Studies of Cultivated Plants in Choco Dwelling Clearings, Darien, Panama[1]

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Useful plants and techniques of their cultivation were studied in and around dwelling clearings of Choco Indians in tropical rain forests of Darien, Panama. The population sampled consisted of 115 adult Chocos living at 26 sites along the banks of the Rio Chucunaque and two of its tributaries, the Rio Tuquesa and Rio Chico. The Rio Chico had a higher population density per linear mile of river bank, but less dwelling area per person was kept clear of vegetation. A map of each clearing allowed comparison of the frequency and spatial distributions of useful plants. These data are statistically treated elsewhere. A decrease in both numbers and variety of native plants occurred as commercially important plants were established on a larger scale. Creation of open niches by means of trash heaps became more definite as distance from the riverbank increased; edible plants were often growing in such locations. Present-day agricultural techniques among the Choco may illustrate their agricultural history. A comparison is made with several extant theories of early agriculture. Small-scale, more intensive gardening was noted in village clearings; groups of dwellings may thus have been a cause rather than a result of field agriculture.

Introduction

Several theories have been advanced concerning the origin of plant cultivation in the tropics. Further research on the present conditions of primitive cultivation is one way to substantiate or modify these theories. The objective of the present study was to investigate current methods of cultivation by a representative group of Choco Indians. These data were obtained in March, 1962, and June, 1963, in Darien, Panama; the authors were members of teams which had missions in animal ecology (Sexton *et al.*, 1964) and oral pathology (Rowe and Johnson, 1964), in addition to the work described herein. The future of the area as a possible canal site shortens the time available for its study in a relatively undeveloped state.

Twenty-six clearings around Choco Indian dwellings were studied; particular attention was paid to plant associations. Data have been assembled on spatial relationships, competition with jungle vegetation, and the habitats of those cultivated plants grown by the Choco Indians of Panama. These findings are discussed in the light of recent Choco history in Panama and several of the theories regarding origins of cultivated plants in the tropics.

The site studied is in the Republic of Panama's southeastern province of Darien. The climate, as noted by Sapper (1938), falls under the Köppen and Geiger *Aw* classification. Bennett (1959) noted that the Indians were able to obtain a good yield from the latosol soils only for one year. He reported also that along the rivers were alluvial soils, the fertility of which appeared to be fairly high. Martini *et al.* (1960) classified the river soils which are used as dwelling sites by the Choco as *As* or river alluvial; their work substantiates the observations reported by Bennett. Annual rainfall averages 80 inches (Lamb, 1953; Holdridge and Budowski, 1956). The population consists mainly of Negroes and Choco Indians, scattered along river banks so that the dugout canoe is the only practicable means of access. Thirteen Indian dwellings and their surrounding clearings were found along the 17 miles from the small town of Yaviza to

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the confluence of the Rio Chucunaque and the Rio Canglon (Fig. 1). The Rio Chucunaque is the largest river in Darien, and the total Indian population along this small section of the river made up our first sample group with each dwelling designated by letters A (starting at the Rio Canglon) through M. Another 13 dwellings and surrounding clearings (lettered N to Z) were studied along about 10 miles of the Rio Chico. This river flows into the Rio Chucunaque at the town of Yaviza (Fig. 1). An additional site was studied on the Rio Tuquesa above its confluence with the Rio Chucunaque. There a small group of dwellings with a school was apparently near the lower edge of scattered Indian settlements in this region, known locally among the Choco as "a Tuquesa" (Plates 1, 2, 3; Fig. 3).

Methods

The procedure was as follows: (1) We recorded the name of the head man in each dwelling as well as the number of men, women and children living in that dwelling at the time of our study. (2) We measured the "garden area" by pacing the size of the clearing around the house. These data appear in Table I. (3) We mapped the entire

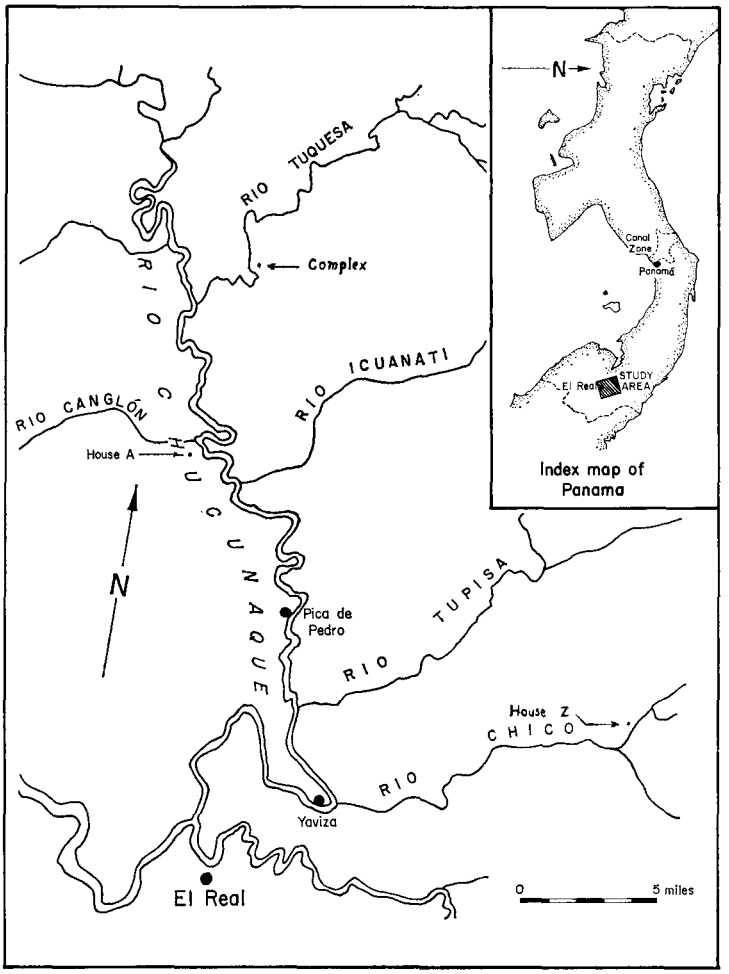


Fig. 1.—Map of Darien, Panama, showing approximate distances covered by this expedition along the Rio Chucunaque and the Rio Chico. Location of the one site visited on the Rio Tuquesa is also shown.

