

The Birds of Hacienda Palo Verde,
Guanacaste, Costa Rica

PAUL SLUD

SMITHSONIAN CONTRIBUTIONS TO ZOOLOGY • NUMBER 292

SERIES PUBLICATIONS OF THE SMITHSONIAN INSTITUTION

Emphasis upon publication as a means of “diffusing knowledge” was expressed by the first Secretary of the Smithsonian. In his formal plan for the Institution, Joseph Henry outlined a program that included the following statement: “It is proposed to publish a series of reports, giving an account of the new discoveries in science, and of the changes made from year to year in all branches of knowledge.” This theme of basic research has been adhered to through the years by thousands of titles issued in series publications under the Smithsonian imprint, commencing with *Smithsonian Contributions to Knowledge* in 1848 and continuing with the following active series:

Smithsonian Contributions to Anthropology
Smithsonian Contributions to Astrophysics
Smithsonian Contributions to Botany
Smithsonian Contributions to the Earth Sciences
Smithsonian Contributions to Paleobiology
Smithsonian Contributions to Zoology
Smithsonian Studies in Air and Space
Smithsonian Studies in History and Technology

In these series, the Institution publishes small papers and full-scale monographs that report the research and collections of its various museums and bureaux or of professional colleagues in the world of science and scholarship. The publications are distributed by mailing lists to libraries, universities, and similar institutions throughout the world.

Papers or monographs submitted for series publication are received by the Smithsonian Institution Press, subject to its own review for format and style, only through departments of the various Smithsonian museums or bureaux, where the manuscripts are given substantive review. Press requirements for manuscript and art preparation are outlined on the inside back cover.

S. Dillon Ripley
Secretary
Smithsonian Institution



FRONTISPIECE.—Palo Verde marshes as seen from the hacienda; Cerros de Rosario in background.

SMITHSONIAN CONTRIBUTIONS TO ZOOLOGY • NUMBER 292

The Birds of Hacienda Palo Verde,
Guanacaste, Costa Rica

Paul Slud
...



SMITHSONIAN INSTITUTION PRESS

City of Washington

1980

ABSTRACT

Slud, Paul. The Birds of Hacienda Palo Verde, Guanacaste, Costa Rica. *Smithsonian Contributions to Zoology*, number 292, 92 pages, frontispiece, 6 figures, 33 plates, 1 table, 1980.—Hacienda Palo Verde is located geographically in northwestern Costa Rica, climatically and vegetationally in the Tropical Dry Forest life zone. Avifaunally it is the southern terminus of the Central American Arid Avifauna ranging southward in the Pacific lowlands from western Mexico. Palo Verde is also the site of a field station of the Organization for Tropical Studies, and it possesses one of the few remaining areas of tropical dry forest. Until recently a cattle ranch, it has been decreed a protected area and will soon become a national park. To my knowledge this is the first comprehensive report on the avifauna of any locality in the Central American Arid Pacific lowlands. It is intended to provide a point of reference for the making of avifaunal or environmental comparisons among comparably known localities anywhere in tropical America.

OFFICIAL PUBLICATION DATE is handstamped in a limited number of initial copies and is recorded in the Institution's annual report, *Smithsonian Year*. SERIES COVER DESIGN: The coral *Montastrea cavernosa* (Linnaeus).

Library of Congress Cataloging in Publication Data

Slud, Paul.

The birds of Hacienda Palo Verde, Guanacaste, Costa Rica.

(Smithsonian contributions to zoology ; no. 292)

Bibliography: p.

1. Birds—Costa Rica—Palo Verde. 2. Palo Verde, Costa Rica. I. Title. II. Series: Smithsonian Institution. Smithsonian contributions to zoology ; no. 292

QL1.S54. no. 292 [QL687.C8] 591'.08s [598.2'97286] 78-27666

Contents

	<i>Page</i>
Introduction	1
Acknowledgments	4
The Guanacaste Lowland	4
Hacienda Palo Verde	6
Climate	6
Geology and Soils	9
Physiognomy	10
Field Work	12
Wet Season (1969)	12
Dry Season (1970)	13
Dry Season (1971)	14
Wet Season (1975)	15
Remarks	17
Annotated List	24
Hypothetical List	59
Literature Cited	60
Plates	63
Index to Annotated List	91



FIGURE 1.—Physiography of northwestern Costa Rica (reproduced from map by Istituto Geografico de Agostina, 1968).

