Honduran Folk Entomology[1]

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Do people discover their world or create it? If people discover the categories of nature, then folk taxonomy of living things should have formal similarities cross-culturally because of the biological integrity of our planet. If people create the categories of nature, each culture should order living things uniquely (see Berlin 1992, Brown 1984, Hunn 1990, Ellen 1993). The universalist or intellectualist school claims that some living things are so perceptually salient, so biologically real, that they are "crying out to be named" (Berlin 1992:53). American college students faced with a pile of bird skins from the Peruvian Amazon classify them the same way as Jivaro and ornithologists on the basis of the birds' morphology (Boster 1987, Boster, Berlin, and O'Neill 1986). The cultural relativist or utilitarian school observes that plants and animals are named because people use them; "survival placed a premium on knowledge of utilitarian value" (Hunn 1990:117; see also Conklin 1962:129). The Sahaptin of the Columbia River have an extensive folk taxonomy of edible plants, while hundreds of species of culturally insignificant flowering plants are peremptorily dismissed as "just a flower" (Hunn 1990:198–99). We try to reconcile the utilitarian and universalist perspectives by showing how cultural importance and the ease of observation of animal morphology interact in influencing which species are named, which are lumped into residual categories (Hays 1983), which are confused, and which are ignored in ethnobiological systems. Many researchers have noticed that cultural importance and morphological attributes are key to folk classifications (Hays 1982; Brown 1984; Posey 1984; Arioti 1985; Atran 1985; Ellen 1986, 1993; Berlin 1992) without distinguishing their roles.

Paul Sillitoe's (1996) ethnography of the folk ecology of the Wola people of Highland New Guinea is scientifically sophisticated and reveals a comprehensive, sympathetic knowledge of the Wola's view of their land. Both universalist and utilitarian explanations apply here. Wola knowledge of some topics is highly detailed; for example, there are 64 named varieties of sweet potato. At the same time, Wola are completely unaware of, for example, microorganisms, including the ones that cause disease, and have only a "hazy" idea of the relationship of some grubs to their adult forms and only partial knowledge of insect metamorphosis. They label butterflies, spiders, and some other major morphotypes of arthropods but do not name various beetles and larvae at all. They do not give separate names to the many kinds of grubs, even the ones that they realize are different species, because these grubs are not important to them. Yet for topics that are important to them, such as rat damage to their gardens, local knowledge is not so much incomplete as highly contradictory to modern science. For example, Wola believe that if someone who has recently eaten meat sees a garden, that crop may be devastated by a rat attack. Farmers build screens of cane grass to shield their sweet potato plants from the sight of possible meat eaters who may be passing by.

In the modest hypothetical scheme we propose in this paper, folk knowledge has an uneven texture which can be explained by comparing the cultural importance (utility) of the domain with its ease of observation (conspicuousness, perceptual salience). We say that a species is easy to observe if it is large, social, colorful, abundant, noisy, and diurnal (Berlin 1990:23–24; 1992:81; Atran 1987:150; Bentley 1992*a*, *b*, 1993, 1994). Many species go unobserved because they are very small, solitary, cryptic, rare, silent, or nocturnal. Hunn (1977) emphasizes perceptual salience: the more distinctive a species is, the more likely it is to be named. The boundaries of biological categories are formed along the lines of discontinuities in nature. While this notion is thoughtful and logical, we propose that perceptual salience is less relevant than ease of observation; species that look very much alike are commonly named if there is a cultural reason to do so. Of the common grain crops, maize is by far the most salient, followed by rice, while rye, oats, barley, and wheat are nearly identical to a city person, but farmers who grow these crops distinguish them all. Their ease of observation and the motivation of cultural importance allow farmers to name them in spite of their lack of perceptual salience.

By "cultural importance" we mean perceived importance within a specific culture, whether useful or harmful. The utilitarian school has emphasized economic use.

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The universalist school has countered that many animals are named that are not strictly useful (Hays 1982: 93; Berlin 1992:89; see also Brown 1992). Defining "culturally important" to include harmful species and not just useful ones gives the utilitarian argument wider range.

Cultural importance and ease of observation influence each other. People take the time to observe useful insects such as bees and harmful ones such as crop pests. Honduran peasants ignore harmless and useless species such as mud dauber wasps (Hymenoptera: Sphecidae), which do not sting and make nothing people use, despite the fact that some of these wasps make mud nests shaped like pan pipes and others nests shaped like footballs, all common along with nests of other shapes around farmhouses.

Arguing against the role of cultural relativism in folk classification, Berlin (1992:80) writes, "To the extent that one is able to predict which plants and animals in some society will be named without prior knowledge of the cultural significance of those organisms, the Utilitarian argument loses much of its force." Several cross-cultural domains of plants and animals are, however, important enough to be classified in detail in most languages. These include domesticated and game animals; edible plants, seasonings, and medicines; firewood; cordage and textiles; weeds and other crop pests; pests of the human body and of our animal intimates; dangerous or painful organisms; and anything used for games, toys, ornament, ritual, or art.

Many large animals and vascular plants are either useful, harmful, or impossible to ignore and therefore named. However, folk classification of entomofauna often lumps thousands of species into a single category because the creatures are small and hard to see (Atran 1987; see also Berlin 1992:81). Insects are a challenge to classify, even for entomological taxonomists, because of their sheer number—30 to 50 million species (Erwin 1988; Wilson 1988; 1992:143). Because insects evolved before Pangea assembled and broke up again, individual insect families tend to range farther than vertebrate families (DiMichele et al. 1992). Insects persist in interacting with people, and therefore ethnoentomology can be used to test cross-cultural hypotheses with any human group. A traditional community is able to name most of the birds, mammals, and trees in the local environment but must cram several million insect species into (at most) a few hundred categories. Insects are perfect for illustrating the biological and cultural criteria a community uses to name, lump, confuse, or ignore living things. We present a case study of Honduran ethnoentomology.

To reject the universalist hypothesis, we would need to find folk taxonomies ordered along the lines of the utility of the organisms; folk names for taxa would be based on cultural criteria (e.g., use, harm), and folk knowledge would be deeper for the culturally important creatures than for the perceptually salient ones. To reject the utilitarian hypothesis, we would need to find folk taxonomies ordered along the lines of the creatures' morphology; plants and animals would be named for their physical characteristics, and folk knowledge would be deeper for the easy-to-observe than for the culturally important. According to the utilitarian school, folk taxonomies should be based on taxa that the people in a specific culture use (e.g., Hunn 1982, 1990). Supporters of the universalist hypothesis argue that all languages have words for the major morphotypes of insects and have other similarities (Berlin 1992). We show that these two perspectives are complementary, since (1) folk taxonomies show both tendencies, (2) some folk categories are named for their roles in local culture and others for their biological properties, and (3) folk knowledge is deepest for creatures that are both culturally important and easily observed.

TABLE 1
Categories of Honduran Folk Entomology and Examples

	Culturally Unimportant	Culturally Important
Easy to observe	Mud dauber wasps Earwigs Spiders	Social bees Social wasps
Difficult to observe	Parasitic wasps Nematodes	Pest caterpillars (especially early instars and Lepidoptera reproduction)

We divide rural Honduran folk entomology into four categories according to cultural importance and ease of observation: (1) the culturally important and easily observed (e.g., bees, social wasps), (2) the easily observed but culturally unimportant (e.g., mud dauber wasps, earwigs, spiders), (3) the culturally important but difficult to observe (e.g., pest caterpillars), and (4) the culturally unimportant and difficult to observe (e.g., parasitic wasps, nematodes). We discuss (nonstandard, rural) Honduran (Spanish) folk knowledge, taxonomy, and semantics of insects and other terrestrial invertebrates for each category (table 1).

Each category has its own epistemology, taxonomic structure, and semantics. Easily observed and culturally important taxa have deep folk knowledge[2] and hierarchical taxonomies. They tend to be named for their physical characteristics more than for their cultural importance, and some have semantically opaque names. For easily observed but culturally unimportant taxa folk knowledge is thinner and taxonomies are broad and shallow. Their names tend to reflect their appearance (nature). For the culturally important but difficult-to-observe taxa folk knowledge is complex, and much of it

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[2] We originally used the term "thick knowledge." We are grateful to Peter Baker for pointing out that in British English one of the meanings of "thick" is "stupid."

clashes with modern science.[3] Taxonomies include binomial folk names that reflect the insects' interaction with humans. Difficult-to-observe and culturally unimportant organisms are not known, named, or classified.

We identified each creature as culturally important or not and as easy or difficult to observe. We ranked a creature as culturally important if we knew that Honduran farmers considered it a pest, a danger or a nuisance, a plaything, or of any utility at all. It was harder to identify organisms as easy or difficult to observe. We classed social insects, larger ones, and brightly colored flying ones as easily observed. We considered cryptic and nocturnal animals (unless they were social) as difficult to observe. Although some caterpillars are quite conspicuous, we classified most of them as difficult to observe; many are cryptically colored, and most are too small to be very noticeable until their later instars. Few of the creatures were difficult to classify by cultural importance. We did, however, end up classifying all bees as "important" because campesinos distinguish the otherwise unimportant ones from the troublesome or useful ones. A few taxa were hard to classify as easy versus difficult to observe (notably the pest Lepidoptera larvae), but our findings would have been little altered by reclassifying them. In future work we may want to make "ease of observation" a longer scale, with a category for insects that are themselves conspicuous but for which key aspects of their lives are difficult to observe.

FOLK KNOWLEDGE

The folk knowledge of culturally important and easily observed groups is deep. Almost all descriptions of folk knowledge have dealt with culturally important and easily observed domains, and this has produced the impression that all folk knowledge is deep. Scholars of traditional people tend to discuss topics of importance to the people themselves, topics on which they are experts. Traditional agriculture in general is dependent on elaborate systems of folk knowledge (Netting 1993:321; see also Wilken 1987 and Wilk 1991).

We agree that folk knowledge can be quite sophisticated. For example, Honduran campesinos can describe the brood chambers, worker and queen morphology, and honey quality of the bees whose hives they harvest (see Posey and Carmago 1985). They understand that bees and wasps lay eggs and that the workers tend the brood. They distinguish species of bees for their utility: some give honey and others do not. Some of the honeys are medicinal; the honey of the *jimerito* (*Trigona angustala*, Hymenoptera: Apidae) is used as an ointment for injured eyes (see Chittampalli and Mulcahy 1990). Some honeys are merely edible, and others are considered poisonous. The bees must also be distinguished because one stings, some bite, one secretes a blister-causing liquid, and others are passive.

Folk knowledge about these insects is sometimes ahead of current entomological thought. For example, campesinos told Bentley that leaf-cutter ants (Hymenoptera: Formicidae: Attini) have a *nahual* (an animal soul companion), a snake or a lizard. They said that digging into a nest until one found the lizard would cause the nest to die (see also Hunn 1977:262). While digging up leaf-cutter ant nests with campesinos we have seen a coral snake emerge from one of the ant tunnels and unearthed a nest of reptile eggs on a bed of spent leaf tissue in a chamber. It is apparent that leaf-cutter ants do have reptilian commensals (see Hölldobler and Wilson 1990: 471). Again, dozens of campesinos told us that social wasps eat flower nectar, but entomologist colleagues insisted that social wasps preyed on insects. Formal research in vespid diet confirms both ideas. Adult social wasps drink nectar but forage for caterpillars and other insects to feed to their brood (Reeve 1991, Gadagkar 1991, Jeanne 1991, Hunt 1991).

Most of the folk knowledge of the easily observed but not culturally important taxa tends to agree with modern science: dragonflies live around water; spiders weave webs; mud dauber wasps have spiders in their nests; June beetles emerge with the first rains; dung beetles roll balls of manure; and earwigs live in maize plants. These examples may seem trivial; they are facts that entomologists and Honduran farmers know but few find remarkable. Campesinos know of some predatory insects, such as army ants, but few know that social wasps hunt for insects or that many other insects are beneficial predators of insect pests (González 1993). Honduran farmers know that spiders and fire ants prey on insects but not that there are many other serious predators of other insects. Once we had shown farmers wasps and ants preying on pests, they continued to notice it on their own. This new information did not clash with local knowledge; folk knowledge is thinner than modern science for topics that are not culturally important.

For the culturally important but difficult-to-observe taxa, local knowledge and modern science part company. Beliefs in caterpillars that rain from the sky, pests created by spontaneous generation, and wasps that lay papaya-eating worms are some examples. Farmers watching their maize fields being eaten by caterpillars that seem to have come from nowhere may be forced to adopt explanations that are consistent with local observations but not with modern science. Without the benefit of devices such as microscopes and without conceptual tools such as germ theory and metamorphosis, people may conclude that disease is caused by spirits (Last 1981) and caterpillars are produced by spontaneous generation (Bentley, Rodríguez, and González 1994).

Anthropologists have been reluctant to discuss gaps and misunderstandings in folk knowledge. Chambers (1983:84) has criticized ethnoscience for focusing on competent informants and large, well-known domains. Vayda and Setyawati (1995) write that cognitive anthro-

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[3] We avoid the phrase "Western science." Many of the Eastern countries, such as Japan, now have more than a passing familiarity with "Western" science, while much of the culture of Latin American countries such as Honduras is of Western European (Spanish) origin. One could write of "Northern" science, but it makes more sense to omit the geographic stereotyping.

pological accounts of traditional knowledge discuss linguistic distinctions of little practical relevance and are deficient in describing knowledge and ignorance about insects which could be useful for informing pest-management practices.