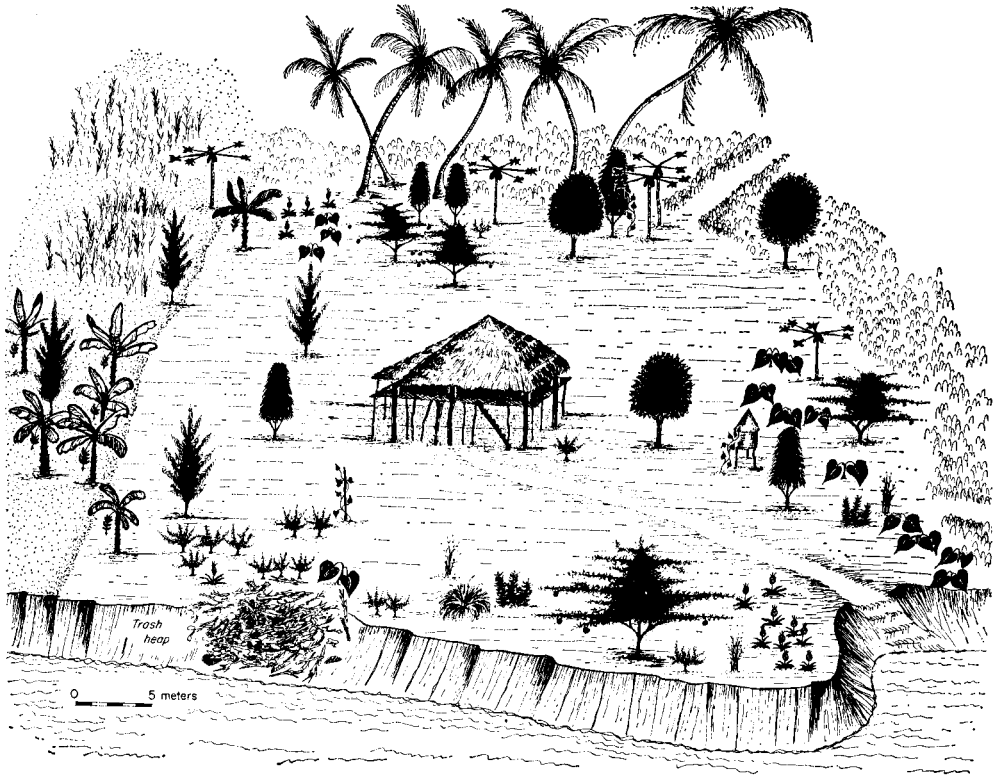


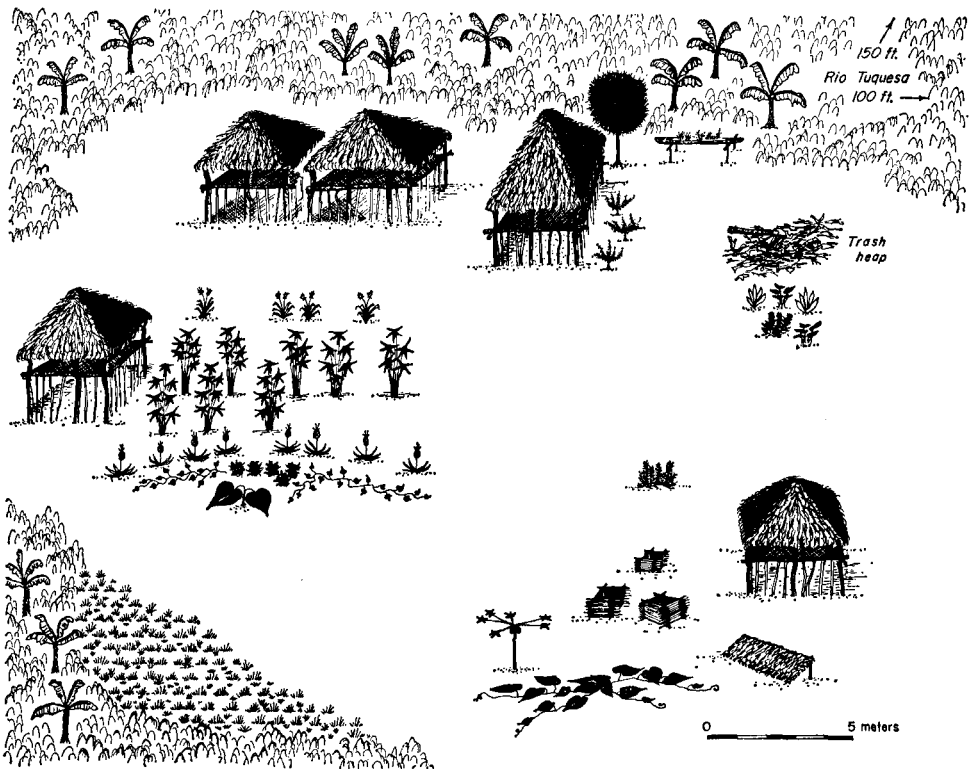
Fig. 2.—Sketch-map of House "A" and its clearing, at the confluence of Rio Canglon and Rio Chucunaque. This same area was mapped earlier (Sexton, *et al.*, 1964; here reproduced as Fig. 4) when clearing was less well cared for. Legend identifies plant species, the individual symbols of which are spaced as near as possible to scale.

clearing so that each plant was located in relation to the others and to various components of the house site. Figs. 2 and 3 are examples. (4) Occurrences of plants not previously recorded at other sites were noted. (5) We determined particular names (Table III) and uses of plants by asking non-structured questions. The Indians were usually able to reply quickly; our hired boatman often assisted us. (6) Plants were photographed, collected and usually identified in the field; later, most were checked at the Smithsonian Institution Biological Research Station at Barro Colorado. Some of the specimens were deposited in the Herbarium of the Missouri Botanical Garden, St. Louis, Missouri.

Findings

Demography. The Indians live within a narrow band alongside the rivers, each hut usually separated by a considerable distance from its neighbors. No radial distribution from the trade center of Yaviza occurs, except where radii coincide with river systems.

