently evaluated by Carl Sauer (1966, 41–48). The map is remarkably detailed and accurate, showing the key mountain chains in fifteenth-century, North Italian technique (see Harvey 1987 for examples). Sauer rates highly the information on indigenous territorial organization and land use, but the abbreviated topographic descriptions preserved in Martyr are also intriguing. Morales appears to have had accurate views on the

pattern of ocean currents in the North Atlantic, and later served as Chief Pilot in the Casa de Contratación of Sevilla (Becker 1917, 81, 90–91). That institution in Sevilla was the key European center of navigational science from 1508 onwards (Broc 1980, 194–96). For insights into its curriculum for ship pilots, see Lamb (in Medina 1972).

8. An early appreciation of Columbus's observations is given by Humboldt (1845–47, I, 296–97, 335; II, 55–57, 277, 299–304, 325; IV, 233, 250, 253, 261), who lauds his poetic descriptions, and interprets his observations on botany, wind patterns, and magnetic declination; but at times, I suspect, he reads too much into the statements of Columbus. For a humanistic evaluation, see Gerbi (1985, chap. 2), who also emphasizes the Genoan navigator's feeling for nature, as well as his focus on differences or affinities between the biota of the Indies and the Old World. It is surprising to read in Sale (1990, 102) that Columbus's language is "opaque and lifeless"; I can only infer that Sale did not sample the evocative original language, in favor of a "flat" English translation. Sale (1990, 101) laments the absence of an exultant description of "old-growth tropical forest" from the Bahamas, a curious gaffe for a professed ecologist, both in view of the subclimax woodlands of these low, hurricane-lashed islands and of their considerable indigenous population in 1492. When Sale (1990, 101) further faults Columbus for not writing about melodious bird songs with due excitement, I can only conclude that Sale did not read the journal carefully after the entry for October 28 (a scant ten of his forty references are subsequent to that date). Only a superficial reader or an ideologue could conclude that Columbus "cares little about the features of nature" (Sale 1990, 102).
9. There is some ambiguity in Fernando Colón (1908–15, 1) about the initial entry that the Itinerary was "begun" August 3, 1517, as to whether this meant the project or the writing (see De la Rosa 1906 vs. Ponsot and Drain 1966). Since Fernando had only returned from Rome in October 1516 and was in Spain without interruption until late in 1519 (when he began his peregrinations throughout western Europe in search of books [see Arranz, in F. Colón 1984, 31–37]), his major role in this effort appears to date from 1517–19.
10. O'Gorman (1946) believes that Oviedo's conversion to science began with his trip to the court of Charles V in Brussels (1516–17), where he delivered a formal complaint against the injustices of Pedrarias Dávila, Panama's notorious governor. In Belgium, Oviedo was exposed to Erasmian thought, if not seminars by Erasmus (c. 1466–1536) himself, who taught at Louvain from 1517–21. This Renaissance philosopher, a close friend of Thomas More, emphasized a humanistic rather than a dogmatic Christianity, based on the New rather than Old Testament. According to O'Gorman (1946), Oviedo began to see the European enterprise in the New World as a providential mission that it was his vocation to describe. I have trouble discerning a utopian thread in Oviedo's history, and the only obvious trait he shares with Erasmus is his frequent use of satire to criticize Spaniards in general and churchmen in particular. The Spanish Erasmian movement, especially as represented by Juan Luís Vives (1492–1540), may, however, be pertinent, with its emphasis on inductive argument.
11. Ideal scientific procedure, according to Humboldt (1845–47, I, 65–70) proceeds from accurate observation and description to understanding, via analogy and induction, a view worth remembering in a time when empirical and inductive research are denigrated by some social scientists. In praising Oviedo's "incredible virtuosity in botany," J. D. Sauer (1976, n. 16) states that he "was far ahead of his only model, Pliny, in accuracy and originality." Also in regard to accuracy, Ferrando (1957) emphasizes that Oviedo's data on the Pacific Ocean were extracted with great care from trustworthy sources, providing a realistic picture of exactly what was known to Europeans about its coastlines and islands c. 1550. There were no imaginary islands on Oviedo's mental map.
12. That Oviedo did not know the work of Aristotle, Theophrastus, or Dioscorides on plants (Butzer forthcoming [b]), nor the late Medieval herbal literature, is readily explained by the fact that these were only used in the medical curriculum of the time (Alvarez 1957). He was also unaware of the agricultural treatise of Gabriel Alonso de Herrera (1970), published in 1513. Far more orthodox as a botanist was Francisco Hernández, Philip II's personal physician, who was sent to the New World to collect medicinal plants (Goodman 1988, 234–37). He spent six years (1571–77) collecting, drawing, and describing thousands of species on Hispaniola and Cuba, and especially in Mexico (Somolinos 1960–84), but died shortly after his return. López Piñero (1991) shows that Fernández's illustrations were probably drawn by indigenous artists.
13. To make his case, Las Casas (1967) gleaned an endless litany of bestial customs from the Classical authors and early church fathers, to show that Old World peoples were more depraved than those of the New World. But all too many of his Old World comparative "data" are no more than ethnocentric hearsay about foreign peoples or practitioners of other religions. For a more sympathetic presentation of this complex personality, see Friede and Keen (1971). In regard to ritual cannibalism in the New World, it is appropriate to cite Phillips and Phillips (1992, 295, n. 22): "To deny that cannibalism existed, one needs to assume that a wide range of European commentators simply made up the stories, an interpretation that defies reason, logic, and the available evidence."
14. There is an extensive literature on urban planning in Colonial Latin America, and several of the above references help identify larger collections of papers, mostly in English. A wealth of translated documents related to the Spanish colonial enterprise, including many of the ordinances or decrees cited here, can be found in Parry and Keith (1984), a treasure trove for students inter-