Of all the insects, Honduran campesinos generally recognize only bees and wasps as reproducing sexually. They say that caterpillars reproduce by spontaneous generation. The reproduction of pest Lepidoptera is economically important but difficult to observe. The *cogollero* (fall armyworm, *Spodoptera frugiperda* [Lepidoptera: Noctuidae]), a maize pest, for example, is a dull gray moth as an adult. Few farmers name the moth; even fewer notice its egg masses, cream-colored blobs on fence posts and maize leaves. The tiny larvae hatch and glide through the air on silk threads that they spin. They land and search for a maize whorl to live in and feed on. Honduran farmers notice them when the caterpillars have molted two or three times and grown big enough to be easily seen and to cause enough damage to worry about. *Cogolleros* pupate in the soil or in the maize ear. The brown pupae escape rural people's attention. Other traditional peoples have misunderstood insect reproduction by generally failing to grasp the notion of metamorphosis (see Winarto 1996).

There is little or no folk knowledge about the taxa that are culturally unimportant and difficult to observe. Honduran farmers do not recognize the causal agents of disease (Bentley 1990, 1991), and most of them (along with anthropologists and most other nonentomologists) are unaware of the existence of insect parasitoids (of other insects), especially of the abundant but almost microscopic parasitic wasps.

In summary (see table 2), for insects that are culturally important and easily observed, folk knowledge is deep: local people often know more about them than scientists do. This local knowledge can be empirically verified by the scientific method. For insects that are not culturally important but are easily observed, folk knowledge is thin: local people know them in a way that scientists can understand, although local knowledge may be less complete than that of specialized natural scientists. Local knowledge of the culturally important but difficult to observe is gritty: local people may have beliefs and perceptions which are at odds with scientific notions and cannot always be tested with the scientific method. About insects that are difficult to observe and of no cultural importance, local people know very little.

TABLE 2
Characteristics of Folk Knowledge in Each Category

	Culturally Unimportant	Culturally Important
Easy to observe	Thin but consistent with formal (so-called Western) science	Deep, much of it unknown to formal science
Difficult to observe	Absent	Complex but often inconsistent with formal science

TAXONOMY

Berlin (1992) divides folk taxonomies into hierarchical levels: kingdom, life-form, intermediate, generic, specific, and varietal. There is an obvious similarity with formal biology: kingdom, phylum, class, order, family, genus, and species. The key Berlinian level is the generic, which includes the most basic primary meaningful categories; their labels are simple (Berlin 1992:27; Conklin 1969:106). Folk species usually have binomial labels (Berlin 1992). Intermediate categories are rare (Brown 1984: 4; Berlin 1992:27).

Our study deals with a single life-form, *insecto*. (The Standard Spanish word *bicho* is rarely used in Honduras.) Like Brown's (1984:16) WUG, *insecto* includes not just insects but other terrestrial invertebrates. Spiders and centipedes are *insectos* and so are slugs, which are mollusks. Each of the four categories of taxa has its own taxonomic properties. Culturally important and easily observed taxa are ordered in hierarchies: they are the only taxa with intermediate categories. Some folk genera are polytypic (divided into folk species). Culturally unimportant but easily observed taxa are lists of generic names, without categories of intermediate or specific rank. Culturally important but difficult-to-observe taxa may be taxonomically quite different from those of modern science. There are some polytypic folk genera, with species labeled with productive binomials. Culturally unimportant and difficult-to-observe species escape classification.

Outlining a test of the universalist hypothesis, Berlin (1992:267) predicts that the following morphotypes (if found locally) are likely to be named in any ethnobiological system of classification: ants, wasps, bees, flies, butterflies and moths, grasshoppers, dragonflies, cicadas, ticks, roaches, beetles/bugs, weevils, spiders, scorpions, fleas/lice/chiggers, caterpillars, and millipedes. Our work fails to disprove his hypothesis. Honduran Spanish labels bees, wasps, flies, caterpillars, and most of the others on Berlin's list (table 3). Unlike Standard Spanish, Rural Honduran Spanish has no single term for ant or beetle (*escarabajo* refers only to some of the larger species). Weevils, fleas, lice, and chiggers are probably familiar to people more for their cultural importance as pests than for their morphology. To Berlin's list of major morphotypes we would add earwigs (order Dermaptera) and grubs (larval Coleoptera).

Hymenoptera (bees, wasps, and ants) are some of the larger, more colorful insects. Many are diurnal. Some of the nests of the social ones are larger than a person's

TABLE 3
Honduran Folk Categories for Terrestrial Invertebrates (*Unique Beginner* Animales, *Life Form* Insectos) *Classified by Cultural Importance and Ease of Observation*

Intermediate	Generic	Specific	English Common Name	Translation of Spanish	Category
	Babosa (Gastropoda: Veronicellidae) (*Sarasinula plebeia* and others)		Slug	Slobberer	Important, difficult
	Lipí **Moclija** (Gastropoda: Limacidae)		Slug	Unanalyzable	Important, difficult
	Realillo **Real** (Diplopoda)		Millipede	Little coin[a] Coin[a]	Unimportant, easy
	Ciempiés (Chilopoda)		Centipede	Hundred legs	Unimportant, easy
	Lombriz (Annellida)		Earthworm	Earthworm	Unimportant, easy
	Araña (Araneae)		Spider	Spider	Unimportant, easy
		Araña meacaballos **Picacaballos** (Theraphosidae)	Tarantula	Horse pisser[b] Horse stinger	Important, easy
	Pendejo (Opilionnes)		Daddy longlegs	Pubic hair[c]	Unimportant, easy
	Cazampulga (unidentified small spiders)			Flea hunter	Unimportant, easy
	Alacrán (Scorpiones)		Scorpion	Scorpion	Important, easy
	Coloradilla (Acari: Trombiculidae)		Chigger	Little red one	Important, difficult
	Garrapata (Acari: Ixodidae)		Tick	Leg grabber	Important, easy
		Garrapata chata *Dermacentor imitans*		Thick (blood-filled) tick	Important, easy
		Garrapata menudita **Coloradita** *Dermacentor imitans*		Small tick Small red tick	Important, easy
	Mosca (Diptera, especially Muscidae)	**Mosca**	Fly	Fly	Unimportant, easy
		Queresa (eggs and larvae) (Calliphoridae)	Screwworm	Unanalyzable	Important, easy
		Mosca de la queresa (adult) (Calliphoridae)	Screwworm	*Queresa* fly	Important, easy
		Mosca tábano (Tabanidae)	Horse fly	Horse fly	Important, easy
		Mosca lambesudor **Chupasudor** (Syrphidae)	Syrphid fly	Sweat licker Sweat sucker	Unimportant, easy
		Mosca de la fruta especially *Ceratitis* spp. and *Anastrepha* spp. (Tephritidae)	Fruit fly	Fruit fly	Important, difficult
	Zancudo (Culicidae)		Mosquito	Long legs	Important, easy
	Mosquito (various small Diptera)		Gnat	Little fly	Important, difficult
	Mosquito (various small Diptera)		Gnat	Little fly	Important, difficult
Avispa (Vespidae)			Wasp	Wasp	Important, easy
	Turma **Campanillas** **Caucsiril** **Caushogo** *Polybia* spp., usually *P. occidentalis*			Scrotum[c] Little bell[c] Unanalyzable Unanalyzable	Important, easy
		Turma de las largas *Polybia diguetana*		Scrotum, the long kind[c]	Important, easy

TABLE 3
(*Continued*)

Intermediate	Generic	Specific	English Common Name	Translation of Spanish	Category
		Turma de las redondas		Scrotum, the round kind[c]	Important, easy
		Polybia occidentalis			
		Turma de toro		Bull's scrotum[c]	Important, easy
		Polybia rejecta			
	Catala			Unanalyzable	Important, easy
	Chilera			Chile-like[d]	
	Chilizata				
	usually *Polistes* spp.				
		Catala de las rojas		Red catala	Important, easy
		Polistes major, *P. instabilis*,			
		and *P. erythrocephalus*			
		Catala de las negras		Black catala	Important, easy
		Mischocyttarus spp.			
		Ahorcadora		Strangler[e]	Important, easy
		Polistes sp.			
	Jarrito			Little jar[c]	Important, easy
	Polybia emaciata				
	Pico de chanco			Pig snout[c]	Important, easy
	Alas blancas			White wings	
	Parachartergus apicalis				
	Chirechancho			Pig snout[c]	Important, easy
	Epipona sp.				
	Carnicero			Butcher[f]	Important, easy
	Comecarne			Meat eater[f]	
	Agelaia cajennensis				
	Quitacalzón			Underwear remover	Important, easy
	Papelillo			Little paper[c]	
	Protopolybia acutiscutis				
	Media luna			Half-moon[c]	Important, easy
	Apoica thoracica				
	Pupusa			Stuffed tortilla	Important, easy
	Metapolybia azteca				
	Panal			Honeycomb[g]	Important, easy
	Brachygastra mellifica				
	Guitarrón			Bass guitar[h]	Important, easy
	Corroncha de cuzuco			Armadillo's shell[c]	
	Panza de burro			Donkey's belly[c]	
	Synoeca septentrionalis				
	Caserita		Mud dauber	Little house[c]	Unimportant, easy
	Casitas de tierra				
	(Sphecidae)				
	Avispón			Big wasp	Unimportant, easy
	Rey de arañas			King of spiders	
	Cazarañas			Spider hunter	
	(Pompilidae)				
	Avispa de la papaya		Papaya fly	Papaya wasp[i]	Important, difficult
	Toxotripana curvicauda				
	(Diptera: Tephritidae)				
Abeja			Bee	Bee	Important, easy
(especially Apidae)					
	Blanco		Bee	Hive	Important, easy
	Colmena grande			Big hive	
		Abeja blanco de castilla	European honeybee	Castilian bee[j]	Important, easy
		Apis mellifera			
		Abeja aluva	Stingless bee	*Aluva* (unanalyzable) bee	Important, easy
		Blanco aluva		*Aluva* hive	
		Melipona beecheii			
		Abeja mora		*Moro* bee[k]	Important, easy
		Blanco moro		*Moro* hive[k]	
		Melipona fasciata			
	Morroco		Stingless bee	Unanalyzable	Important, easy
		Morroco		Unanalyzable	Important, easy
		Trigona amalthea			
		Trigona nigerrima			

TABLE 3
(*Continued*)

Intermediate	Generic	Specific	English Common Name	Translation of Spanish	Category
		Morroco pequeño		Little *morroco*	Important, easy
		Morroco tapiero		*Morroco* that makes earth walls	
		Talnete		Unanalyzable	
		Partamona bilineata			
		Culo de buey		Ox's anus[c]	Important, easy
		Culo de vieja		Old woman's anus[c]	
		Trigona fulviventris			
	Chumela			Unanalyzable	Important, easy
	Zope				
	Cumún				
	Nannotrigona sp.				
	Jimerito			Unanalyzable	Important,easy
	Trigona angustala				
	Quemaquema			Burns burns[l]	Important, easy
	Trigona pallens				
	Lambesudor			Sweat sucker	Important, easy
	Plebeia latitarsis				
	Zunteco			Unanalyzable	Important,easy
	Trigona nigerrima				
	Panta			Unanalyzable	Important, easy
	Zuncuán				
	Magua				
	Scaptotrigona pectoralis				
	Melero			Honey-maker	Important, easy
	Trigona sp.				
	Abejón		Bumblebee	Big bee	Unimportant, easy
	Abejorro			Hummingbird	
	Moscarrón			Big fly	
	Bombus ephippiatus				
	Galga		Ant	Greyhound	Important, easy
		Galga bala		Bullet greyhound[d]	Important, easy
		Pachycondyla sp.			
		Galga chela		Red greyhound	Important, easy
		Camponotus abdominalis			
		Galga loca		Crazy greyhound[m]	Important, easy
		Monacis bispinosa			
		Galga mora		Blackberry greyhound	Important, easy
		Camponotus sericeiventris			
	Guerreadora		Army ant	Warrior or guerrilla	Important, easy
	Guerrillera				
	mostly *Eciton* spp.				
		Guerreadora negra		Black warrior	Important, easy
		Eciton burchelli			
		Guerreadora roja		Red warrior	Important, easy
		Eciton hamatum			
	Hormiga		Ant	Ant (small)	Important, easy
		Hormiga brava	Fire ant	Mean ant[d]	Important, easy
		Solenopsis geminata			
		Hormiga de carnisuelo		Acacia ant[n]	Important, easy
		Pseudomyrmex flavicornis			
		Hormiga loca		Crazy ant[m]	Important, easy
		especially *Azteca* spp. and *Pheidole* spp.			
		Hormiga roja		Red ant	Important, easy
		Ectatomma tuberculatum			
		Hormiga tigre	Velvet ant	Jaguar ant[d]	Important, easy
		Hormigón		Big ant	
		Hormiga peluda		Hairy ant	
		(Mutillidae)			
	Zompopo		Leaf-cutter ant	Unanalyzable	Important, easy
	(Formicidae: Attini)				
	Mariposa		Butterfly	Butterfly/moth	Unimportant, easy
	(Lepidoptera)				
	Palomilla		Butterfly moth (small)	Little dove	Unimportant, easy
	(Lepidoptera)				
		Palomilla del maicillo	Sorghum moth	Sorghum moth	Important, difficult
		Polilla del maicillo			
		Sitotroga cerealella			