At the end of June, 1963, there were 57 Choco Indians living along the banks of approximately 17 miles of the Rio Chucunaque from where it flows by the town of Yaviza up to the point at which the Rio Canglon enters. The average river bank density would be about 3.4 Indians per mile. Along about 10 miles of the Rio Chico from its confluence with the Rio Chucunaque at Yaviza were 58 adult Choco. An approximate Rio Chico bank density would be 6 Indians per mile. These estimates should be accompanied by Negro density figures to describe the population fully. Data on Negro populations, however, were not taken in this study.



EXPLANATION

Ananas (pineapple)	*Crescentia* (calabash)	*Manihot*
Brassica	*Crinum*	*Mirabilis* (Four O'Clock)
Cajanus (bush bean)	*Cucurbita* (squash)	*Musa* (plantain)
Capsicum (pepper)	*Cymbopogon* (lemon grass)	*"Oregano"*
Carica (papaya)	*Dioscorea* (yam)	*Persea* (avacado)
Citrus (orange, lemon)	*Guilielma* (pejibaye)	*Saccharum* (sugar cane)
Coix (Job's Tears)	*Mangifera* (mango)	*Xanthosoma*
Grass and shrubs	Secondary forest	

Fig. 3.—Sketch-map of houses and school in common clearing, Rio Tuquesa. Compare with Plates 1, 2 and 3, all of which were taken in that area. Legend identifies plant species, the individual symbols of which are spaced as near as possible to scale.

An index useful in studying the subsistence of the population is the ratio of square meters of cleared area around the dwellings per Indian (Table I). For the Rio Chucunaque sample (from Yaviza to the Rio Canglon), this density index is 1,085 square meters per adult, where 57 adult Choco Indians cleared 61,830 square meters. The cleared area on the Rio Chico for which we have data amounted to 16,000 square meters

TABLE I

DEMOGRAPHY AND LIVING SPACE FOR 26 CHOCO SITES IN DARIEN, PANAMA

Dwelling	Owner	Men	Women	Children	Dwelling Dimensions	Clearing around Dwelling-Area
A	Porras Rosales	2	2	6	7 × 10 m.	1,000 sq. m.
B	Ierzo Ortegas	2	1	2	7 × 9	1,450
C	Sr. Pacheco	2	2	4	5 × 9	3,590
D	Sr. Demeso	3	1	6	5 × 8	11,760
E	Adolfo Salasar	2	3	2	8 × 10	3,500
F	Dionicio Agapito	2	3	4	7 × 7	22,500
G	Achillio Badipino	1	1	4	3 × 3	10,500
H	Parceluk Caysamo	2	2	5	3 × 6	6,550
I	Sr. Buche	3	3	9	5 × 8	900
J	Heronimos Salasar	1	1	3	5 × 9	2,100
K	Liberto Caysamo	4	8	9	9 × 4 11 × 10 9 × 5	3,500
L	Chumeco Amallio Lino	1	3	4	6 × 9	980
M	Blas Guainora	1	1	2	2.5 × 9	13,500
Total Rio Chucunaque		26	31	60		61,830 sq. m.
Average dwelling area cleared per adult (57 adults): 1085 sq. meters						
N	Catalino Chanchorez	3	3	5	13 × 13	1,500
O	Simon Besi	2	1	5	7 × 9	
P	Sr. Ortegas	5	6	9	7 × 13	1,110
Q	Elio Beloya	1	1	2	9 × 13	
R	Meleno Meloya	1	2	2	5 × 9	
S	Miguel Placo	3	2	4	10 × 8	700
T	Monico Beloya	4	1	5	7 × 9	
U	Lorenzo Dojirama	3	3	3	7 × 7	1,100
V	Leobihildo Tocamo	3	2	6	8 × 14	
W	Casilio DeGaiza	1	2	6	4 × 7	
X	Rufino Rosales	2	3	3	6 × 7	
Y	Raquildo Ortegas	1	1	4	6 × 8	
Z	Heronimo Machi	1	1	5	4 × 7	1,700
Total Rio Chico		30	28	59		16,000 sq. m.
Average dwelling area cleared per adult (30 adults): 535 sq. meters.						

for 30 adults, or an average of about 535 square meters per adult. Thus, the average family dwelling clearing contained twice as much area on the Rio Chucunaque where linear density is only half as great as on the Rio Chico.

In at least one place, the Indians live in a village-like settlement along the Rio Tuquesa; they have thus departed from the usual habit of living at considerable distances from one another. In this one instance, the Indians have grouped their houses around a house which is used as a school. At the time of our study, the population (Plate 1) of this complex consisted of 27 inhabitants; all were Choco Indians. Of this number, there were five men, four women and 18 children. The spatial distribution of the dwellings and the school relative to the few cultivated plants is shown in Fig. 3.

Useful Plants. Table II lists the useful plants that we found growing in 25 clearings. One-third of these plants are believed to have been introduced since the Conquest either by the Spanish or by Negroes who were for-

Plate 1.—Inhabitants of the school-hut complex, Rio Tuquesa. Standing in rear center is Dr. O. J. Sexton, Dept. of Zoology, Washington University; to his left is the Choco teacher of the predominantly male student body. Other adult Chocos are at rear and right. Balloons were distributed by Dr. N. H. Rowe, School of Dentistry, Washington University, for cooperation with dental examinations (Rowe and Johnson, 1964). Forest in background is essentially undisturbed; secondary growth of *Musa, Heliconia,* vines of *Dioscorea* and other weedy herbs form a story at the edge of the clearing. Note modern magazine held by one boy and watch on wrist of Choco at lower right. (Photo by H. T. Andrews).

merly slaves. Twelve different kinds of plants were found growing in some amount at more than 40% of the 25 sites considered (Table II). (The last site, lettered Z, is not referred to in Table II, since it was just recently established, and no useful plants were found growing there.) Of these 12 frequently found plants, only seven are native to the New World. (Col. 1, Table II). Origins of cultivated plants are not entirely certain, but it appears that the Choco have adopted a large number of plants in recent times, and some of these have become mainstays of the Indian diet. Authorities for origins and names are Bailey (1958), Dressler (1953), Patiño (1963, 1964), Sauer (1950), and Standley (1928).