The Birds of Hacienda Palo Verde, Guanacaste, Costa Rica

Paul Slud

Introduction

Hacienda Palo Verde, the site of a field station of the Organization for Tropical Studies (OTS), is situated near sea level in the lower Tempisque valley of Guanacaste Province, northwestern Costa Rica (Figure 1). It lies within the Tropical Dry Forest life zone of Holdridge, occupying only 10 percent of the national territory, in contrast to all the rest of the country, which is humid to wet (Figure 2). The Tropical Dry Forest life zone in Costa Rica is the southern terminus of the Central American Arid Pacific Avifauna of Griscom (1940: 427), "ranging from the tropical lowlands of western Mexico south along the Pacific coast to the Guanacaste region of northwestern Costa Rica." Within Costa Rica the distribution of this "arid" Pacific avifauna corresponds to the dry "tierra caliente" of Coen (1953:37, map). Over the entire range from western Mexico to Costa Rica, it coincides climatically, ecologically, and biogeographically with reduced rainfall and a long dry season, with seasonal deciduous forest alternating with savanna and scrub, and with the distributions of other vertebrates.

Dry-adapted reptiles and amphibians have a similar distribution to that of the birds. Indeed, the zonation is even stricter. Termed the Western Lowland Herpetofauna by Savage (1966), it ranges continuously from western Mexico to the Gulf of Nicoya, thence upon the seasonally dry central

plateau of Costa Rica. South of the gulf it barely filters through humid southern Pacific Costa Rica to dry Pacific Panama. The same humid barrier has prevented most of the dry-adapted species in Pacific Panama from filtering northward into Guanacaste. Herpetofaunally, Guanacaste is closely related to dry Pacific Mexico and Central America, dry Pacific Panama to South America.

Freshwater fishes follow the same pattern. Miller (1966) defined his Chiapas-Nicaragua Province as extending from the basin of the Río Tehuantepec approximately to the Nicoya Peninsula, essentially the equivalent of the Pacific Mexico-Nicaragua Biotic Province of Stuart (1964). Bussing (1976:158) agreed that the Chiapas-Nicaragua Province (depauperate with marked endemism) "as delimited by Miller . . . certainly qualifies as a fish province." The coastal ranges reaching the sea at the entrance to the Gulf of Nicoya create "an exceptionally effective filter barrier that demarcates the Chiapas-Nicaraguan and Isthmian Provinces."

Mammals, so far as known, do not fit neatly with the preceding. Ryan (1963) attempted to establish biotic provinces in Central America on the basis of the mammalian distributions to be found in Hall and Kelson (1959). Rather than including Guanacaste in his dry Chinandegan Province, Ryan placed it in his Puntarenas-Chiriquí Province extending along the Pacific coast from the level of Lake Nicaragua to central Panama (Figure 3). His faunal resemblance indices "at the geographic core of each biotic province" (Ryan, 1963:42) show that, on the Pacific slope, dry Chinandegan Province has a similarity value of 48.4 with dry Escuintla-Usulután

Paul Slud, Department of Vertebrate Zoology, National Museum of Natural History, Smithsonian Institution, Washington, D.C. 20560.