TABLE 3
(*Continued*)

Intermediate	Generic	Specific	English Common Name	Translation of Spanish	Category
	Gusano (larvae of several insects, especially Lepidoptera)		Worm	Worm[o]	Unimportant, easy
		Gusano peludo (several hairy larvae) (Arctiidae)		Hairy worm	Important, easy
		Gusano dorado *Estigmene acrea* (Arctiidae)		Golden worm	Important, easy
		Gusano quemador (Arctiidae)		Burning worm[d]	Important, easy
		Gusano cogollero larvae of *Spodoptera frugiperda* (Noctuidae)	Fall armyworm	Whorl worm[p]	Important, difficult
		Gusano medidor larvae of *Mocis latipes* (Noctuidae)	Grasslooper	Measurer	Important, difficult
		Falso medidor larvae of *Trichoplusia ni* and *Pseudoplusia includens* (Noctuidae)	False grasslooper	False measurer	Important, difficult
		Gusano elotero larvae that eat corn, e.g., *Helicoverpa zea* (Noctuidae)	Corn seed worm	Corn ear worm	Important, difficult
		Gusano cortador larvae that cut the cornstalk, e.g., *Agrotis* spp.	Cutworm	Cutter	Important, difficult
		Gusano cuerudo cutworms, e.g., *Spodoptera sunia*	Armyworm	Leathery worm	Important, difficult
		Gusano cachudo	Horned worm	Horned worm	Important, difficult
		Gusano corronchudo especially larvae of *Manduca sexta* (Sphingidae)		Thick, leathery worm	
		Gusano barrenador larvae of *Diatraea lineolata* (Pyralidae)		Driller[q]	Important, difficult
		Gusano barrenador de caña larvae of *Diatraea saccharalis* (Pyralidae)		Cane driller	Important, difficult
	Gusano de . . . (larvae of various Lepidoptera)			Worm of . . .	
		Gusano del pepino larvae of *Diaphania nitidalis* (Pyralidae)		Cucumber worm	Important, difficult
		Gusano del melón larvae of *Diaphania hyalinata* (Pyralidae)		Cantaloupe worm	Important, difficult
		Gusano del repollo larvae of *Ascia monuste* and *Leptophobia aripa* (Pieridae)		Cabbage worm	Important, difficult
		Rasquiña		Scratcher[r]	Important, difficult
		Gusano del repollo *Plutella xylostella*		Cabbage worm	
	Langosta (larvae of Noctuidae, e.g., *Mocis latipes*)			Locust	Important, difficult
	Coralillo (larvae of *Elasmopalpus lignosellus*) (Pyralidae)			Little coral snake[s]	Important, easy
	Coyota			Female coyote	Important, easy

TABLE 3
(*Continued*)

Intermediate	Generic	Specific	English Common Name	Translation of Spanish	Category
	Tórsalo (larvae of *Dermatobia hominis*) (Cuterebridae)		Botfly	Unanalyzable	Important, difficult
	Clavito (larvae of Culicidae)		Mosquito larvae	Little nail[s]	Unimportant, easy
	Gallina ciega (larvae of Scarabaeidae, especially *Phyllophaga* spp.)		White grub	Blind chicken	Important, difficult
	Gusano alambre (larvae of Coleoptera, Elateridae)			Wire worm[t]	Important, difficult
	Cucaracha de agua (Hydrophilidae)			Water cockroach[s]	Unimportant, easy
	Ronrón Especially *Phyllophaga* spp. (Scarabaeidae Subf: Melolonthinae)			(Onomatopoeic)[h]	Unimportant, easy
	Rueda mojón **Mierdero** (Scarabaeidae Subf: Scarabaeinae)		Dung beetle	Turd roller Shitter	Unimportant, easy
	Escarabajo (larger beetles of several families)			Beetle	Unimportant, easy
	Tronador **Trastrás** (Elateridae)		Click beetle	Cracker[h] (Onomatopoeic)[h]	Unimportant, easy
	Carapacho **Carapachito** *Megascelis* spp. (Chrysomelidae) and *Eutheola* spp. (Scarabaeidae)			Carapace[s] Little carapace[s]	Unimportant, easy
	Burro **Cachetón** (Meloidae, Cantharidae, Cerambycidae)			Donkey Big cheeks	Unimportant, easy
	Trozapalo (Passalidae)			Log breaker[u]	Unimportant, easy
	Candelilla **Luciérnaga** (Lampyridae)		Firefly	Little candle Light maker	Unimportant, easy
	Camaleón **Taladro** (Buprestidae)			Chameleon Drill[v]	Unimportant, easy
	Gorgojo (especially Curculionidae and Bostrichidae)		Weevil	Weevil	Important, difficult
	Picudo (especially Curculionidae)		Weevil	Big snout[s]	Important, difficult
	Tortuguilla **Malla** **Pulgón** (Chrysomelidae, especially *Diabrotica* spp.)		Leaf beetle	Little turtle[s] Mesh[w] Big flea[s]	Important, easy
	Pulga (Siphonaptera)		Flea	Flea	Important, difficult
	Nigua *Tunga penetrans* (Siphonaptera: Tungidae)		Chigoe flea	Chigoe flea	Important, difficult
	Ladilla (*Pthirus pubis*) (Phthiraptera: Pthiridae)		Crab louse	Unanalyzable	Important, difficult
	Piojo (*Pediculus humanus*) (Phthiraptera: Pediculidae)		Louse	Louse	Important, difficult
	Cusuquito (larvae of Myrmeleontidae) (Neuroptera)		Ant lion	Little armadillo[s]	Important, easy

TABLE 3
(*Continued*)

Intermediate	Generic	Specific	English Common Name	Translation of Spanish	Category
	Perro de agua			Water dog[s]	Unimportant, easy
	(larvae of Corydalidae)				
	(Neuroptera)				
	Chinche	**Chinche de agua**		Water bug	Unimportant, easy
	(Hemiptera)	**Tortuga de agua**		Water turtle[s]	
		(Belostomatidae)			
		Chinche estrella	Water strider	Star bug[s]	Unimportant, easy
		Patillo		Little duck	
		(Gerridae)			
		Chinche talaje	Bed bug	Unanalyzable	Important, easy
		(Cimicidae)			
		Chinche picuda	Cone-nosed bug	Big snout bug[s]	Important, easy
		Chinche casera		House bug	
		Triatoma dimidiata			
		(Reduviidae)			
		Chinche pata de alacrán		Scorpion foot[s]	Unimportant, easy
		Pata de hoja		Leaf foot[s]	
		Especially *Leptoglossus* spp.			
		(Coreidae)			
		Chinche hedionda	Stink bug	Stink bug[x]	Unimportant, easy
		Chinche pedorrilla		Fart bug	
		Chinche miona		Piss bug	
		(Pentatomidae)			
	Caballitos del diablo		Dragonfly	The devil's little horses	Unimportant, easy
	Libélula			Dragonfly	
	San Juán			Saint John	
	Guaro			A distilled cane liquor	
	Zuncún			Unanalyzable	
	Mojaculo			Ass wetter	
	Helicóptero			Helicopter	
	(Odonata)				
	Tijerilla		Earwig	Little scissors	Unimportant, easy
	Tijereta				
	Doru spp.				
	(Dermaptera: Forficulidae)				
	Chuchito de agua			Little water dogs	Unimportant, easy
	(Orthoptera: Gryllotalpidae)				
	Chapulín		Grasshopper	(Nahuati loanword)	Important, easy
	Langosta			Locust	
	Saltamontes			Grasshopper	
	Chachalaca			Chachalaca	
	Grillo			Cricket	
	(Orthoptera: Acrididae)				
	Grillo de noche		Cricket	Night cricket	Important, easy
	(Orthoptera: Gryllidae)				
	Esperanza		Katydid	Hope[y]	Unimportant, easy
	(Orthoptera: Tettigoniidae)				
	Cucaracha		Cockroach (large)	Cockroach	Important, easy
	(Blattaria: Blattidae)				
	Jate		Cockroach (small)	Unanalyzable	Important, easy
	(Blattaria: Blatellidae)				
	Ponemesas		Praying mantis	Table-setter[s]	Important, difficult
	Religiosa			Nun[s]	
	Rezadora			One who prays[s]	
	Madre de culebra			Mother of snake[z]	
	(Mantodea)				
	Quiebrapalitos			Break little sticks[s]	Unimportant, easy
	Secamano			Hand dryer[z]	
	Palo			Stick[s]	
	Chilincoco			Unanalyzable	
	(Phasmatidae: Phasmatidae)				
	Palomillas		Termite kings and queens with wings	Little moth	Unimportant, easy
	Polillas			Moth	
	(Isoptera: Termitidae)				
	Comején		Termite	Unanalyzable	Important, easy
	(Isoptera: Termitidae)				
		Comején de madera		Wood termite	Important, easy

TABLE 3
(*Continued*)

Intermediate	Generic	Specific	English Common Name	Translation of Spanish	Category
		Comején de tierra		Earth termite	Important, easy
		Comején de pelota		Ball termite	Important, easy
		(*Nasutitermes* spp.)			
	Piojillo		Thrip	Little louse[s]	Important, difficult
	(Thysanoptera)				
	Chicharra		Cicada	Cicada	Unimportant, easy
	Chiquirín			(Onomatopoetic)[h]	
	(Homoptera: Cicadidae)				
	Lomo de camello			Camel's hump	Unimportant, easy
	Torito			Little bull	
	(Homoptera: Membracidae)				
	Espuma de sapo		Spittlebug	Toad foam	Unimportant, easy
	Sapillo			Little toad	
	Salivazo			Glob of saliva	
	Espumón			Big foam	
	Ponchito			Little punch	
	(Homoptera: Cercopidae immature)				
	Lorito verde		Empoasca	Little green parrot[s]	Important, difficult
	Especially *Empoasca kraemeri*				
	(Homoptera: Cicadellidae)				
	Pulgon		Aphid	Big flea[s]	Important, easy
	Piojillo			Little louse[s]	
	(Homoptera: Aphidiidae)				
	Mosca blanca		Whitefly	White fly	Important, difficult
	(*Bemisia tabaci*)				
	(Homoptera: Aleyrodidae)				

[a] Rolled up, looks like coin.
[b] Believed to urinate while plucking hair for nest from horse's leg, causing horse to lose its hoof.
[c] Allusion to shape of nest.
[d] Stings.
[e] Sting produces choking sensation.
[f] Eats carrion.
[g] Makes honey.
[h] Allusion to sound it makes.
[i] Mimics a wasp.
[j] Originally brought to Latin America from Spain.
[k] *Moro* means "Moor" and *mora* means "blackberry," but in this case *moro* is probably unanalyzable.
[l] Secretes a burning liquid on attacker's skin.
[m] Runs around.
[n] Lives in symbiosis inside the thorns of the bullhorn acacia.
[o] In Spain *oruga* is the word for "caterpillar," but in Latin America *gusano* is generally used for both "worm" and "caterpillar."
[p] Lives in and eats maize whorls.
[q] Drills into cornstalk.
[r] Scratches into flesh of cabbage.
[s] Allusion to appearance.
[t] Calqued from English by agronomists?
[u] Lives in fallen timber.
[v] Bores into trees.
[w] Makes the leaves it eats look like mesh.
[x] Defends itself with foul-smelling urine.
[y] Brings good luck.
[z] Is believed to deform hand of person who picks it up.

head and have unique shapes and colors. Hymenoptera are culturally important for their honey, their edible brood, and their defense strategy (stinging, biting, and blistering). Fifty-one (38%) of the folk names we recorded for *insectos* are for Hymenoptera. The only two intermediate taxa in Honduran folk entomology are for Hymenoptera: bee (*abeja*) and wasp (*avispa*).

We would expect a detailed folk taxonomy for insects that people eat (see Conconi 1982, Dufour 1987, Posey 1987, Moran 1991, Setz 1991). Honduran peasants eat some social wasp brood and honey, and they have a complex classification for wasps, with many folk genera and a few specifics. Some of the social wasp folk genera are polytypic, among them, *catala* (*Polistes* spp. and some *Mischocyttarus* spp.) and *turma* (some *Polybia* spp.). The Jicaque of Honduras, formerly hunter-gatherers, eat wasp brood and classify wasps in nearly the same way as Hispanic Hondurans (Oltrogge 1975). In contrast, the Bribri, forest horticulturists of Costa Rica, classify a fairly similar wasp fauna with binomial labels (Starr and Bozzoli 1990). Most Honduran bee names are generics, but there are three folk species in the genus *abejas de blanco*, "hive bees" (*Apis mellifera* and two *Melipona* spp.). All three species live in the forest and are also tended in the villages. In the woods, the bees nest in hollow tree branches, which campesinos cut off and bring home to hang from their front porches, harvesting the honey regularly, somewhat as described by Posey (1983) for the Kayapó. The three "hive" (*blanco*) species are much larger than other bees. This folk genus is classified by size, not by use, since at least two species of smaller bees are also brought home and protected but are not classified as *abejas de blanco*. The folk genus *morroco* (several smaller Meliponinae bees) is also polytypic.

Campesinos say, "Wasps sting and don't make honey. Bees don't sting and do give honey." However, the (*avispa*) *panal*, "honeycomb (wasp)" (*Brachygastra mellifica*), is a honey-making vespid wasp, and the European honeybee, *abeja de castilla* (*Apis mellifera*) stings, unlike other local bees. In spite of this ambiguity, Honduran farmers classify the *panal* as a wasp and the honeybee as a bee, as do entomologists.