In addition to the commonly occurring papaya, avocado and cassava, several other native trees and shrubs were noted only rarely in the clearings and at the edges. These are noted in Col. 1, Table II, by the designation "T." A "sapote," a "madroño" (*Rheedia* sp.?) and a "marañon" (*Anacardium* sp. ?) were also noted but not collected nor identified. Confusion in identification of *Mammea americana* resulted because only one specimen was collected, and the common name "mamey" is used for both *Mammea* and *Calcocarpum mammosum,* the sapote or zapote (synonyms *Calocarpum sapota, Pouteria mammosa, P. campechianum*).

About 80 common Spanish plant names were obtained in the field. Of these, only 18 were found to have common Choco Indian names (Table III). Most of the plants with Choco names are known to be native or introduced early into the New World. No major differences in Choco nomenclature were found in comparing plant names with Duke's (1963a) list for the Rio Pirre. A

first attempt at gathering Choco names resulted in a list of Indian personal names which may have been the Indians from whom seeds or cuttings were first obtained in that area. Additional data and specimens of drug plants were obtained by the James Duke expedition of 1962, and specimens are in the James Duke collections, #5452 through #5464, deposited at the Missouri Botanical Garden Herbarium (Duke, 1963b).

Major Crop Plants. This study is concerned with useful plants grown in dwelling clearings rather than plants grown in extensive fields. A few dwelling clearings were bordered by fields of rice and plantain; these fields were considered.

Maize or Indian corn, *Zea mays* L., has been the mainstay of the native American diet for thousands of years. In 36% of the sites studied, this plant was found growing in fields adjacent to dwelling clearings; in a few instances, it occupied fields approximately 30 × 40 meters, somewhat removed from the dwelling site. Most of the Indian fields contain mixed crops; maize usually is planted with sugar cane, plantains, rice and manihot. The combinations and proportions of these mixed crops were quite variable, except that no maize occurred under mature plantains. Young plantain corms were, in one instance, growing among tall maize plants in full silk.

In April, 1962, one of us (NHN) was given 14 ears of what the Indian Porres Rosales and family considered to be a representative sample of his maize. He insisted that red ears and husks were not common, yet, of the 250 ears in his storehouse, about half were red in husk color, and the others were light brown. The corn had been grown in his fields along the Rio Tuquesa. It is a four-month corn, planted generally from sometime in March into May. It appears to be different from varieties referred to by Wellhausen *et al.* (1957) and Patiño (1964). This collection is discussed further elsewhere (Nickerson and Covich, 1966).

The Choco plant their corn below the surface, sowing it in irregular rows after use of the field for one or two years for rice. The tall corn (4m and generally without tillers) is apparently better able to compete with weeds than is rice. Corn is used also as a border plant in rice fields, seldom more than one or two rows wide, and often grows as much in the jungle as in the clearing. The unique "slash-mulch" cultivation of Maiz Chococito by the Colombian Choco Indians (Patiño, 1956; West, 1957) was not encountered. Open containers of bark which the Choco used to store the unhusked maize ears were almost all empty, and few grinding implements were noted. The amount of maize growing in the fields was far less than we expected to find. Maize is definitely no longer a major staple food for most of the Indian families.

Rice, *Oryza sativa* L., is not native to the New World, but a dry-land form is commonly grown by the Indians; indeed, rice is now their chief single foodstuff. It was grown in fields next to dwelling clearings at 20% of the sites and was often planted on relatively isolated, steep hillsides and fields. Mixed cropping was minimal where fields were large; rice predominated and other crops were sparsely planted around the edges of the field. At almost every Indian hut, the large wooden *mano de pilón,* used as a "mortar and pestle" device for hulling rice, was present.

Plantains, *Musa paradisiaca* L., were the most frequent plants in and at edges of clearings, occurring in some amount at all of the sites. Most of the fields along both rivers were covered with these plantains, the main source of starch in the diet, and the main article of trade. A small corm takes approximately seven months from being newly transplanted to reach bearing age; after that, new inflorescences are produced sporadically on shoots of varying ages. Many of these plants occur apparently untended along paths; they do not, however, grow in shade of any sort. The ground beneath them is quite shady and relatively free from vegetation.

The platano is usually considered to have been introduced, but there seems to be evidence of widespread dispersal before the Conquest (Jeffreys, 1963), and fossil leaves and fruits have been found in some Cretaceous rock formations in Colombia which closely resemble *Musa paradisiaca* (Huertas and van der Hammen, 1953).

Spatial Distributions Relative to Type of Introduction. The spatial distribution of

TABLE II. USEFUL PLANTS OF THE CHOCO INDIANS, DARIEN, PANAMA

T = New World tree X = Introduced species	Scientific Name	Rio Chucunaque													Rio Chico											% of sites at which plant occurred
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	
	GRAINS:																										
X	*Oryza sativa* L.			X			X	X	X			X															20%
	Zea mays L.			X		X		X	X		X						X		X						X	X	36%
	BEANS:																										
X	*Cajanus cajan Millsp.*			X		X				X			X		X						X						24%
	Cassia occidentalis L.	X										X					X					X					16%
	Phaseolus vulgaris L.										X		X					X									12%
	FRUITS:																										
	Ananas comosus Merr.	X					X				X	X			X	X			X	X	X		X	X	X	X	52%
T	*Annona muricata* L.			X							X					X		X					X				20%
X	*Artocarpus altilis* Fosberg.					X					X	X															12%
T	*Carica papaya* L.	X	X		X	X	X			X	X	X	X	X		X					X		X				52%
X	*Citrullus vulgaris* Schrad.	X														X											8%
X	*Citrus* spp.	X		X	X		X			X	X	X	X	X	X	X	X	X		X	X			X		X	68%
T	*Mammea americana* L.																					X				X	8%
X	*Mangifera indica* L.	X	X	X	X	X						X			X		X			X	X						40%
T	*Maniikara zapotilla* Gilly. (syn. *Achras zapota*)		X									X				X	X	X		X			X				28%
X	*Musa paradisiaca* L.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	100%
T	*Persea americana* Mill.	X	X				X			X	X	X	X	X		X				X			X	X		X	52%
	ROOTS:																										
	Dioscorea alata L.	X			X		X		X				X							X							24%
	Dioscorea trifida L.						X																				4%
T	*Manihot esculenta* Crantz			X			X		X	X	X	X			X							X		X		X	40%
	Xanthosome violaceum Schott.	X	X	X	X		X			X	X	X	X	X	X		X	X	X	X		X	X	X		X	76%
	OTHER FOODS AND SEASONINGS:																										
X	*Allium* spp.*																										
X	*Brassica* spp.*																										
	Capsicum spp.	X		X			X				X	X	X							X		X	X	X	X		44%
X	*Coffea arabica* L.	X		X											X		X										16%
	Cucurbita spp.		X			X	X	X		X	X	X	X						X		X						40%
X	*Cymbopogon citratus* Stapf.	X	X	X	X		X			X		X	X		X		X		X	X		X	X				56%