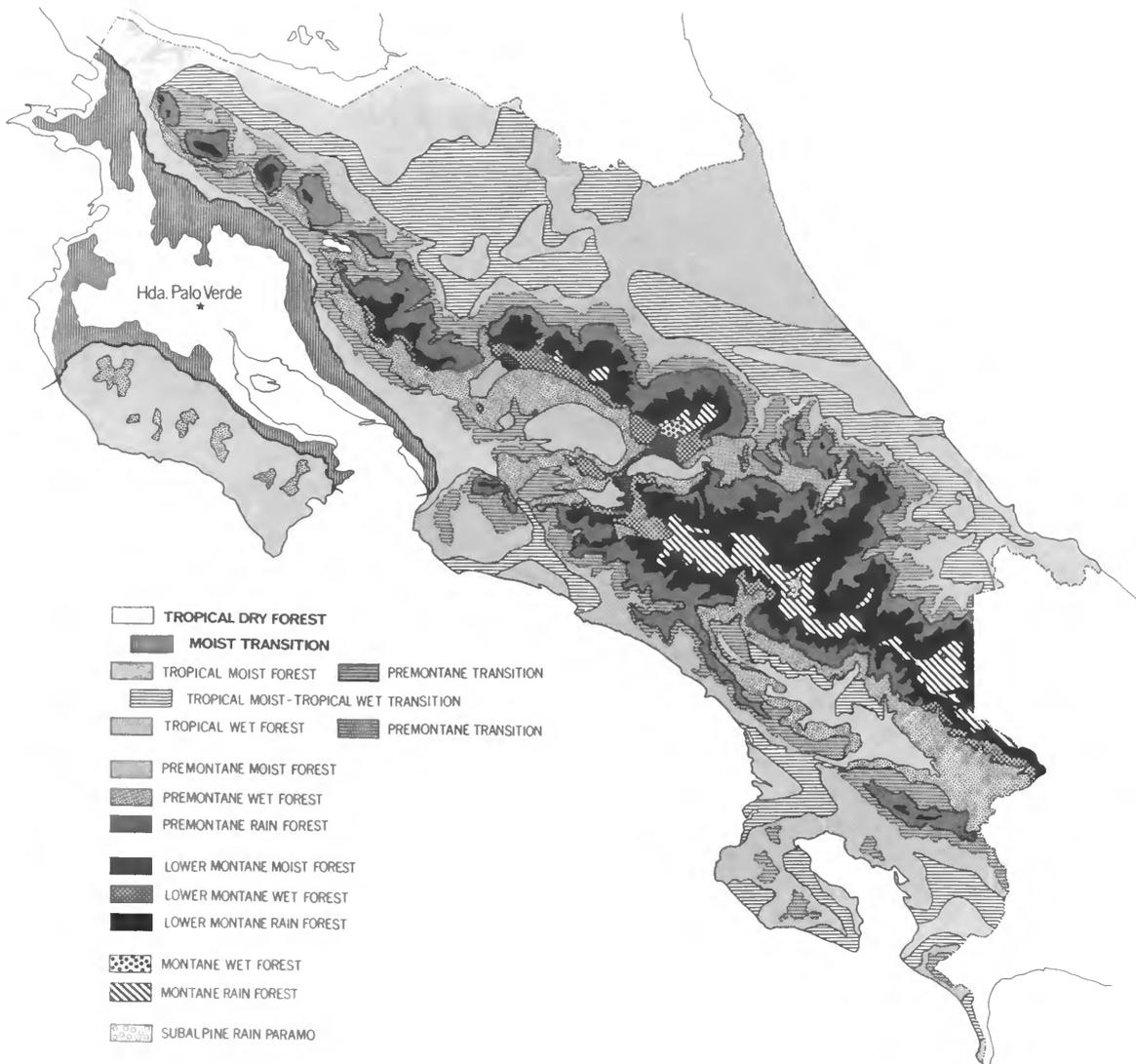


FIGURE 2.—The Holdridge life zones in Costa Rica (heavy lines bound the dry Guanacaste lowland in the northwest; redrawn and slightly modified from map by Tosi, 1969).

Province to the north but only 38.9 with his Puntarenas-Chiriquí Province to the south, despite the inclusion in the latter of dry Guanacaste and the adjoining portion of Nicaragua. Further, Chinandegan Province has a higher similarity value, 42.6, with Guatuso-Talamancan Province on the opposite slope than it has with Puntarenas-Chiriquí Province, with which it is continuous, on the same slope.

Ryan neither listed the species nor indicated how small were his samples in the unspecified localities comprising his "geographic cores." Checklists for his biotic provinces can, however, be compiled from the distributional table provided by Ryan. Compared to the dry Pacific Chinandegan and Escuintla-Usulután provinces, each with 96 species, the humid Puntarenas-Chiriquí and Guatuso-Talamancan provinces rise, respectively, to 157 and 138 species.

If bats are excluded, the relative increase is still greater: Chinandega and Escuintla-Usulután with totals of 47 and 50 species compared to Puntarenas-Chiriquí and Guatuso-Talamanca with 94 and 83 species, respectively. The much higher total in humid Puntarenas-Chiriquí (as well as in Guatuso-Talamanca and Colón-Darién) than in the dry provinces matches the situation in the other vertebrate groups.