Hondurans classify ants (Hymenoptera: Formicidae) in four folk genera—*zompopos*, *guerreadoras*, *hormigas*, and *galgas*—but have no word for "ant." *Zompopos* (leafcutter ants—Formicidae: Attini, especially *Atta* spp. and *Acromyrmex* spp.) are not classified as ants. Few insects are more conspicuous or perceptually salient. Large and red or black, they travel in long columns carrying crescent-shaped pieces of leaves like sails. Some of their trails through the tropical vegetation are as bare and wide as human paths. They are common, and some species are diurnal. The mounded entrances to mature colonies cover several square meters. They occasionally attack maize or other crops and can strip an orange tree bare overnight.

Army ants (*guerreadoras*), "warriors" (especially *Eciton burchelli* and other *Eciton* spp.), are the next-most-salient ants; the colonies move constantly and can field several million workers each, fanning out in long columns and eating every small animal they catch (see Hölldobler and Wilson 1990: chap. 16). The Honduran folk name is grammatically feminine, suggesting that it may have evolved from **hormiga guerreadora*. All other ants fall into two residual categories. Large ones are *galgas* (literally "greyhounds"). Small ones are *hormigas* ("ants" in Standard Spanish). There are several folk species of *galga* and *hormiga*. Stinging and nonstinging folk species are distinguished, for example, *hormiga brava* (*Solenopsis geminata*) and *galga bala* (*Pachycondyla* sp.) are known mainly for their bite and sting.

Several species of orange hairy caterpillars, *gusano peludo* (family Arctiidae—especially *Estigmene acrea*—and Megalopygidae), are distinguished. The megalopygid species have urticating hairs that burn to the touch, while arctiid caterpillars are harmless, fuzzy Batesian mimics. Many campesinos fail to distinguish the imitators from the burning caterpillars. This contrasts with local knowledge of bees, but in contrast to bees, none of the hairy caterpillars are useful and therefore they can all receive the same behavioral response (Hays 1982:92): avoidance.

Campesinos consider few other insects as important as bees or wasps and classify them at the biological order or family level. However, they may single out a few families because of their harmfulness. Tabanidae (horse flies) are distinguished from other flies because of their bite (see Posey 1984:133).

Important, easily observed species may be named in orders which are otherwise not highly classified. There are few Honduran terms for the various true bugs (order Hemiptera). One of these is *chinche picuda* (especially *Triatoma dimidiata* [Hemiptera: Reduviidae]), a large red-and-black bug that lives in people's houses and sucks blood from humans and other warm-blooded animals. Campesinos are becoming aware through public health programs that it transmits Chagas' disease. The Spanish term used in these programs, *chinche* (true bug), unfortunately leads to some confusion.

Honduran campesinos know some insects because of their role in children's play. Dry sand patches are often dimpled with the conical traps of ant lions (Neuroptera: Myrmeleontidae). The late Arnulfo Flores, a Honduran farmer, showed us how to blow the sand out of the traps and collect the fat, squirming insects and said, "We used to play with them when we were kids."

Culturally important, easily observed taxa are finely categorized. Many of the terminal taxa are folk species that coincide with Linnaean species. The only two intermediate categories (bee, wasp) in Honduran folk entomology are culturally important and easily observed. This category could be used as an illustration for a paradigmatic description of biological folk categories, with hierarchical taxonomic levels and some polytypic folk genera divided into binomial folk species. The other three categories could not.

Hondurans label the following invertebrates even though they have little if any local cultural significance: millipede, centipede, earthworm, spider, harvestman, hover fly, mosquito larvae (not recognized as the young of mosquitoes), butterfly, small butterfly (*palomilla*), water scavenger beetle (Hydrophilidae), June beetle, large beetle, click beetle, timber beetle, lightning bug, metallic woodboring beetle (Buprestidae), larval dobsonfly, true bug, dragonfly, earwig, mole cricket, katydid, termite reproductives, cicada, treehopper, spittle bug, mud dauber wasp, tarantula wasp, and bumblebee. These categories are folk genera, but their organization is not very hierarchical. They are not subordinate to intermediate ranks, and they rarely have subordinate specific ranks. This long, flat taxonomy of generic categories lumps invertebrates at the biological order or family level, with the result that each folk genus includes hundreds or thousands of biological species. The taxonomy of the easily observed but culturally unimportant has little structure. It could be represented as an index or a finding list (Conklin 1969:107).

Campesinos classify some insects at the order level or lump several families together while singling out other insect families for names of their own. They notice *candelillas* (lightning bugs—Coleoptera: Lampyridae) because of their light and find the insects difficult to recognize in the daytime. Click beetles (*tronadores*) (Coleoptera: Elateridae) have little cultural importance as adults, but they are noticeable; they can snap a joint between two thoracic segments with enough force to hurl themselves into the air.

Small, cryptic arthropods that would otherwise escape attention demand a name if they are pests of the human body such as ticks, chiggers, and lice.

Culturally important mimics are named but may be misclassified from a modern scientific perspective. Campesinos label the papaya "wasp" at the biological species level; they know that the *avispa de papaya* causes worms to appear in papaya fruit. Entomologists, in contrast, know it as a fly (*Toxotrypana curvicauda* [Diptera: Tephritidae]) that, except for its long ovipositor (egg-laying organ) and two wings (wasps have four), is an uncanny mimic of a tiger-colored social wasp, *Agelaia cajennensis* (Hymenoptera: Vespidae).

Because they are difficult to observe, all grain-dwelling Honduran beetles (at least 25 species) are classified as *gorgojos*, "weevils" (Hoppe 1986), including true weevils (Curculionidae) and members of at least three other families (Bostrichidae, Tenebrionidae, Cucujidae). They spend their first three life stages buried in stored food. Many farmers confuse the parasitic wasps of the weevils with the weevils themselves. However, they classify weevils as *picudos* if they feed on beans, chiles, and other crops in the field (rather than in storage). *Gorgojos* and *picudos* are contrasted ecologically (field versus storage), not by morphotype, because of their cultural importance as pests.

Most Lepidoptera (butterflies and moths) are specialized plant eaters in their larval (caterpillar) stage. Some are pests, and these are important and labeled at the biological species level. Caterpillars that feed on wild plants are labeled by the residual term *gusano*. The insects themselves are often difficult to observe—small, colored to blend with the host plant, and buried in plant tissue—but are noticed because of the attention that farmers pay to their crops. As Hunn (1982) observed in Chiapas, Honduran campesinos label pest caterpillars but classify the adults as separate species. There are many names for pest caterpillars, while the adults are lumped into larger, almost residual categories such as *mariposa*, "moth/butterfly." Crop varieties are often binomial folk species (Hunn and French 1984; Berlin 1992: 24), and so are many crop pests.

Few anthropologists have discussed what local people do not label. It is easier to notice what is present than to notice what is missing (Hearst 1991). However, cross-culturally, there are consistent gaps in local classifications. Many organisms are too difficult to observe and too unimportant to be included at all in Honduran folk entomology. Most parasitic wasps are solitary and too small to be seen easily, in spite of being among the most numerous insects on Earth (LaSalle and Gauld 1991). Terrestrial nematodes tend to be microscopic and soil-dwelling. Insects of the order Collembola are small, flightless, and soil-dwelling; even some relatively large insects like green lacewings (Neuroptera: Chrysopidae) are not named even though they are occasionally seen. Green lacewings are difficult to see because they are solitary, pale green, and nocturnal. Millions of species of mites go unobserved and unlabeled. The exception that proves the rule is the *coloradilla* (chigger—Acari: Trombiculidae), a larval mite that digs into human skin and causes an agonizing itch.

TABLE 4
Taxonomic Properties of Each Category

	Culturally Unimportant	Culturally Important
Easy to observe	Shallow, often a long string of generic terms. Organisms named to the level of Linnaean orders or families.	Deeper, hierarchical (often including intermediate and specific levels). Organisms frequently named to the level of Linnaean species.
Difficult to observe	None	Deep (e.g., with folk species), but adult and juvenile forms are not necessarily classified together and adults may even be lumped in large, residual categories. Some stages of some organisms are labeled to the level of the Linnaean species.

Some highly salient species are unnamed because they are so scarce that they are rarely observed. We noticed a colony of wasps (*Brachygastra smithi* [Hymenoptera: Vespidae]) with an asymmetrical, lumpy nest envelope. The wasps stung us when we touched their tree. We asked several campesinos about the species. They had never seen it before and recognized it as a new species but had no name for it. The colony moved on within a few days, and in four years we never saw another.

In summary (see table 4), intermediate categories are found only in the culturally important and easily observed group. Folk genera may be divided into species if they are culturally important, whether easy or difficult to observe. The easily observed but culturally unimportant taxa have little hierarchical organization and correspond roughly to scientific orders and families. Folk classification of culturally important but difficult-to-observe organisms may be inconsistent with modern scientific taxonomy, especially where a species mimics a distantly related one, where creatures are small, or where people fail to associate larvae with their adults. The culturally unimportant and difficult to observe are unclassified.

SEMANTICS

Some plant and animal names are semantically opaque. Most other names are coined from either appearance or utility (or damage). As Berlin (1992:27) has observed, encoding salient morphological and behavioral features in ethnobiological names makes a large vocabulary easy to learn and remember. In Honduras, most of the culturally unimportant and easily observed invertebrates are named for their appearance and behavior, and a plurality of the culturally important and difficult-to-observe creatures are named for their importance (e.g., the crops they attack). Some culturally important and easily observed invertebrates are named for their natural attributes and others for their cultural roles, but some names in all three of these categories are unanalyzable.

The culturally important and easily observed insects tend to be named for natural rather than cultural traits. Of 66 categories which we judged to belong to this group, 34 (52%) were named for natural attributes. For example, the leaf beetle is *tortuguilla* ("little turtle") because it has a hard round shell. Most wasp and bee species are named after an object that the nest resembles: a pig's snout, an ox's anus, or a bass guitar.

Seventeen (26%) of the culturally important and easily observed insects are named for their cultural roles. For example, the "underwear remover" (the social wasp *Protopolybia acutiscutis*) is named for the way it attacks humans, and so is a bee called *quema quema* ("burny burny") (*Trigona pallens*), which burns its victims with a toxic secretion. As we have seen, a wasp that makes edible honey is called *panal*, "honeycomb." The tarantula (Theraphosidae) is called (*araña*) *meacaballo* ("horse-pissing spider") because campesinos insist that tarantulas urinate on a horse's foot and make it lose its hoof. (Most agronomists deny the validity of this belief.) The *comecarne* ("meat eater") wasp (also called *carnicero*, "butcher") (*Agelaia cajennensis*) feeds on carrion and sometimes annoys farmers butchering an animal.

Fifteen (23%) of the culturally important and easily observed insects have semantically opaque names, some of which are old Spanish words and a few of which are loans from Native American languages. The 29 categories with semantically opaque names in Honduran folk entomology are spread fairly evenly and do not correlate with either cultural importance or ease of observation. This result was unexpected. Balée (1989) notes that cultivated plants (which are culturally important and easily observed) are labeled by single-word, unanalyzable lexemes.

We expected that the easily observed but culturally unimportant creatures would be named for natural attributes. Of 41 insects in this category, 31 (76%) are so named. For example, daddy longlegs (harvestmen) (order Opiliones) are called *pendejos* ("pubic hairs") because when they are huddled in a gregarious mass they look like a clump of body hair. Dung beetles (Coleoptera: Scarabaeidae: Scarabaeinae) are *ruedamojón* ("turd roller"); the lightning bug is *candelilla* ("little candle"). Eight (20%) have unanalyzable, semantically opaque names. Only two categories (5%) are named for the way in which the insects interact with humans. Hover flies are named *chupasudor*, "sweat-sucker," for their habit of lapping sweat from the arms of people at work.

TABLE 5
Semantics of Each Category

	Culturally Unimportant	Culturally Important
Easy to observe	Most named for a natural characteristic	Named for a natural characteristic; fewer named for the role they play when interacting with humans
Difficult to observe	Not named	Many named for their role in human culture; some named for a natural characteristic

We expected that culturally important but difficult-to-observe insects would be named for their interaction with humans. Only 13 (38%) of the 34 categories in this group are named for their cultural importance. Most of the caterpillar pest species are named for the fruit they attack (e.g., *gusano del melón* [*Diaphania hyalinata* (Lepidoptera: Pyralidae)]) or the kind of damage they do (e.g., *gusano cogollero*, "whorl worm"). Another 13 of these insects are named for natural characteristics, again reflecting the overall Honduran bias toward natural rather than cultural insect names. The *babosa* (slug) (several gastropod families, especially Veronicellidae) is named for the trail of slime it leaves. *Picudos* (field weevils) are named for their snouts. *Gusano cachudo* (several horned caterpillars of the family Sphingidae, especially *Manduca sexta*) is named for its horn. It seems paradoxical that any difficult-to-observe insects could be named for their physical characteristics, but while difficult to observe they are not invisible. Six (18%) of the culturally important and difficult-to-observe insects have semantically opaque names.