T = New World tree X = Introduced species	Scientific Name	Rio Chucunaque													Rio Chico											% of sites at which plant occurred
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	
	Eryngium foetidum L.	X			X	X	X																				16%
T	*Guilielma utilis* Oerst.	X										X		X									X				16%
	Hyptis spp.	X		X																		X					12%
T	*Inga edulis* Mart.	X					X		X		X			X	X		X									X	32%
	Lycopersican esculentum Mill. var. *cerasiforme* Hort.										X					X											8%
X	*Momordica charantia* L.	X		X	X	X					X					X											24%
X	*Ocimum* spp.		X	X			X		X		X		X					X					X	X		X	40%
	Opuntia sp.												X														4%
X	*Saccharum officinarum* L.	X	X		X	X	X	X		X	X	X	X	X	X				X	X			X	X		X	68%
T	*Theobroma cacao* L.						X								X					X							12%
	DRUGS:																										
T	*Jatropha curcas* L.																			X			X				8%
	Pothomorephe peltata Miquel.	X	X	X		X	X	X		X		X		X	X				X	X	X				X	X	60%
	Quassia amara L.			X																							4%
	Sida rhombifolia L.										X																4%
	Spilanthes ocymifolia L.	X										X															8%
	Tagetes erecta L.	X		X		X												X								X	20%
	ORNAMENTAL:																										
X	*Codiaeum variegatum* Blume.											X					X										8%
X	*Hibuscus esculentus* L.	X		X		X	X			X			X					X	X				X	X		X	44%
	Hymenocallis americana Roem.						X											X					X				12%
X	*Jasminum* sp.											X															4%
	Mirabilis jalapa L.	X	X	X	X	X	X				X				X			X		X	X			X		X	52%
X	*Nerium oleander* L.																								X		4%
	Poinciana pulcherrima L.	X	X			X				X	X	X							X	X	X						32%
	Zinnia elegrans Jacq.	X																						X			8%
	MISCELLANEOUS:																										
T	*Bixa orellana* L.				X		X			X			X		X		X			X			X			X	36%
T	*Carludovica palmata* Ruiz and Pav.		X		X		X		X		X			X						X			X	X		X	36%
X	*Coix lacryma-jobi* L.	X		X						X																	12%
T	*Crescentia cujete* L.	X	X			X	X			X	X	X		X	X	X	X	X		X	X		X	X		X	68%
T	*Genipa americana* L.						X																				4%
	Gossypium hirsutum L.			X	X					X		X	X						X							X	28%
	Nicotiana tabacum L.											X															4%
	Solanum mammosum L.	X										X	X	X								X					20%
Total number of species per site		28	15	11	14	15	27	6	7	17	23	26	18	12	16	11	13	12	11	18	11	9	18	14	6	19	

plants in dwelling clearings results from an overlapping of both intentional and non-intentional introductions and is rarely stable. The percent co-occurrences of major food plants have been compared with random probabilities of occurrence. These matrices and their interpretations are presented elsewhere. (Covich and Nickerson, 1966, in preparation). Most of the plants in the clearings are brought to the site. Many times seedlings are grown in cans, dishes and other discarded utensils placed on stumps and other places out of the way of livestock and children. After being transplanted from these "seed beds," some plants are protected until they are more fully grown. These techniques seem to be a remnant of an early gardening method reported for the Choco in Colombia. Raised platform gardens or *azoteas* were noted among the Choco by explorers as early as 1593 (West, 1957). These *azoteas* were made in old dugout canoes and were used to raise medicinal plants and condiments. The only actual *azotea* that we observed was outside a Negro house on the outskirts of Yaviza. The present-day Choco have substituted much smaller old utensils for dugout canoes in making their *azoteas* and no longer use this technique as much as in former times. The end result is a