Stuart (1964) outlined the biotic provinces of all of Middle America on the basis of the multiple factors relevant to the concept, not just mammals. Though cognizant of Ryan's attempt, Stuart placed the southern terminus of the dry Pacific coastal provinces at the entrance to the Gulf of Nicoya. It would appear likely, therefore, that Guanacaste

mammals, viewed from a life-zone perspective, would be allied more closely to those in the dry Pacific lowlands to the north than to those in humid Costa Rica and adjoining Panama to the south.

Northwestern Costa Rica was also the southern terminus of high cultural Mesoamerica, sharing with it more than a score of distinctive traits (Quirós, 1954:77-80). For these and other reasons, modern archeologists have divided Costa Rica into two sectors, one tied more to Mesoamerican influences, the other to South American traditions (Ferrero, 1977:58). The former was confined to the Pacific side down to the Cerradura Mountains below the entrance to the Gulf of Nicoya (Figure 1), whereas the latter spread over the rest of the

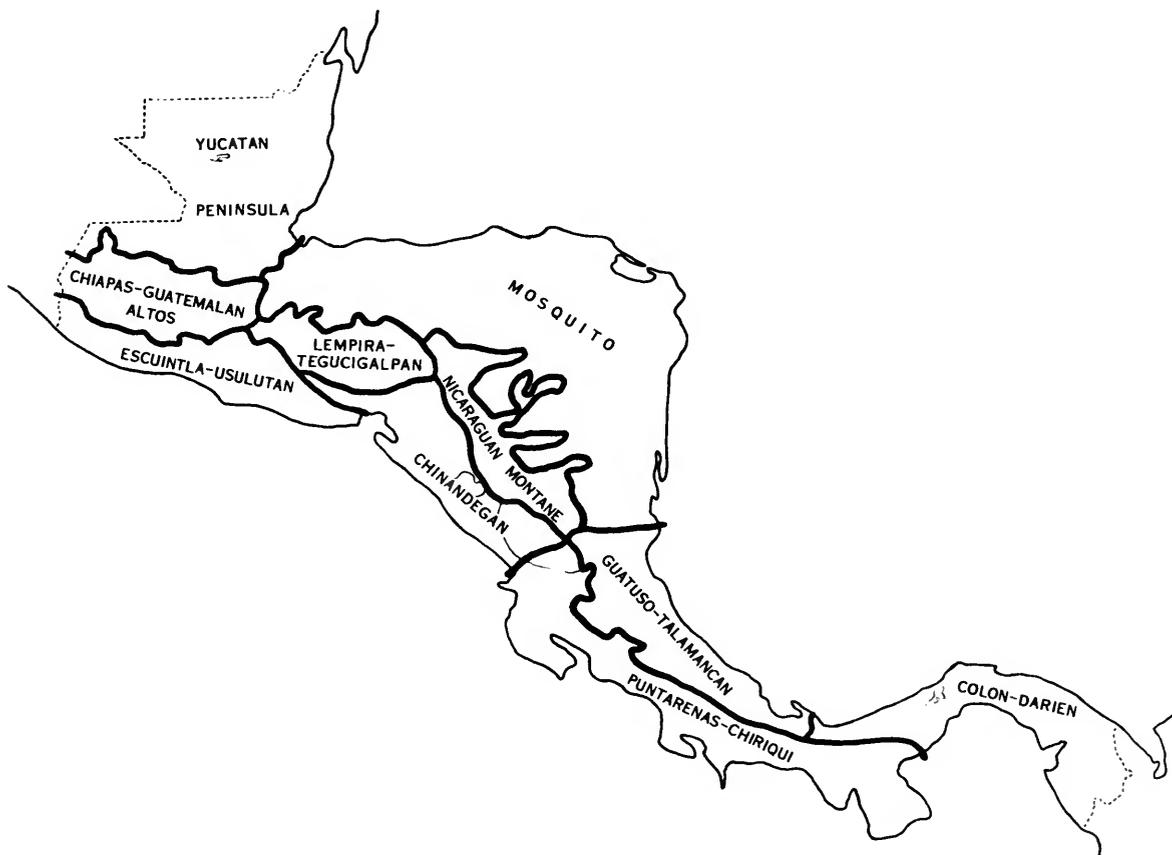


FIGURE 3.—Biotic provinces of Central America of Ryan (1963), based on mammalian distribution (redrawn and simplified).

country. Northwestern Costa Rica was likewise the terminus of a linguistic belt, termed "Gran Nicoya" (Ferrero, 1977), covering the Pacific slope of Nicaragua (Stone, 1966).