In summary (see table 5), 80 (57%) of all categories are named for natural attributes. This lends modest support to the universalist hypothesis, and, as would be expected, the tendency is especially strong for the easily observed but culturally unimportant. Some names, especially for the culturally important insects, reflect the creatures' interaction with humans. Thirty-two (23%) of all categories are named for their interaction with humans, which lends a little support to the utilitarian hypothesis. Almost all of those names (30, 94%) are for culturally important taxa. The 29 (21%) categories labeled with unanalyzable names are evenly spread through the whole lexical set. Binomial folk species generally label culturally important insects, whether easy or difficult to observe. The names for pests are highly productive (tomato worm, melon worm, etc.).

DISCUSSION

We began by asking whether people discover their world or create it—that is, whether they know and name living things for their natural (universal) qualities or for their culturally specific roles in human life. On semantic evidence, the rural people of Central Honduras pay more attention to natural attributes but name a substantial minority of creatures for their roles in human culture—suggesting that the people both discover and create their world. Honduran campesinos discover (and label) nature's major morphotypes, the biologists' orders and families—the ants and the butterflies "crying out for names." This supports the universalist argument. They discriminate finer categories according to local cultural priorities of avoiding pain, playing, getting food and shelter, and managing pests. This supports the cultural relativist argument, misnamed "utilitarian" in that culture deals with creatures as much for their nuisance value as for their utility. When a culture classifies the creatures that nature camouflages, some species are confused with unrelated ones; some relationships between adults and offspring are misunderstood. Culture ignores the microscopic species and others that nature hides.

We propose that people first discover their world. As the universalist argument suggests, they notice and name the great categories of natural things that cry out for labels. At least with insects, they name major morphotypes (dragonflies, for example) just because those organisms are so perceptually salient, even when they are perceived to have no utility or harm value for humans. However, as people make a living, they create or at least modify their world. They notice more subtle details of coloring, habitat, locomotion, etc., to distinguish pests from nonpests, food from the inedible, the safe from the dangerous (consistent with the utilitarian argument). Traditional rural people label the insect world along universalist lines about to the level of the Linnaean order or family but generally label entomofauna at the (formal, biological) genus or species level only when necessary for utilitarian reasons. In other words, as the universalist perspective suggests, nature provides people with the basic framework for biological taxonomies, the names for living things and the folk knowledge of them. However, people elaborate on that basic system in culturally specific ways to make a living, to play, to avoid pain, and occasionally to meet spiritual and other culturally mediated needs.

Given the limits of unaided human observation, the millions of Earth's species, and other demands on people's attention, traditional peoples cannot label all invertebrates. However, ethnoentomology has ample categories for discussing work and play and for wondering about living things. Folk classification of terrestrial invertebrates is reasonably comprehensive and usually consistent with formal, scientific entomology. Traditional rural people know insects more intimately than anyone except entomologists, but few entomologists know how to harvest wasp honey or are aware that leafcutter ants host lizard lodgers.

We hypothesize that cross-culturally, fish, mammals, birds, trees, weeds, and crops will also be associated with deep knowledge and deep taxonomies and will be named for a mix of natural and cultural properties (because these taxa are culturally important, usually, and easily observed). Disease organisms and most pests of crops, livestock, and the human body will be associated with gritty knowledge and taxonomies that are somewhat stratified and will often be named for their utility (harm) value (because they are culturally important but difficult to observe). Larger insects, large but inedible fungi, and useless but harmless herbaceous plants will be associated with thin knowledge and flat taxonomies in categories formed at high Linnaean levels, and their names will describe their appearance (because they are culturally unimportant but easy to observe). The very small, rare, cryptic beings, such as most nematodes, bacteria, and microscopic fungi, will be associated with no local knowledge, no taxonomies, and no names (because they are difficult to observe and culturally unimportant).

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Assessing the Biological Status of Human Populations[1]

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The biological status of human populations is an important object of research on human evolution and adaptation to contemporary living conditions and on practical applications related to its role as a mirror of socioeconomic transformations. Every human biological trait reflects living conditions, but the phenotype is the product of all the traits taken together. Moreover, cultural adaptation modifies and replaces biological adaptations and must therefore also be taken into consideration. The biological status of a population describes its potential for health in terms of both negative and positive indices. Body height and weight are usually taken as positive indices of health, especially in childhood. The biological status of an adult is the result of growth and development. From this the health of the environment is also assessed. Biological status, health status, nutritional status, and reproductive fitness are interrelated but have independent meanings and values. The last three of these are also related to certain psychological and social problems. In our discussion the term "biological status" is in general broader than the other three terms.

"Adaptation" is here understood as the structural and functional characteristics of individuals that enhance their survival and reproduction and enable them to cope with their environment. Adaptation may be genetic or cultural. "Adaptive changes" are understood as a pattern of adaptation and/or adjustment to the environment, biological and/or cultural. Any change in environmental conditions causes adaptive changes in human populations. In contemporary populations these changes are usually assessed in terms of a synthetic biological marker, stature. Although such comparisons are based on several traits, each trait is considered separately (Wolański 1966, 1990). Indices relating one trait to another are sometimes used to eliminate differences resulting from variation in stature or weight, but there is a lack of such relations between traits involved in the same physiological process. Some progress in this direction has been provided by factor analysis, which creates a smaller number of noncorrelated factors or components. Unfortunately, these nonmeasurable factors or components are difficult to identify and interpret.

Studies of populations living under different social and economic conditions and at various cultural levels have revealed that it is impossible to distinguish them in terms of any single trait. For example, if individuals representing a certain population are tall, their nutritional and health conditions can be expected to be good; however, the same population may show low endurance fitness, considered a negative trait. People from one population may display high muscular strength but low persistence fitness (stamina), whereas others have high persistence fitness but low muscular strength. Many biological traits—for example, the various respiratory, cardiovascular, and blood traits involved in transporting oxygen to the tissues—interact. If vital capacity alone were examined, the process of respiration would not be fully understood. In the case of some environmental influences, vital capacity, blood pressure, or hematocrit index may not show any changes while changes are apparent in ventilation and/or hemoglobin concentration and/or heart output. The question is which population is biologically better off.

The main aim of this work is to show that the kind of evaluation just described is insufficient. Thus, the problem becomes how to assess the biological status of human populations as an indicator of health and how to interpret variations in individual biological traits. We shall present an attempt to elucidate this problem using investigations conducted in different geographical regions and including populations living under different socioeconomic conditions. We want to show how contemporary human populations in a country that is ethnically rather homogeneous adapt to their living conditions by presenting their phenotypic differences. We suggest that the criteria used for the assessment of biological traits need to be revised; instead of attempting to assign positive or negative values to traits we should

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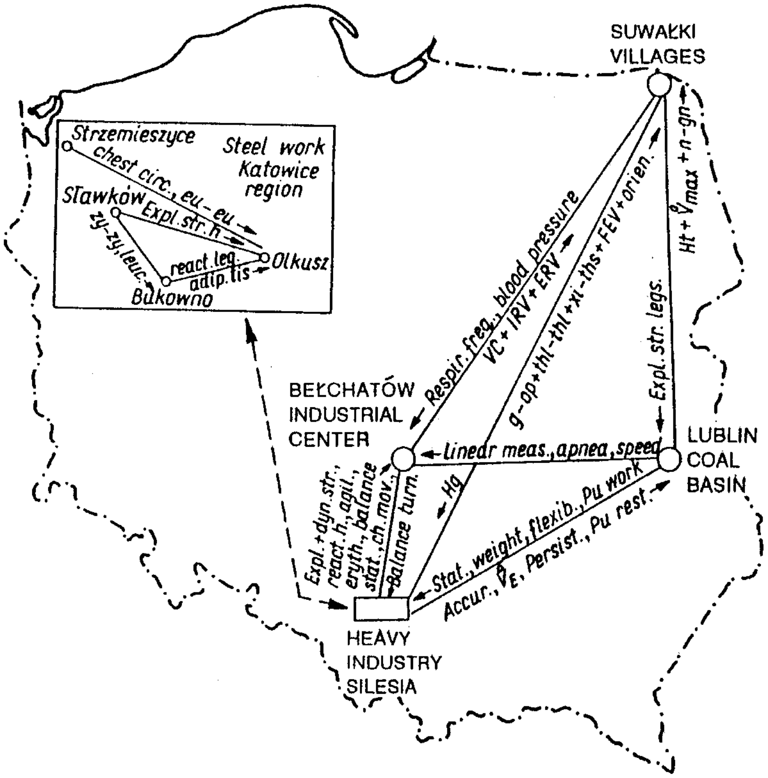

Fig. 1. *Greatest differences between Polish populations for certain somatic, physiological, and psychomotor traits. Arrows point to population in which the value of the traits in question is greatest or best. Abbreviations:* accur., *accuracy of movements;* adip. tis., *thickness of subcutaneous fat tissue;* agil., *agility;* apnea, *duration of apnea;* balance stat. (turn.), *static (or turning) sense of equilibrium;* chest circ., *chest circumference;* ch. mov., *chest movement range;* dyn. str., *dynamic strength;* eryth., *erythrocyte count;* eu-eu, *head breadth;* expl. str. legs (h.), *explosive power of lower (upper) extremities;* FEV, *forced expiratory volume per second;* flexib., *spine flexibility;* g-op, *head length;* Hg, *hemoglobin concentration;* Ht, *hematocrit index;* IRV (ERV), *inspiratory (expiratory) reserve volume;* linear meas., *various linear measures;* leuc., *leucocyte count;* n-gn, *total facial height;* orien., *spatial orientation;* persist., *persistence fitness (stamina);* Pu rest, *pulse rate at rest;* Pu work, *pulse rate at work;* react. h. (leg), *reaction time of hands (legs);* respir. freq., *frequency of respiration;* speed, *speed of movements;* stat., *stature;* thl-thl, *chest breadth;* VC, *vital capacity;* $\mathring{V}_{max}$ = *maximal minute ventilation;* weight, *body weight;* xi-ths, *chest depth;* zy-zy, *face breadth (Siniarska 1984).*

consider the broad range of living conditions to which they are adapted.

MATERIALS AND METHODS

The synthesis presented below is based on data we collected between 1971 and 1993 in Poland and Mexico and comparisons with the data of other researchers. In 1959 and 1979, 3,235 subjects (1,618 males) and 2,856 subjects (1,420 males), respectively, between 2 and 20 years of age were studied in Warsaw (Wolański 1962, Wolański and Lasota 1964, Kozioł and Wolański 1982). In 1960 a similar study of 2,600 children and youths (1,305 males) of the same age was conducted in Polish villages in the area of Kurpie and Suwałki (Wolański and Lasota 1964, Wolański 1973). Between 1963 and 1968, 3,119 subjects (1,570 males) between 5 and 17 years of age were studied in various parts of Poland: rural areas (Suwałki and Kurpie regions), coastal areas (the Hel Peninsula), an area of low mountains (Pieniny Mountains), cities (Warsaw and Katowice), and a heavily industrialized region (Silesia) (Pyżuk and Wolański 1972). In 1971, 297 subjects (156 males) between 21 and 70 years of age were studied in two villages in the Kurpie region, Jeglijowiec and Brzozówka (Szemik 1986). Between 1975 and 1978, 5,692 subjects (2,951 males) between 2 and 80 years of age were studied in a rural area (the Suwałki region), in regions undergoing initial industrialization (the Lublin coal basin and the Bełchatów industrial center), and in a heavily industrialized region (Silesia) (Siniarska 1984, Siniarska and Wolański 1986). The last of these studies took place in 1993 in Mexico, where 642 subjects (321 males) between 2 and 18 years of age were studied in Mérida and

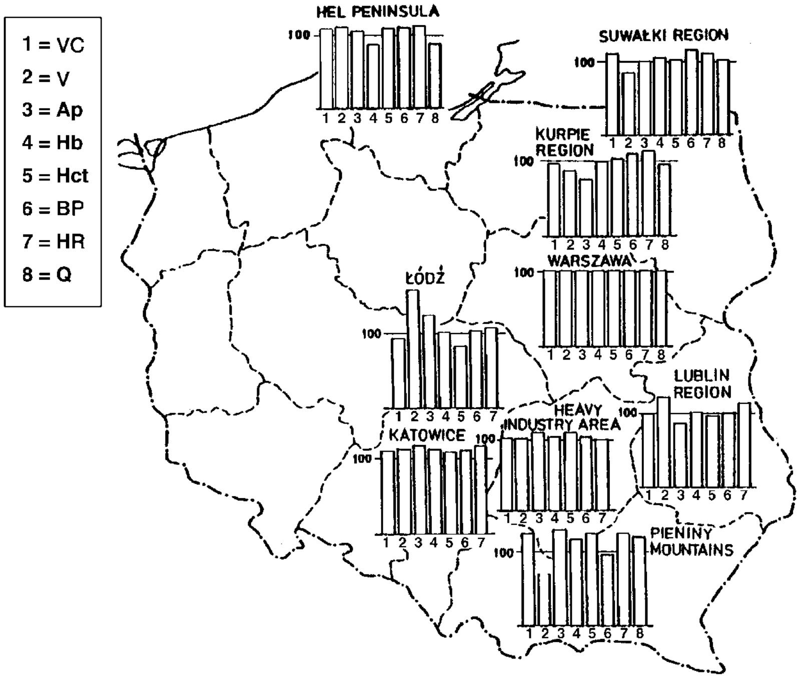

FIG. 2. *Differences in respiratory-circulatory functions under various climatic and altitude conditions and conditions created by industrialization and urbanization (especially air pollution). Abbreviations:* VC, *vital capacity of lungs;* V, *lung ventilation at rest per minute;* Ap, *apnea, time without breathing;* Hb, *hemoglobin concentration;* Hct, *hematocrit index;* BP, *arterial blood pressure;* HR, *heart rate at rest;* Q, *minute heart volume at rest (cardiac output) (Pyżuk and Wolański 1972, Kozioł and Wolański 1982).*

Progreso, Yucatán (Wolański 1994). Descriptions of the study areas and their demographic characteristics and of the methods of measurement have appeared elsewhere (Pyżuk 1973; Wolański, Siniarska, and Szemik 1982; Siniarska 1984, 1996; Wolański 1994). Various morphological and physiological variables and some psychomotor characteristics were used in the summary paper (Siniarska 1996).