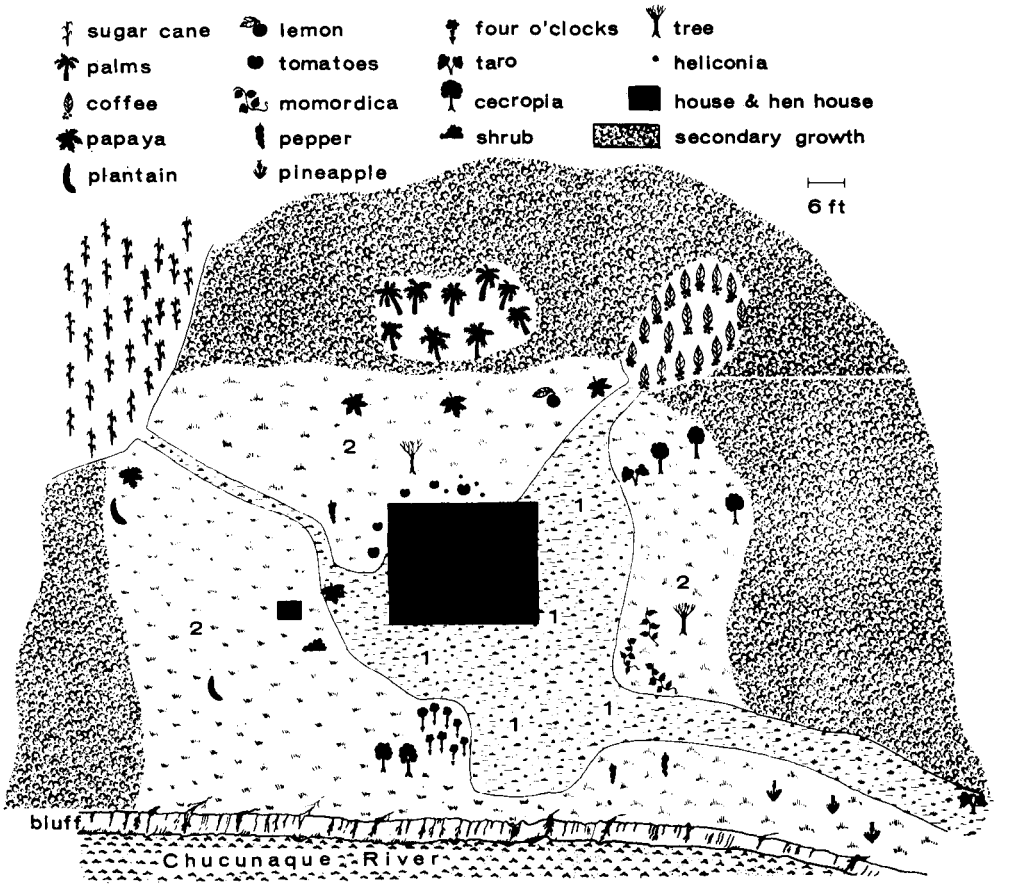


Fig. 4.—A reproduction of Sexton's Fig. 6 (Sexton *et al.*, 1964), showing plant distributions around House "A," Rio Chucunaque—Rio Carglon area, Darien, Panama. Drawing was done by Dr. Walter Hewitson. Original legend reads as follows: "A map of Stand 5 made during the wet season, 1961. Zones 1 and 2 are indicated by number; areas peripheral to these zones are not necessarily to scale." Compare with Fig. 2. (Reproduced by permission of O. J. Sexton).

small scale, intensively cultivated, raised garden. In transplanting seedlings and root-propagated cuttings into their clearings, the Choco Indians apparently are unconcerned about arrangement.

Non-intentional introductions are usually herbaceous and have the characteristics of weeds (numerous easily dispersed seeds either capable of rapid germination or able to withstand prolonged exposure without desiccation or molding). Some of these uninvited plants are capable of growing in a variety of ecological conditions. Although not seemingly of quantitative importance, these plants are of interest because they fill man-made habitats and excite only casual interest among the people creating these niches.

The spatial distribution maps show various types of clearings and arrangements of plants. The sketch map of dwelling "A" (Fig. 2) is apparently typical of the Darien Choco Indians. Another map of the same area was made in 1961 (Sexton *et al.*, 1964); it is here reproduced as Fig. 4. Comparison with Fig. 2 shows, as might be expected, stability with regard to most of the trees. However, our sketch-map was made after nearly six months of continuous habitation; thus the smaller plants like pineapples, young *Xanthosoma* plants and young *Dioscorea* plants were much more in evidence, and the cleared area was larger.

Dwelling "U" illustrated agricultural specialization, in that the Indian had departed from the more frequent close location of home-site on river-bank by building his house in the middle of an extensive platano field or "finca." The field extended more than 75 to 100 meters in each direction from the house and had just been completely cleared to a height of one-half inch with a machete. The dwelling itself was built as usual, and among the inhabitants Indian

Plate 2.—View of a Choco trash heap, Rio Tuquesa. Note round gourd-like fruit wall of "merique" (*Crescentia cujete*), corn cobs and husks, chopped stems, trunks of palm, stems of sugar cane, pieces of banana leaf and at extreme right center, a top from a pineapple. Edge of forest is at right. Seedlings of several sorts may be seen germinating in the pile of rubble. (Photo by Owen J. Sexton.)

Plate 3.—View of area around the two huts and school, Rio Tuquesa. See Figs. 3 and 4. Note that vegetative cover is essentially lacking where there is frequent foot travel. Plants of 4-o'clock (*Mirabilis jalapa*) are prominent; platanos occur near the forest edge. The typically elevated huts, open on the sides, are thatched with palm leaves brought from considerable distances upstream. An elevated fireplace, working area and utensil platform of the near hut may be seen at the left. The notched logs used for stairs are visible at right. The school and huts were connected by an open catwalk. (Photo by Owen J. Sexton).

dress was maintained, but economic considerations had changed the spatial distribution of the plants in the clearing around the dwelling. Most of the plants were drought-hardy, such as *Manihot* and *Xanthosoma;* several *Musa* also occurred close to the house. The border between the platano field and the clearing was not distinct, even though the field had just been cleared. Fewer numbers and varieties of plants were found growing in such a site.

Except for the few Indians living permanently in Yaviza, only at the site on the Rio Tuquesa (Fig. 3) were the Choco living in a manner which might resemble a village (Plates 1, 3). The site was located about 50 meters away from the Rio Tuquesa. The effect of population concentration on the spatial distribution of the plants is illustrated in Fig. 3. Plate 3 shows the manner of plant distribution and barren aspect of most of the remaining clearing.

Generally, the Indians had no concept of plants being "weeds"; some spiny amaranths were considered "bad plants," as were others which might be injurious, and these were usually eradicated. The other invading plants apparently were not considered, until they grew high enough to become bothersome, and then all were indiscriminately trampled or thoroughly cut with a machete by the women (cf. Plate 3).

Shifting of Open Habitats. Open habitats are those niches where adapted plants can germinate and reproduce. Much attention has been directed to trash heaps as being open habitats where such plants could grow (Anderson, 1947, 1952). A possible exception to this idea would seem to be sites, similar to that at dwelling "A," in which the trash heap was continually sliding down the steep river bank. Such a habitat is probably not stable long enough to allow selection of

TABLE III

LIST OF COMMON PLANT NAMES

Botanical Name from Table II	Spanish and English Common Names	Choco Indian Name (approximate)
1. *Zea mays* L.	Maíz, Corn	"ve" or "pe"
2. *Carica papaya* L.	Papaya	"panpanajo"
3. *Citrullus vulgaris* Schrad.	Sandía, Watermelon	"limona"
4. *Mammea americana* L.	Mammey	"mamejo"
5. *Musa paradisiaca* L.	Plántano	"pata"
6. *Persea americana* Mill.	Aguacate, avocado	"vego"
7. *Capsicum* spp.	Ají, various peppers	"pida"
8. *Guilielma utilis* Oerst.	Pejibaye, Peach palm	"gea"
9. *Inga edulis* Mart.	Guayaba, Guava	"purijo"
10. *Pothomorphe peltata* Miquel.	Gallinasa, Pegaplato	"angoso"
11. *Bixa orellana* L.	Achiote, Annatto	"canlli"
12. *Carludovica palmate* Ruiz & Pav.	Nagualla, Hat palm	"chuguala"
13. *Coix lacryma-jobi* L.	Ruema, Job's tears	"ta"
14. *Crescentia cujete* L.	Merique, Calabash	"sau"
15. *Genipa americana* L.	Jagua	"kipara" or "quipara"

any forms which might germinate there.