Similarly, pre-Columbian Middle America was divided into two agricultural zones. One, based principally on the cultivation of grains, characterized culturally dominant Mesoamerica, centered in Mexico. The other, based on vegetative reproduction and the utilization of the vegetative parts of the plants, such as tubers and roots, characterized the areas under northern South American influence (Ferrero, 1977:51-53). "The growing and processing of roots is undoubtedly more simple than comparable operations involving the cereals" (Mangelsdorf et al., 1964:429). The line of division between cultural Mesoamerica and the remainder of Middle America followed a north-south direction through Honduras, Nicaragua, and the Gulf of Nicoya, thus isolating northwestern Costa Rica from the rest of the country. The position of this line corresponds to that separating the dry Pacific life zones from the humid Caribbean life zones on the ecological maps of Holdridge (Holdridge, 1959a, 1959b, 1962a, 1962b; Tosi, 1969).

ACKNOWLEDGMENTS.—This report dealing primarily with Palo Verde is part of a pilot project carried out under the auspices of the Organization for Tropical Studies (OTS). An additional visit to Palo Verde was funded by the Smithsonian Institution. Little could have been accomplished without the cooperation of Jorge R. Campabadal, Resident Director of OTS; I thank him for his many kindnesses. Paul A. Opler of the U.S. Fish and Wildlife Service generously provided lists of the species he observed at Palo Verde and Hacienda Ciruelas. Reference is made to specimen labels from American Museum of Natural History (AMNH), New York, and from University of Michigan Museum of Zoology (UMMZ), Ann Arbor.

The Guanacaste Lowland

Guanacaste Province covers northwestern Costa Rica from the Pacific shore to the crest of the continental divide (Figure 1). It includes the greater part of the Nicoya Peninsula which, with its adjacent gulf and structural lowland, is the result of a NW-SE fault system that separated the old granitic rocks of the peninsula from the young volcanics

and sedimentaries of the interior (West, 1964:80). The volcanic rocks forming the Guanacaste and Nicoya cordilleras are very different from each other. According to Quirós (1954:24), scoria ejected from the Guanacaste volcanoes fell over the Tempisque valley, which in that epoch lay under water, producing large deposits of tuff. Especially at lower levels, the lacustrine and fluviolacustrine sediments are dominated by the volcanic material. Out of this great Tempisque lake arose basaltic hillocks, still clearly visible today, and mounds of ash. The lacustrine sedimentation is probably Pliocene-Pleistocene in age and forms horizontal strata on top of the other formations. In the Nicoya Peninsula, the sedimentary rock complex has been folded extensively and is probably older than the Eocene-Oligocene series on the Pacific slope of the mainland.

The Guanacaste lowland is today roughly equivalent to the Tempisque depression, which extends northward from the shores and head of the Gulf of Nicoya almost to Nicaragua (James, 1959; Wagner, 1958). It is in this lowland that the Tropical Dry Forest life zone and the distinctive Arid Pacific Avifauna are located. The lowland is bordered on the southwest by the steep block mountains of the Nicoya Peninsula which reach an elevation of more than 3,000 feet. On the northeast rise the volcanoes of the Guanacaste Cordillera, on the east the high crystalline mountains and volcanoes of the interior. South of the Gulf of Nicoya the lowland is cut off by mountains almost reaching the Pacific. The Gulf of Nicoya is filled in its northern extremity with depositional materials from the Tempisque valley. The Río Tempisque is bounded along the left bank by the volcanic Guanacaste plains, terminating in steep ash bluffs that converge with the coastline. On the right bank the land is low and rises gradually toward the hilly core of the Nicoya Peninsula. Limestone hills near the head of the gulf overlook the lower Tempisque valley from either side (Plates 10, 13, 14).