The illustrative material in this paper is based mostly on males for two reasons. First, boys often demonstrate greater variability of response to environmental and cultural variables than girls, and therefore the influence of many environmental factors is more clearly seen. Second, the changes in females are of the same character, and therefore it seemed appropriate to save space by presenting our results using only one gender.

RESULTS

Trait values in various populations. Siniarska's (1984) data on morphological, physiological, and psychomotor traits show that different populations have different maximal (or optimal) values of various traits. Of the populations under study (fig. 1) the tallest are those from the heavily industrialized area of Silesia. Possible reasons for this are higher incomes, greater consumption of foods rich in animal protein, and a tendency toward greater body size in polluted environments. People in this environment show the lowest values for physical fitness, for which the highest values are found in one of the areas just beginning industrialization, Bełchatów. This latter population shows the lowest values for respiratory traits, for which the highest values are found in the rural agricultural villages of Suwałki. The Suwałki population also shows the lowest blood pressure and resting respiration frequency but a high hematocrit index and maximal ventilation. Both maximal ventilation and stature have the lowest values in the rural population from another area in the initial phase of industrialization (the Lublin coal basin), which also has a low working heart rate and a low hematocrit index.

Summing up the positive trait values in the populations studied, (1) the rural agricultural population has the best respiratory traits and hematocrit index; (2) the rural population under initial industrialization shows a low working heart rate and the greatest stamina; (3) the town population under initial industrialization shows long apnea duration, high erythrocyte count, high speed of movement, great explosive power, short reaction time, and good sense of balance; and (4) the population from the heavily industrialized area shows great stature and body weight, high hemoglobin concentration, and high spine flexibility. From these results it is impossible to

TABLE 1
Results of Motor Fitness Tests in Polish Villages, Towns, and Industrializing Areas

Trait	Villages	Towns	Industrializing Areas
Agility and coordination			
Spine flexibility	1	2	3
Turning balance	2	1	3
Static balance	1	2	3
Movement memory	1	3	2
Spatial orientation	1	–	3
Throwing accuracy	2	3	1
Running agility	3	1	2
Strength and power			
Grip strength	3	1	2
Back lifting strength	3	–	1
Explosive power of arms	2	1	3
Explosive power of legs	1	2	3
Speed			
Reaction time	2	1	3
Arm movement	2	1	3
Leg movement	2	1	3
Stamina			
Burpee test	1	2	3
Kraus-Weber test	1	2	3
Hanging with arms	1	2	3
Endurance fitness (oxygen power)	2	3	1

NOTE: 3, high; 2, moderate; 1, low.

categorize the populations in terms of biological well-being. It cannot be said that the rural agricultural population is better off because of its respiratory traits or that being tall makes the heavily industrialized society healthier or that better motor fitness shows the merits of living in relatively small industrial towns. It can only be said that these populations differ.

Differences in physiological functions. In the population from the coastal area, the Hel Peninsula, individuals have low vital capacity, high minute lung volume, low hemoglobin concentration, high blood pressure, and low heart output. In the population from the Pieniny Mountains, ca. 700 m above sea level, the values for these traits are reciprocal: high vital capacity, low minute volume, high hemoglobin concentration and hematocrit index, low blood pressure, and high heart output (fig. 2). Which is better? If the hemoglobin concentrations of 12% typical of the coastal areas are considered normal, then the mountain dwellers can be judged anemic. However, we know that populations with low hemoglobin also have high vital capacity and minute heart volume, which means that oxygen transport is efficient in a different way. Again, people working in agriculture need efficiency in different motor traits from those required for work in industry or in offices. All these differences should reflect the conditions under which each population lives.

The differences between mountain and coastal populations are also seen in other physiological traits. However, if we assume that all these traits play an important role in oxygen transport it is normal for some traits to have elevated values and others lower values under different climatic and probably nutritional conditions because the final result is expected to be the same: the delivery, under the same workload, of sufficient oxygen to the tissues. Therefore it cannot be said that one population shows better biological status than others because of the value of a single trait. In populations living in heavily industrialized areas, the values of almost all the traits studied are elevated. It may be that a trait that normally shows a low value increases under critical conditions to help in oxygen delivery and this phenomenon plays a special role in the biological reserve system. Where all physiological traits show elevated values, this may indicate a lack of reserves that may be destructive to the organism. The organism adjusts to particular climates and nutritional regimes in different ways, and the fact that physiological traits show high values in some populations does not mean that their biological status is satisfactory.

Differences in motor properties. Studies of psychomotor traits measured in rural, urban, and industrializing-area populations show that high running agility and static muscular strength (table 1) characterize the rural population. The urban population shows a high movement memory (proprioceptive sense), throwing accuracy,

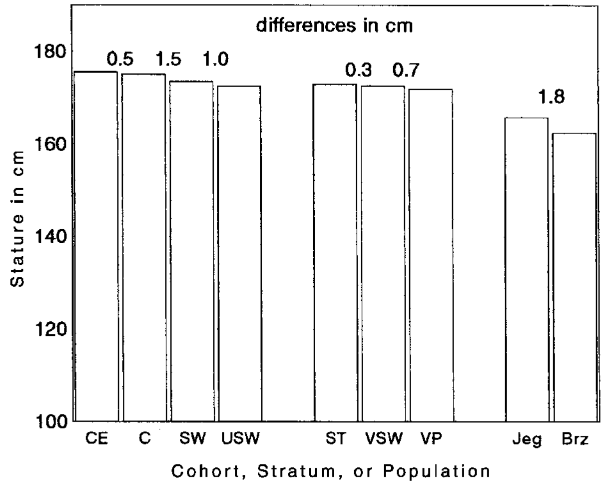

FIG. 3. *Stature of adult males in various social strata of Polish towns, small towns, and villages and in two Kurpie villages, Jeglijowiec and Brzozówka (data from Bielicki and Welon 1982, Bielicki and Waliszko 1991, Szemik 1986). Abbreviations:* CE, *parents have college education;* C, *parents are clerks;* SW, *parents are skilled workers;* USW, *parents are unskilled workers;* ST, *from small towns;* VSW, *skilled workers from villages;* VP, *peasants;* Jeg, *from Jeglijowiec;* Brz, *from Brzozówka.*

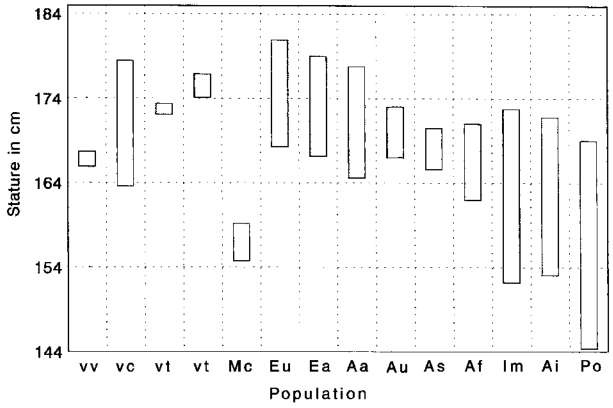

Fig. 4. *Minimal and maximal mean stature in adult males from various ethnic groups (Williams 1931), settlements (villages and towns; Wolański 1962, 1973, 1987; Szemik 1986), social strata (Bielicki and Waliszko 1991), and continents, including individuals of African and European origin (Comas 1971; Eveleth and Tanner 1976, 1990; Das 1993). Abbreviations:* Mc, *Maya and ladinos;* vv, *two villages;* vt, *village and town;* vc, *village and city;* Eu, *European;* Ea, *European-ancestry;* Aa, *African-ancestry;* Au, *Australian;* As, *Asian;* Af, *African;* Im, *Indo-Mediterranean;* Ai, *American Indian;* Po, *Polynesian.*

and endurance fitness. The populations of the areas under initial industrialization have the highest values for spine flexibility, balance, spatial orientation, explosive power of arms and legs, reaction time, arm and leg movement speed, and stamina. Again, on the basis of motor functions and physical fitness we cannot say which population is fittest in general terms. Each population shows traits that express its adjustments to a particular workload, nutritional regime, and set of living conditions.

Differences in body size. Martorell (Martorell and Habicht 1986) believes that greater differences in stature between various social strata than between the upper social strata of various ethnic groups show that "the variation that can be attributed to the environment is several times greater than that which can be attributed to genetics." This can be understood as a suggestion that differences between ethnic groups are not a matter of genetic differences alone. In our opinion differences in biological traits among ethnic groups may be related to differences in gene pools, but they may also be dependent on the environmental conditions under which biological development takes place (nutritional habits, traditional physical activity, cultural practices). Martorell is probably right about the developmental adjustment of stature, a phenotypic effect of typical polygenic traits. However, averaging on the population level as an effect of inbreeding determines the phenotypic picture of a population. The dispersion of a trait value in the population is probably also important.

The differences between different populations and social strata within a population are compared in figs. 3–5. The differences in stature reported by Williams (1931) between Maya and ladinos in the same village in Yucatán are greater than those between two neighboring Polish villages with different kinds of rural economy (Szemik 1986) and between various social strata in Poland (Bielicki and Waliszko 1991)—the reverse of Martorell's result—but less than those between urban and rural populations in Poland (Wolański 1962, 1973).

Differences between populations should increase with geographic distance because distance increases environmental differences. Face and head breadths are, however, more different between close (see fig. 2) than between distant populations (Siniarska 1984), while the difference in mean stature between two neighboring populations is greater than that between social strata in towns, and the difference in stature between towns is greater than the difference between average villages and average towns. Small island populations in Polynesia show greater differences in stature than the populations of other continents. Rather large standard deviations are found in the small populations of Polynesia and Africa, and the differences between standard deviations in these populations are also large (fig. 5). The large Asian populations show the smallest standard deviations and differences between them. Finally, increasingly negative (poor) living conditions affect the organism in one direction only to some extent. For example, poorer living conditions retard maturation, but excessive emotional stress (distress) can accelerate sexual maturation (Kowalska, Valsik, and Wolański 1964, Hulanicka 1986, Prokopec, Dutkova, and Vignerova 1987).

These considerations indicate that Martorell's obser-

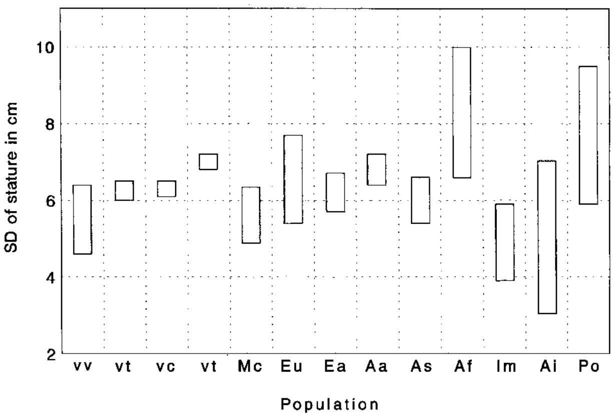

Fig. 5. *Standard deviations of stature in adult males from various ethnic groups (Williams 1931), settlements (villages, towns; Wolański 1962, 1973, 1987; Szemik 1986), social strata (Bielicki and Waliszko 1991), and continents, including individuals of African and European origin (Eveleth and Tanner 1976, 1990). Abbreviations as for figure 4.*

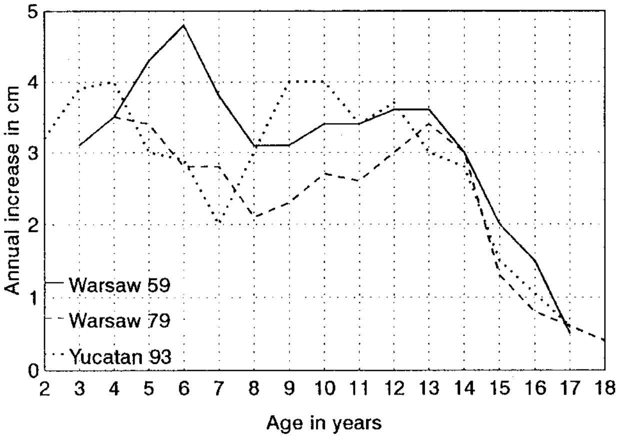

FIG. 6. *Annual increase in length of lower extremities in boys from Warsaw in 1959 and 1979 (Wolański 1962, 1987) and in Maya from Yucatán in 1993 (Wolański 1994).*

vation tells us only that differences in living conditions affecting stature in different human groups (as mean values) are greater between social strata than between the ethnic groups he studied. The stabilized local populations are "well" adapted to their regional and local environmental conditions, but social strata are not as "well" adapted because of mobility between strata and rapid changes in living conditions. It is not uncommon for adults to live under different conditions from those they experienced as children.