The trash heap location apparently is changed depending upon location of the house site. For example, in the clearing of dwelling "U" there was no distinct trash site; it simply was thrown in many directions. In the village-like arrangement on the Rio Tuquesa, a gully was filled with trash (Fig. 3, Plate 2). It is doubtful if the river rises high enough to remove this accumulation; apparently there was tacit agreement to dump the bulk of the litter from the four larger dwellings in this one place. In such places, the open habitat was stable enough to allow seeds to grow (Plate 2).

Competition with Invading Vegetation. Once the Indians have introduced a useful plant, either by intent or accident, its continued existence depends upon successful competition with invading grasses and other fast-growing vegetation. The Indian women clear the areas around the dwellings and thus select those useful plants to remain. Clearing seems to be done after the start of the rainy season, when wild vegetation grows rapidly. The dwellings are not in continual occupancy, since the Indians may live part of the year along another section of the river or visit with their friends and relatives. During these periods of absence, cultivated plants may be killed if competition with wild vegetation is continued for a long time. Some of the cultivated plants, especially trees, seemed to be quite hardy and probably endure considerable competition. Indeed, nearby abandoned avocado and cocoa plantings still produce heavily, although they have been completely overshadowed by large forest trees. Cherry tomatoes (*Lycopersicon,* Table II), seemingly non-intentional introductions, were found in the clearing of dwelling "A" in 1961 (Sexton, *et al.,* 1964), but not at the time of this study (compare Figs. 2 and 4); we noted only one other occurrence along the Chucunaque at a considerable distance from dwelling "A." On the other hand, dwelling "A" had also been visited by Heatwole (personal communication) seven months before this study was made; he noted that grassy vegetation was ten feet tall around the vacant dwelling. It is not known when the Indians returned to clear the area again, but many of the plants illustrated in Fig. 2 must have survived the competition with this tall weedy vegetation.

As a result of the constant invasion by introduced and jungle vegetation and intermittent re-clearing of the area by the Indians, there are distinct zones around the dwelling sites as shown in Figs, 2, 3 and 4. Among the shrubby secondary growth, there are hardy fruit trees, some ornamental trees and several coffee trees. Apparently, these zones are "reclaimed" and cleared to increase the size of the clearing and its production if the family or guests intend to stay for a long time.

Discussion

Within the last 200 years (West, 1957), the Choco Indians have apparently migrated into Panama from Colombia, and their distribution now extends up the banks of the Rio Chucunaque some distance above its confluence with the Rio Tuquesa, approximately to the Rio Chiari. Reichel-Dolmatoff (1963) has studied the ethnology of a large Choco population in Colombia. In his data on population distribution, he noted that approximately 200 Indians were living in 20 houses along the Rio Esmeraldas. His map showed the houses to be spread out along approximately 70 miles of the river's extent. The average river bank density would thus be 2.8 Indians per mile, which is lower than our Rio Chico density of 6 Indians per mile, but closer to the Rio Chucunaque estimate of 3.4 Indians per mile.

The other rivers in Reichel-Dolmatoff's study area appear to have had much lower densities. Such areas with less population pressure may be more suitable sites for study of plant-man relationships than the area employed here. The greater numbers of ceremonial objects and apparently less acculturation seems to indicate this group of Noanama Choco Indians might profitably be compared to the Darien Choco in more detail regarding cultivation patterns and techniques than has been done by Gordon (1957). Other recent works on ethnology of the various groups of Choco (Patiño, 1953; Reichel-Dolmatoff, 1960, 1962; Farrón, 1961, 1962; Torres de Arauz, 1958, 1962) as well as on their linguistics (Loewen, 1960, 1963) will help to develop a composite picture of the Choco when sufficiently detailed accounts of their cultivation techniques and adaptive ecology become available.

The latest estimate of the Choco Indian population in Darien is 4,000 (Torres de Arauz, 1958, 1962). The *Censos Nacionales de 1950,* published by the Republic of Panama, estimated the non-Indian population to be 10,480. The population density for the province was given at less than one inhabitant per square kilometer. A more realistic index, especially in relation to what we found, would be the population density per linear mile (or kilometer) along the river bank. As noted in Table I, the average dwelling area cleared per adult on the Rio Chucunaque is twice the dwelling area cleared per adult on the Rio Chico, yet the families are essentially the same size. Dwelling clearings along the Chucunaque contain on the average 19 of the species listed in Table II; along the Rio Chico they contain only 13 of the same species. Seven of the Rio Chucunaque sites had five or more of the 14 native American trees listed in Table II; only four such sites had that number along the Rio Chico. The introduced plants listed in Table II were much more common along the Rio Chucunaque. Along the Rio Chico, there is better fishing in the shallow clear pools, and mosquitoes are absent. Rio Chico Indians have more extensive platano fields and sell platanos at nearby Yaviza with a minimum of effort; they can thus derive income from a single agricultural activity, and this circumstance makes it easier for them to buy rather than grow many of their staple foods. All these factors reinforce the conclusion that there is a greater dependence upon a more diverse agriculture among the Choco along the Rio Chucunaque.