The climatic regime on the Pacific side of the country for the most part follows a predictable pattern (Holdridge et al., 1971:45-46):

. . . there is a single extended period of heavy rains beginning in late April or early May and terminating in early November. . . . This rainy period is characterized by two maxima which follow the passage of the overhead sun by about one month, first in May-June and again in September-October. These periods tend to overlap so that the interim

period in July-August is by no means rainless or "dry." From about mid-November to mid-April the sun is in the south and the Subtropical high pressure belt is drawn southward over Costa Rica. This is a period of generally lower temperatures, strong easterly trade winds, and relatively dry, clear weather. This system does not weaken until about mid-April when the sun again passes overhead on its way north. Curiously, the dry winter period is called *verano*, or summer, and the wet summer period *invierno*, or winter, by the Costa Ricans. During the *invierno* the intertropical convergence line apparently lies to the north of Costa Rica and the southeasterly trade winds moving into the low pressure cells along this line are deflected into southwesterly which bring heavy convectional rains to the entire Pacific side of the country. . . . The diurnal pattern, like the seasonal distribution itself, is the "typical" or predictable tropical pattern which corresponds to the daytime heating of the land surface, the development of the sea breeze, and convectional processes with or without the local influence of orography.

The Guanacaste lowland, however, is far more strongly affected. For one thing, it lies in the rain shadow between two mountain ranges on whose windward-oceanic exposures and upper levels precipitation tends to concentrate; for another thing, it suffers additional desiccation from the descending, dry mountain-valley winds (Holdridge et al., 1971:44). With a diminished total rainfall and a five- to six-month long rigorous dry season, the Guanacaste lowland averages 100 days with rain per year compared to 150 days in the Nicoya Peninsula, 200-250 days in the lowlands of the Pacific southwest and 250-300 days in the Caribbean lowlands (Quirós, 1954:47). The lowest average annual rainfall on record in Guanacaste is 1350 mm (53 in). It appears probable, therefore, that all of the area mapped as Tropical Dry Forest lies close to or within the transition to the adjacent, more humid life zones (Holdridge et al., 1971:62). Avifaunally, however, the Tropical Dry Forest life zone and the Moist Transition to Tropical Dry Forest (Figure 2) together contain an essentially dry-forest set of species which is distinctly separated from the Tropical Moist Forest life zone by the 2000-mm isohyet (see Coen, 1953:35, map).

As one proceeds inland from the Nicoya Peninsula towards the Tempisque basin, the landscape becomes increasingly xerophytic. As described by Wagner (1964), the forests appear more open, the tree strata are reduced to two and the percentage of compound-leaved trees and of deciduous species rises sharply. On the hills the woods are predominantly deciduous and less than 20 m tall, with a

thin upper story, a rather scrubby assortment of species and many of the shrubs spiny. A number of plants of the lower tree story also occur together in thickets without tall trees. In the driest places, the hills carry a thorny vegetation of small trees under 10 m, including a columnar cactus (*Cereus*). The plant associations contain widespread genera and resemble closely the associations on most of the Pacific side of Middle America. Strong disturbance by fire and grazing is apparent. The influence on vegetative development is manifested by the prevalence of species that resist fire or produce seeds which are easily dispersed. The latter include, in addition to forest trees, light-seeded species that readily invade disturbed sites, others that scatter their seeds mechanically and those with seeds surrounded by fleshy edible fruits spread about by animals. Because animals also trample plants and destroy foliage, almost pure stands of thorn bush have developed around pens and along driving trails (Plates 30-32). The presence of certain plants in some of the higher forests attests to the former existence of dwelling sites, field borders, or groves of fruit trees.

According to Holdridge (1953), the Tropical Dry Forest life zone (Figure 2) supported rich stands of tall deciduous forest, though with significant local variations and few species covering the whole area. Because of the high percentage of valuable timbers and the use of fire to maintain grasslands, man has altered the vegetation considerably (Plates 1-4). The forests have been greatly reduced in area and despoiled of the better trees. Cattle are raised throughout Guanacaste, and on the better soils large areas have been cleared for cotton, sugar cane, or other crops.