Differences in body proportions. Whether body proportions are related to genetic differences or express nutritional status is the subject of active debate. Body proportions depend on nutrition, hormonal activity, workload in the period of growth, and other things (Lasota, Tomaszewska, and Wolański 1966, Carter 1984). Maya from Yucatán have short lower and relatively long upper extremities, and Polish populations have long lower and relatively short upper extremities (Wolański and Siniarska 1997). The analysis of annual growth increments shows that the increase in lower extremity length is seen at about the fourth or sixth year of life and between 10 and 13 years in various populations (Wolański and Siniarska 2000). There are also differences in rate of growth between ethnic groups. However, studies of the population of Warsaw between 1959 and 1979 revealed changes in the magnitude of annual increments and a small shift in the age of their occurrence (fig. 6) showing that this phenomenon depends strongly on environmental factors. (Figure 6 presents data for boys, but the same phenomenon is observed in girls [Wolański and Siniarska 2000].) Thus, shorter legs probably represent poorer nutritional status, especially in the period of their intensive growth. If this is true, different body proportions may be related to environmental factors and represent developmental adjustments, but genetic components cannot be excluded.

Compensatory mechanisms. In addition to the abovementioned differences between populations, there are several compensatory (self-control) mechanisms at the population level. For example, these populations are characterized by positive secular changes in stature and a tendency toward the arithmetic mean. As a result, the changes in stature between generations of the population level are different from those expected from averaging the values for parents and their offspring.

A model for some more complex changes in the case of lung volume is as follows: Vital capacity is generally very closely related to body size. With the increase in body size, both an increase in vital capacity and a tendency toward the arithmetic mean should be expected. Secular changes toward a slimmer body will probably affect vital capacity negatively. However, pollution promotes an increase in vital capacity and ventilation, while a more sedentary lifestyle or less physical activity reduces vital capacity.

DISCUSSION

Human organisms have become genetically differentiated in the course of evolution, but this differentiation does not reflect the ecosystems and niches they occupy today. Contemporary humans live under more uniform conditions than those in which their ancestors evolved hundreds of thousands of years ago in other parts of the world. At the same time, current living conditions (relations between people, between different social groups and groups of different occupations, etc.) create new demands and give rise to new characteristics (traits).

The biological status of a population cannot be assessed on the basis of a single trait. Each trait has its own adaptive value and shows specific adaptive changes to particular living conditions. Some groups of traits are linked with particular functions of the organisms such as oxygen transport, metabolism, and/or adaptation to workload. Some traits promote better results in running, others in throwing, gymnastics, swimming, etc. There is no one trait that is objectively good. Each trait has a different value for a different activity (performance). It cannot be argued, for example, that tallness represents better adaptation. It is only the effect of adjustment to good nutrition, optimal movement activity, absence of disease, etc. In other words, it is a consequence of particular living conditions and lifestyles against the background of genetic predisposition. It has been suggested that each population has its own genetically determined sensitivity to environmental factors and that under the same conditions stature change in various populations may vary (Lauw and Henneberg 1997).

Surprisingly, given that we would expect geographical distance to increase genetic distance and to be linked to variation in living conditions, differences in head and face breadths have proved greater between close neighbors than between distant populations, and there are similar findings with regard to stature. Contemporary Polish villages are not stratified internally but differ among themselves with regard to localization and type of economy. These differences between villages seem to correspond to the differences between social strata in cities.

Biological traits must be analyzed as a system, taking into account not only their mean values but their dispersion as well. This is also true of the gene pool. The different gene frequencies and the degree of heterogeneity of individuals in a population probably influence the mean and median values, skewness, and dispersion of the distribution. Because of this, mean values do not always express the real genetic difference (distance). In this connection, two well-known regularities should be mentioned: the secular trend toward greater stature under favorable living conditions and the tendency toward the arithmetic mean. These two tendencies counter each other, and the final effect approaches more average values and limited dispersion. There are probably other such mechanisms.

There is no satisfactory way to answer all the questions or to resolve all the issues raised by these studies. Instead, they may serve as the beginning of a very important discussion of the criteria used to assess the biological status of a population as a mirror of socioeconomic and cultural changes.

CONCLUSIONS

1. The different biological traits of the organism are not independent; each trait represents the organism as a whole but plays its own role.
2. No one population is better adapted in biological terms than others; the assessment of individual traits does not allow such a conclusion.
3. Differences between populations have adaptive meaning. They correspond to the conditions (environmental and lifestyle) under which individuals developed and genetic selection (differential fertility and mortality).
4. Differences between populations, even those that are easy to identify, are very hard to interpret. Their causes are complex and their mechanisms latent. One of them is a replacement of functions (a compensatory mechanism) in the realization of a certain purpose, and another is a self-control mechanism related to trait variation. Both mechanisms are very complicated, and they are integrated into the internal environment of the organism, which is under the control of the neurohormonal system.
5. Differences in stature between social strata may be greater than those between the upper strata of various ethnic groups for some samples, probably because of differences in living conditions. The results analyzed do not exclude the possibility of genetic differences among ethnic groups in stature and other morphological and physiological traits (skin, hair, and eye color). The only conclusion to be drawn is that stature has adaptive meaning in both evolutionary and environmental terms.
6. The biological status of a population cannot be identified by a single trait. Indicators of biological status should be selected in terms of changes in environmental conditions, mode of life, and the expected responses of organisms and populations. Stature, which is a very sensitive indicator of socioeconomic changes, must be supported by other indicators (for example, respiratory and psychomotor traits).

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Ceramic Age Seafaring and Interaction Potential in the Antilles: A Computer Simulation[1]

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Computer simulations of ancient maritime voyaging patterns have shed light on a number of issues regarding the movements of prehistoric and historic peoples. The first simulation of this kind was designed by Levison, Ward, and Webb (1973) to investigate Polynesian dispersal. The technique was later used to determine which of the Bahamas Islands is likely to have been the first on which Columbus landed (Fuson 1987). Probably the most complex of these simulations are those of Geoffrey Irwin and his colleagues (Irwin 1989, 1990, 1992; Irwin, Bickler, and Quirke 1990), focused on exploration, colonization, and settlement patterns in Polynesia. A handful of other such works have been conducted elsewhere. This study uses computer simulations of the maritime environment and performance characteristics of aboriginal watercraft to investigate whether technology or the environment would have influenced patterns of human movement among the islands of the Antilles or between the islands and the South American mainland in the Ceramic Age, beginning in the first few centuries B.C. (fig. 1). Two models are tested: chance discovery through unintentional drift voyages (people lost at sea) and directed voyages (intentional exploration).

The evidence for a northern South American origin of the earliest ceramic-producing horticulturists in the Antilles is very clear (Rouse 1992:71–104; cf. Haviser 1997). These peoples, termed Saladoid, appear to have moved rapidly through the Antilles as far as eastern Hispaniola in the second half of the 1st millennium B.C. (Rouse 1986:39; 1992:79–80). In passing through the Lesser Antilles they initially occupied the northeast coasts of the high islands, presumably preferring those locations because they were the most heavily forested parts of the islands and resembled their original home on the mainland (Rouse 1992:9). As Rouse points out, these are the windward sides of the islands, and their settlement would indicate that the Saladoid peoples had a good command of seamanship. This group or some of its variants gave rise around A.D. 600 (p. 92) to the Ostionoid peoples, who then moved west into eastern Cuba. Eventually, the Ostionoid peoples gave rise to the Taíno groups encountered by Columbus (pp. 72–73).

Two dugout canoe designs were evaluated in this study. One is based on the Stargate canoe (fig. 2), recovered in the Bahamas by Stephanie Schwabe and the late Rob Palmer. This canoe is remarkably similar to canoes still being used by the Ye'Kwana and other native groups on the Orinoco River of Venezuela today (Callaghan and Schwabe n.d.). The other (fig. 3) is a platform-style canoe found widely today around the Caribbean mainland and similar to those depicted in the early Spanish chronicles of the islands (Callaghan 1993). Canoes of the two styles were analyzed in Venezuela and Belize respectively to determine their performance characteristics, including speed, leeway, carrying capacity, and stability. These characteristics were also analyzed using naval architecture programs. The data were then used in a simulation model of the Caribbean environment. The environmental factors considered were winds, currents, gale and hur-

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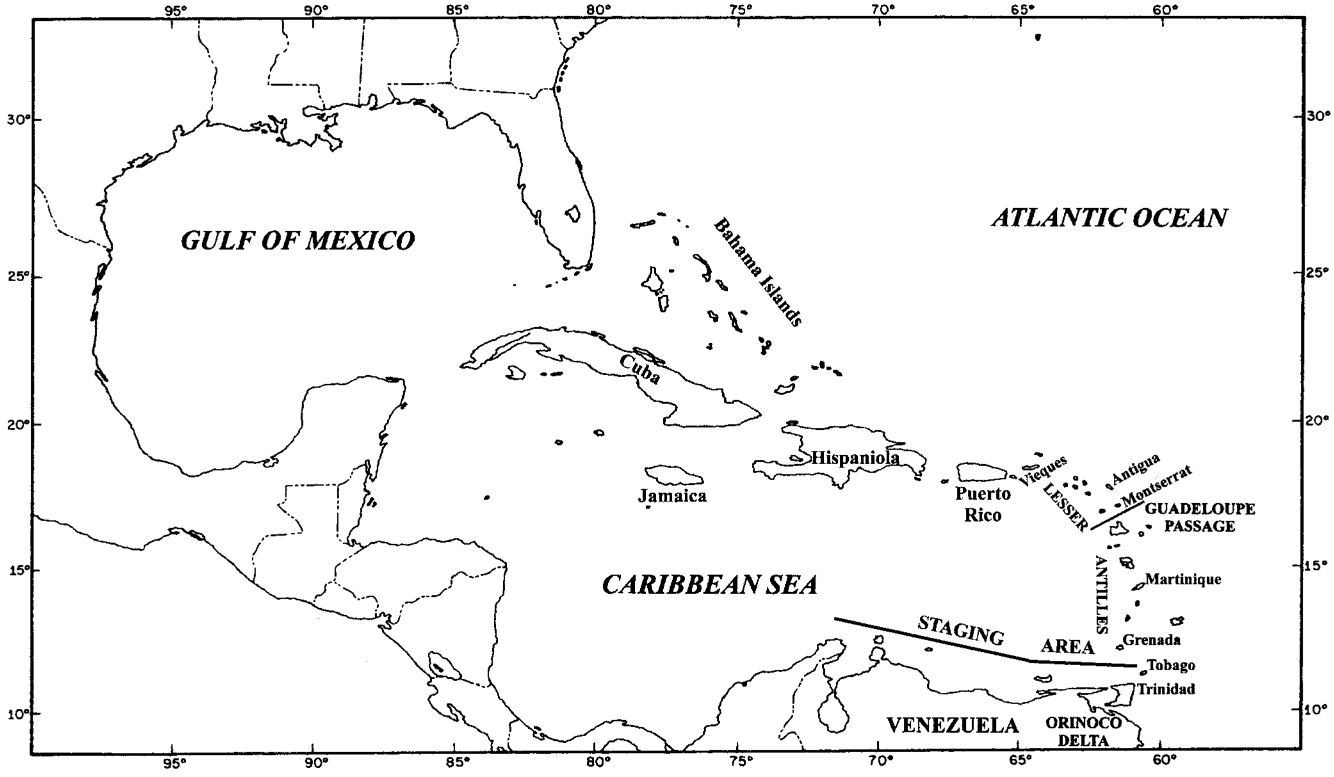

FIG. 1. *The Caribbean region, showing staging area for voyages.*

ricane frequencies, and sea-swell conditions, and the data on these factors were taken from pilot charts and sailing directions compiled by the U.S. Navy and other agencies. The computer program employed for the analysis has been described elsewhere (Callaghan 1999).

One of the most important questions to be asked in applying the model is whether the data presented in the pilot charts for the study area, compiled since the early 19th century, are representative of the time period of interest here. The most important climatic factor affecting the model is surface wind circulation during the period from approximately 2,500 B.P. and 500 B.P. Surface winds not only affect vessels directly but also are the primary determinants of surface current direction. Therefore the question is whether surface wind circulation for the period differed significantly from present conditions.

According to Clarke's (1989:44) summary of weather patterns in the area today, the Caribbean lies within the wind belt known as the Northeast Trades. With the exception of disturbances from tropical cyclones, the weather is quite stable. The prevailing winds are easterly and usually steadiest in the south of the region during the period between December and May. Summer and fall are warmer and more humid than winter and spring. Cloud cover and rainfall increase, as does thunderstorm activity, and winds are often lighter and more variable. Tropical cyclones are most likely in summer and fall. The northern limit of the Northeast Trades is 28° N lat. and is reached between July and September. At this time, the strongest and steadiest winds pass through the middle of the region; near the northern limit they tend to be more variable. The limit shifts south to about 24° N between February and April. On average the winds blow 11–15 knots from the east-northeast. The northern Lesser Antilles experience the steadiest winds in the summer months; for the more southern islands and the coast of South America winds are steadiest in winter because of the southern shift of the central portion of the trade wind belt. The Bahamas are geographically outside of the Caribbean region but during the Ceramic Age were culturally within it. The northern Bahamas, north of 24° N, are beyond the trade winds in winter, and at this time they experience lighter winds that are more variable in direction and occasional strong winds from the north. The wind shifts east to southeast in the summer with the return of the trades.