In addition to the crops which compose the major portion of the Indian diet, the variety of useful plants growing in the clearings apparently contributes significantly to balancing that diet, even though they occur in small numbers. For example, dwelling "K" has growing in its clearing the tree *Manilkara sapotilla, Persea americana, Manihot esculenta* and *Guilielma utilis* (Table II). Consumption of 100 grams from each of these four plants would supply 1.114 grams of N_2 (6.96 g crude protein), 95.6 mg Ca, 4.56 mg carotene, .162 mg thiamin, .534 mg riboflavin, 4.596 mg niacin and 79.3 mg ascorbic acid (data of Munsell *et al.,* 1949). In terms of dietary recommendations currently listed for a United States male in good health by the National Research Council, these amounts would be equivalent to the following approximate percentages of the minimum daily requirement: protein 10%, Calcium 12%, carotene 150%, thiamin 13.5%, riboflavin 31%, niacin 25% and ascorbic acid 113%. The rather low protein yield would infer that additional protein would be required from hunting and fishing if the Indians were considered to be living on materials grown just around their houses. Castro (1963) indicated, however, that pro-

tein need in the tropics is basically related to amount and kind of activity of the individual and not to a set daily minimum amount.

We do not know to what extent the present-day agricultural practices of the Choco reflect their agricultural history. Guzman (1956) cited a list of 31 plants which are known to have been introduced into Panama City by the early Spanish settlers. Half of this number was found among our sites. Thus, the Choco may appear to be more conservative in their agricultural techniques than is the actual case. The population sample dealt with in our study displayed a wide range of acculturation which directly affects the variety and number of useful plants distributed in their dwelling clearings. Gordon (1957) noted that the Choco Indians in Colombia grew a smaller number of cultivated plant species than their Negro neighbors. Such plants as cotton, *sapote* (*Lucuma mammosa,*) *mamon* (*Melicocca bijuga*), *nispero* (*Sapota zapatilla*) and *awjama* (*Cucurbita moschata*) were not grown by the nearby Choco, though the species had been available for a long time. The Choco in Darien, however, do grow these plants and thus may have introduced them into their agriculture quite recently. The newest plant introduction that we noted was *Zinnia,* for which they had no name at all. Further, Gordon pointed out that maize was the principal field crop among the Sinù Choco, and that bare soil, prepared by burning previously-cut undergrowth (but not large trees), was exposed in the fields only at planting time. Conditions among the Darien Choco are almost exactly the opposite. Rice, rather than maize, is the principal field crop, and the soil (prepared by slashing and burning of all vegetation, including large trees) remains exposed and barren of weedy plant growth for most of the first growing season, when it is planted to rice, not maize.

Townsend (Townsend and Rosebaum, 1924; personal communication with APC, 1964) and Krieger (1926) reported that the Darien Choco practiced religious and medicinal ceremonies. We noted no evidence of such practices, except for the possible significance in this regard of a few carved figures. Possibly the body stains obtained with the juice of the fruits of *Genipa americana* (quipara or jagua) have some ceremonial significance. The Indians politely refused to discuss this point, stating only that the stain was of value in repelling mosquitoes. Seemann (1854) reported that, in addition to this use in dye production, the fruits were eaten. Duke (1963a,b) substantiated this finding and noted also that the juice may be fermented to form an intoxicant. In their uses of *Genipa,* as in most other agricultural products, the Choco probably have undergone some culture assimilation. Obvious introductions to their culture are outboard motors on piraguas, modern dentifrices, diving masks for fishing, plastic beads used in making body ornaments, insect repellents, laundry detergents and occasionally canned meats.

This study has so far dealt with a modified agriculture. Interesting comparisons may be made between our findings and various ideas concerning early agriculture. Probably the first recognition of the importance of a primitive "garden-culture" prior to large-scale field cultivation was made by Morgan (1877). Later, Ames (1939) pointed out that man's invention of agriculture was a very long process, occurring probably as food gatherers became increasingly knowledgeable in the uses and dangers of individual plants. Ames stated, ". . . as the transitional period progressed . . . the food gathering industry was supplemented by a food producing process. In a strict sense, the agricultural prelude may be defined as having been a type of horticulture." Ames suggested that the earliest stage of this transition may have been the selection of wild trees which produced edible fruits. The fact that 10 different types of New World fruit trees were commonly found in and around the Choco clearings (Table II) apparently supports Ames' idea. Tree cultivation seems well suited for competition with other vegetation when the areas are only sporadically cleared by a semi-sedentary population. However, Burkill (1953) disagreed and stated that, as far as Old-World agriculture was concerned, woody fruit trees appeared long after the adoption of cereals. The means to resolve these conflicting viewpoints may exist through examination of pollen deposits.

From time to time, other explanations have been offered for origins of agriculture.

Sauer (1950) suggested that sedentary fishermen of the subtropics may have had sufficient time and ample food to experiment with drug plants which already had various uses as fibers and drugs. He theorized that agriculture first began in forest-edge clearings and involved plants propagated by roots and tubers rather than by seeds. Cutler (1954), however, believed that man used whatever was available and that seed crops are fully as ancient as vegetatively propagated ones. Anderson (1952) has suggested the importance of trash heaps as habitats for plant domestication. Ames (1939) made the interesting observation that our main food plants are heliophiles. Indian gardens of the present could have arisen from seeds dropped in trash heaps. Anderson (1952, 1954) described certain cultivated plots of Central American Indians in Santa Lucia, Guatemala, and in Honduras; he speculated that, although these plots had little obvious order, their mixed cropping might be more efficient and productive than realized by those unaccustomed to such casual cultivation. In our study, we have found evidence which may be interpreted as partial support for each of these theories. The mixed gardening technique is found in many parts of the world's tropics where in general only initial studies have been undertaken. Their importance in human diet and in the ecology of crop evolution warrants further comparative studies.

Our data and observations suggested to us that, as populations within clearings increased, more intensive use of specific areas as paths and other specific areas as garden plots (or midden heaps) may have taken place. Expansion of small garden areas from house clearings to open fertile alluvial sites along rivers might have then occurred. Clearing of forests for fields is probably a logical extension of these activities. One might conclude that large-scale agriculture involving extensive cleared areas and fewer plant species developed in such a manner. In other words, fields of crop plants in moist tropical areas may well have *followed* rather than *preceded* clustering of family dwellings. Such a sequence would suggest a longer time for plant domestication than the maximum 9000-year period which has been suggested by present-day workers (Hutchinson, 1965).

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