ested in exploring the possibilities of historical geographical research in the region.

15. The link between Velasco and Colón appears to be the noted cartographer Alonso de Santa Cruz (1505–67), who was appointed cosmographer to the Casa de Contratación in Sevilla 1536 (see Carriazo 1951). He worked in Sevilla until 1564, when he moved to Madrid at the king's request. Although there is no documentation to prove the point, Ovando's reliance on Velasco after 1569 offers a plausible scenario that Velasco had already acquired astronomic and geographic experience while working for Santa Cruz in Madrid. In 1572, Santa Cruz's great map collection was transferred from his old residence in Sevilla into the possession of Velasco, as the new royal cosmographer. In his *Libro de las longitudes* (completed ca. 1557), Santa Cruz notes that he planned to write a geography, while in his *Islario general* (completed ca. 1560), he implies that he was working on a *General geografía e historia* (Carriazo 1951, clxv). Velasco would have been aware of these plans and have had access to whatever notes that had been compiled, although no such materials are separately inventoried for Santa Cruz's estate (see Carriazo 1951). Although Velasco's geography would not have been possible without Santa Cruz's maps, there is no reason to doubt that his scientific organization was his own. In 1556 or 1557 Santa Cruz prepared a set of instructions for explorers in the New World, consisting of seventeen points (Jiménez 1965, 272–77; Carriazo 1951, clxix–clxxiii), evidently a direct antecedent to the questionnaire of Ovando and Velasco, in terms of inventorying environmental features and ethnographic data. Item three instructs the responsible officials to clarify the situation of new lands, "if they are mountainous or level, or if they are swampy or full of lakes, or if they are unhealthy for the natives or for foreigners" (Jiménez 1965, 274). Items twelve and sixteen inquire whether the native peoples have learned men and books, suggesting that indigenous histories be obtained in order to translate them into Spanish (Jiménez 1965, 276)—a remarkable perspective not found in Velasco's questionnaire. These instructions of Santa Cruz, much like the *ordenanzas* for town planning, form part of a chain of ideas, as can be seen from the instruction of Viceroy Mendoza, given in Mexico City in 1538 to Fray Marcos for his exploration of Cibola; he was instructed to make observations on the people as well as of "the climate of the land; the trees and plants and domesticated and wild animals they have; the nature of the land, if it is rough (*aspera*) or flat (*llana*); the rivers, if they are large or small . . . " (Jiménez 1965, 20). Perhaps Mendoza even influenced the scope of the Suma de Visitas in 1547 (see above). It is interesting that Santa Cruz uses *monte* and *montuosa* not for woodland/wooded, as in prevailing Spanish usage, but like F. Colón, for mountain/mountainous—a tantalizing hint for a possible connection with Colón, who would have known Santa Cruz, as a fellow Sevillano with shared interests.

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