Hodell et al. (1991) present a high-resolution reconstruction of the Caribbean climate for the past 10,500 years based on $^{18}O/^{16}O$ ratios in ostracod shells from Haiti's Lake Miragoane. Variation in the ratios reflects changes in precipitation for the period. From about 2,400 B.P. to 1,500 B.P. the $^{18}O/^{16}O$ values and variation are very similar to those for the past 900 years (1991:fig. 2). The

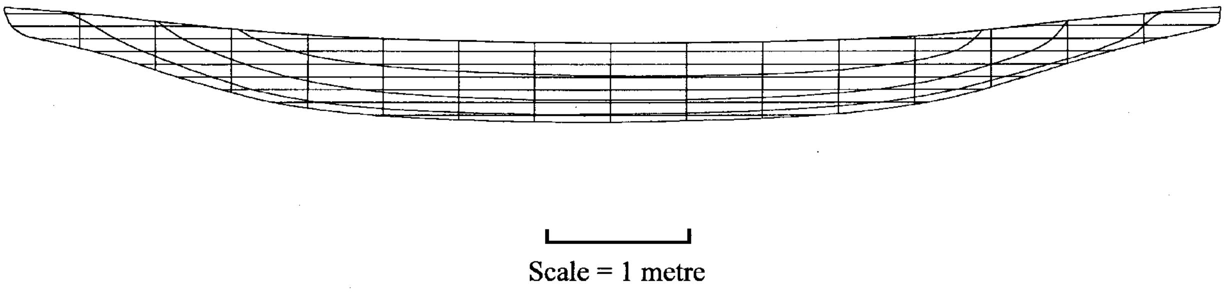

Fig. 2. *The Stargate canoe, South Andros Island, Bahamas.*

values indicate a drying trend for both periods (p. 792). For the intervening years from 1,500 to 900 B.P. the values indicate a brief wetter period but one not as wet as the early to mid-Holocene. While there is variation in rainfall for the period of interest here, 500 to 2,500 B.P., it does not approach the overall variation for the past 10,500 years. Hodell et al. note the correlation between precipitation anomalies and variation in the annual climatic cycle in the Caribbean region discussed above: "Enhancement of the annual cycle led to years of anomalously high precipitation, whereas a reduction led to a deficient rainy season" (p. 792). Thus reconstruction of variation in precipitation should be an accurate indicator of variation in the annual cycle.

The annual cycle is controlled by the summer displacement of the North Atlantic subtropical high by the northward movement of the Intertropical Convergence Zone and the reverse movement in winter. Hodell et al. compared their data with the changes in annual cycle intensity estimated from the seasonal insolation difference at the top of the atmosphere at 10° N between August and February and found the changes in the two records for their 10,500-year period to be similar. This reinforces the conclusion that while variations from present climatic conditions including surface wind patterns existed during the Caribbean Ceramic Age, they were not substantial. It also suggests a major mechanism for variation in both precipitation and the annual cycle in the form of "orbitally forced (Milankovitch) variations in solar insolation" (p. 792).

The field on which the simulation program operates is the Caribbean Sea, the Gulf of Mexico, and the surrounding mainland (U.S. Navy 1995). The area is divided into two-degree Marsden squares (two degrees of latitude by two degrees of longitude), with each square containing wind and current vectors as they have been recorded to occur for a particular month of the year. A separate field is used for each month. Any starting position can be chosen on the field. Positions 20 or 30 nautical miles off the coast were chosen in order to prevent all vessels from simply returning to the nearest coast.

The operator chooses a watercraft type and indicates its initial position. For each vessel type there are data on the speed that it can be paddled and the effect on it of various wind speeds. Vessels can be allowed either to drift before the wind or to be paddled in a specific direction. Each two-degree Marsden square contains eight wind vectors (cardinal and intercardinal points) and the percentage of the total number of observations in which the wind has blown from each direction. The percentage of observations in which calms are recorded is also given. The wind direction is chosen randomly by the program but is weighted to reflect actual observations. The effect of the chosen wind on a particular vessel is then added to the current vector for each two-degree square and the new position is calculated. If vessels are paddled in a specific direction, this needs to be added to the other vectors in order to obtain the new position. The duration over which the vectors affect the vessel between positions is 24 hours, following Levison, Ward, and Webb (1973:24–25). The procedure is repeated until the vessel either reaches an island (or any area designated as a success) or is forced back to the mainland (or off the field). Up to 1,000 runs from the same start can be simulated at a time.

Two questions were asked of the simulation. The first question was how likely it was that the Saladoid peoples from South America would have discovered the Antilles by chance. Each of the two canoes was placed at different points along a 600-nautical-mile staging area off the coast of northern South America, and the simulation was run on the assumption that the vessels were allowed to drift. Although this may not seem a likely response to being lost at sea, it has the advantage of allowing the vessel to cover the maximum distance without expenditure of energy. In a storm situation there is often no other rational option. The simulation was run under weather conditions for each of four months—January, April, July, and October. The percentages of successful chance discoveries of the islands ranged from 0.3% under April conditions to 0.1% under October conditions. The higher success rates for April conditions have some sig-

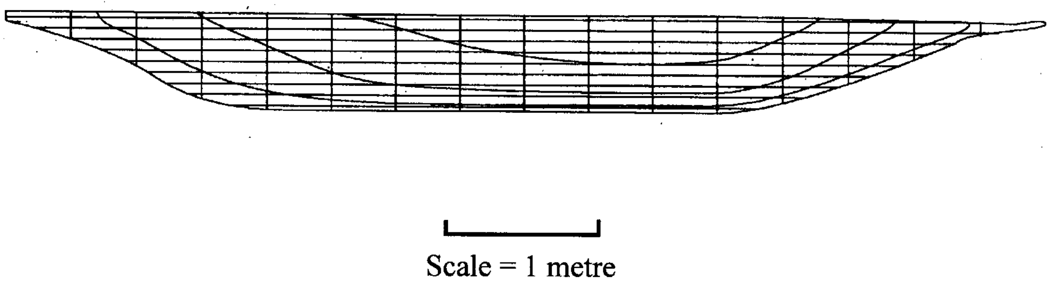

FIG. 3. *A platform-style canoe found widely around the Caribbean mainland and historically recorded in the islands.*

nificance in that April is the only month in which no hurricanes have ever been recorded (Clarke 1989:50).

Work in Polynesia has provided a means of estimating risk to the crew. Risk is determined by length of time at sea. Lengthy drift voyages in open boats due to shipwreck or other misfortune are well known for the Pacific Ocean under conditions similar to those of the Caribbean. The maximum recorded drift seems to be on the order of seven to eight months. Several recorded voyages covered distances of ca. 3,000 miles over a period of six to ten weeks, and a great number covered shorter distances (Howay 1944). Levison, Ward, and Webb (1973: 21) used the survival probabilities presented by McCance et al. (1956), based on 27,000 persons lost at sea, to represent the cumulative percentage of crew losses. From this I estimate that a successful drift voyage from the South American coast taking four to five weeks would have involved a probable crew loss of 10% to 12%—meaning that one or two crew members out of a total of eight to ten can be expected to have died en route.

A slight difference in the success rates of the two vessels is attributable to the difference in the effects of the wind on their different shapes. There was little difference in the success rates from various points along the coast. Although success rates were low, given the long stretch of coast from which success is possible and the long history of coastal adaptations in the region it seems probable that such drift voyages occurred.

Chance discovery of Grenada from a position off the north coast of Trinidad is not indicated by the simulation. The water gap between the continental islands of Trinidad/Tobago and Grenada is the only gap along the Lesser Antilles that cannot be seen across. It is possible, however, for an observer to see Trinidad and Grenada, Tobago and Grenada, or even all three islands from positions at sea. For Trinidad and Grenada there is a 25-nautical-mile overlap in their sighting distances, and for Tobago and Grenada there is a 15-nautical-mile overlap. There is also a 15-by-25-nautical-mile triangular area at sea from which all three islands can be observed given reasonable visibility. It at first appears that someone intentionally exploring for new land would not have had to leave sight of home (Trinidad or Tobago) in order to sight Grenada. However, for intentional discovery of Grenada from Trinidad explorers in a canoe would have had to steer a bearing considerably to the east of the target, and this would have virtually prevented their passing through the areas of mutual interisland visibility. Chance discovery still does not appear likely, as the areas of mutual visibility are relatively small and not on the drift voyage paths.

Another possibility for detecting Grenada from Trinidad or Tobago is the use of clouds as land indicators. Stationary cumulus clouds can form over high islands such as Grenada and indicate their location. Burch (1986: 197) states that stationary cumulus clouds form at all latitudes but may be obscured by lower clouds. Such clouds when developed into cumulonimbus clouds can reach heights of more than 50,000 feet in the tropics (Admiralty Hydrographic Department 1941:50). Even a stationary cloud with an upper height of 7,300 feet would make Grenada detectable from the coast of Trinidad. The question remains whether the first Ceramic Age explorers would have had the opportunity to learn about this effect in their initial forays north, particularly as such clouds are most useful for navigation before midday (Burch 1986:197). Further, these explorers would still have had to become familiar with the wind and current patterns to steer the correct bearing.

The majority of the earliest Early Ceramic Age dates are north of the Guadeloupe Passage, the Fond Brulé site on Martinique being the only exception (Haviser 1997). Although the pattern may be a sampling bias, it does fit with a chance discovery of the Greater Antilles and Northern Lesser Antilles before the islands of the Southern Lesser Antilles. This raises the possibility that the settlement of the islands by Saladoid peoples was not a simple south-to-north progression.

The second question was whether movement along the island chain was so constrained by technology and the environment that it had to be conducted in "stepping-stone" fashion or whether travel between the South American mainland and the northern islands was possible. To investigate this question the two canoes were again placed along the staging area off the north coast of South America with weather conditions for January, April, July, and October. Now, rather than being allowed to drift, the canoes were paddled by their occupants (eight per canoe) in shifts of four, eight hours at a time. The speeds used were calculated from tests in the field, naval architecture programs (Callaghan 1999), and the human-endurance data provided by Horvath and Finney (1976). With regard to navigation skill the only assumption was that the occupants directed the canoe northward. Success in this series of experiments was defined by simply reaching the islands of the Greater Antilles from the same mainland area as in the previous series of experiments. A range of paddled speeds from 3.4 knots to 2.0 knots was employed. All voyages were successful under these stipulations, with only slight variations of landing sites despite variation of speed. Vessels ended up variously in an area from eastern Puerto Rico to western Hispaniola within five to six days. For intentional voyages from all areas the probability of crew loss was less than 1%, which does not translate into a fatality. Return voyages from north to south did not indicate any significant differences; in both directions winds and currents are moving across the path of the vessels.

Applying the results presented here to the Saladoid period, it appears likely that direct crossings of the Caribbean Sea were undertaken either between the mainland and islands like Puerto Rico or between any islands of the Lesser Antilles not adjacent to one another. Once the locations of the Greater Antilles were known, direct contact was possible between the Venezuelan mainland and islands such as Puerto Rico as some researchers have suggested (Chanlatte Baik and Narganes Stordes 1989, Rodríguez and Rivera 1991, Zucchi 1984). Movement within the Lesser Antilles need not have followed a stepping-stone-like pattern. Only modest navigation skill would have been required, and even moderate-sized canoes could have made a direct crossing in five to six days.

A direct route between Venezuela and Puerto Rico may not at first seem advantageous. It would, however, have been only about two-thirds the distance involved in following the curve of the Lesser Antilles island chain. Moreover, the channels between the Lesser Antilles often have currents of 3 knots, and therefore voyagers following the Lesser Antilles would have encountered crosscurrents three to four times the strength of those encountered in a direct crossing. The bottleneck effect on waves that had built up while crossing the Atlantic would also have made crossing the channels less desirable for small vessels than passing to the west (Stone and Hays 1991:224). Finally, the deep valleys and high land of some of the Lesser Antilles, for example, Dominica, produce heavy squalls that are a danger to vessels (Defense Mapping Agency 1985:152).

Another factor in direct crossing between the mainland and Puerto Rico or Hispaniola that should be noted is the formation of altocumulus lenticularis or mountain wave clouds (Burch 1986:197) on the south coast of Puerto Rico. These are highly distinctive, sharply defined lenticular clouds that form when moist air passes over mountains (Admiralty Hydrographic Department 1941: 230). Cumulus clouds form on the mountaintops, and lenticular clouds break off and drift out to sea. As the northeast winds pass over islands like Puerto Rico these clouds move southward into the Caribbean. They can maintain their very distinctive shape for long distances, and I have observed them 240 nautical miles from the mountain ranges that formed them. Under these conditions voyagers would have had a clear indication of land for half of the distance from Venezuela to Puerto Rico.

Overall, a direct route would have been shorter, safer, and easier than a route along the Lesser Antilles. If voyages were made in April, there would have been little danger of encountering tropical storms in the open sea. The expected loss of crew over a five-to-six-day period would have been less than 1%. Finally, for the Taíno toward the end of the prehistoric period a direct route may have had the advantage of avoiding islands of the Lesser Antilles occupied by the reputedly hostile Island Caribs. Neither the environment nor the available seafaring technology would have forced people to travel along any particular route. Any pattern that may emerge from the analysis of lapidary materials (see, e.g., Ball 1941; Chanlatte Baik 1983; Cody 1991*a*, *b*, *c*; Rodríguez 1991; Watters and Scaglion 1994; Watters 1997; Murphy et al. 2000) will be due to social, political, and economic factors.

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