Much of the lower Tempisque flood plain is now a grassland with isolated small trees less than 10 m high. This biotope extends northward over a large portion of the lowland. Almost the only trees on the Nicoya side are *Curatella*, *Byrsonima*, and *Acacia* spp., while across the Tempisque these typical savanna species soon give way, unexpectedly, to oaks (Wagner, 1964). According to Holdridge (1953), the oaks (*Quercus*), *Curatella*, and *Byrsonima* form an association which extends from Cañas to beyond Liberia along a zone of very infertile soil derived from pumice that has never been cultivated; the present-day Guanacaste "savannas" are largely the result of burning and extensive clearing to-

gether with the introduction of exotic pasture grasses.

Hacienda Palo Verde

Palo Verde, as of this writing, is an administrative unit, or hacienda, of the Compañía Ganadera "El Cortez" (Comelco), a cattle ranch over 250 square kilometers in size that extends from north of the Inter-American Highway to the Río Tempisque in Guanacaste (Figure 4). Through a leasing arrangement, the Organization for Tropical Studies (OTS) has been utilizing Palo Verde as a field facility at which to acquaint students with the "dry" tropics. Also under these auspices qualified persons have been permitted to conduct their own research.

The Comelco property possesses remnants of the tropical dry forest still to be found in northwestern Costa Rica. To some extent the wooded areas have been protected by the present ownership, though the principal concern has been a matter of exploitation rather than that of safeguarding the area from damage, whether by cattle or by fire. At Palo Verde, the ranch hands were using guns to supplement their diet with game. The proprietor, they informed me, has in the past invited friends to duck-shoots. OTS instructors, students have assured me, freely collect the flora and fauna. More difficult to control perhaps have been the local residents on the opposite side of the Río Tempisque who cross over to cut timber, hunt the wildlife, and even kill and quarter beeves. Recently an area of 5000 hectares from the hills to the Río Tempisque, including the seasonal marshes with their rich bird life, was decreed a natural refuge. Soon this will be increased to 12,000 hectares and Palo Verde declared a national park.

CLIMATE

The outstanding environmental feature at Palo Verde, as in all of the northwestern lowlands, is the wet-dry climate (Plates 12–14): copious rainfall—more than the annual average in most of the Congo equatorial forest (Chapin, 1932:77–78, tables)—compressed into an approximately 6-month long wet season and an equally long, severe dry season. During my wet-season visits, the mornings

generally began bright and sunny and became increasingly warm until the skies grew dark an hour or so before noon. Threatening dark clouds could be seen developing out of the overcast and moving at different rates, sometimes in opposite directions, at different levels in the air. Often the turbulence was accompanied by intense electrical activity. Showers could be expected at any time until after dark, usually followed by clear weather. The rains, when they came, drove in unpredictably from the east or from the west. The two visits differed in that one was much wetter than the other, and the water bird fauna prospered or suffered accordingly.

The arrival of the dry season, usually by early November, is marked not only by the slackening and cessation of the rains but also by the onset of strong, gusty, irregularly persistent, desiccating winds that can continue to blow as late as the month of March. The combination of sun and wind quickly dries the ground in the open. The "lagoons" and marshes formed on the valley floor from accumulating rainwater evaporate steadily. By March the impoundments are significantly reduced in area and depth. As the drought continues the last of the low places are mostly dried out during April.

The majority of the trees shed their leaves, and this is accompanied or followed by bursts of flowering on the bare branches by an almost uninterrupted progression of species through the dry season (Frankie et al., 1974:898, 910). Hummingbirds are attracted, including some that are rare or absent the rest of the year. The leaf fall permits the sun and dry-season wind to enter, dry out the soil, and eliminate tender ground cover, producing thinner, more open and brighter woodlands than in the wet season. Depending upon slope exposure and the substrate, leaflessness is most apparent on the limestone hills. During my dry-season visits, the reduction in foliage was accompanied by a great reduction in the abundance of insects and in the number of spider webs. The ant armies, small in size, seldom met with, and poorly attended at any time of year, now apparently lacked a regular follower (i.e. *Dendrocincla homochroa*, *Dendrocolaptes certhia*, *Eucometis penicillata*).

I have not been able to obtain weather data specifically for Palo Verde. Information is available, however, for several other places in the Guanacaste lowland (Servicio Meteorológico, 1965). Thus

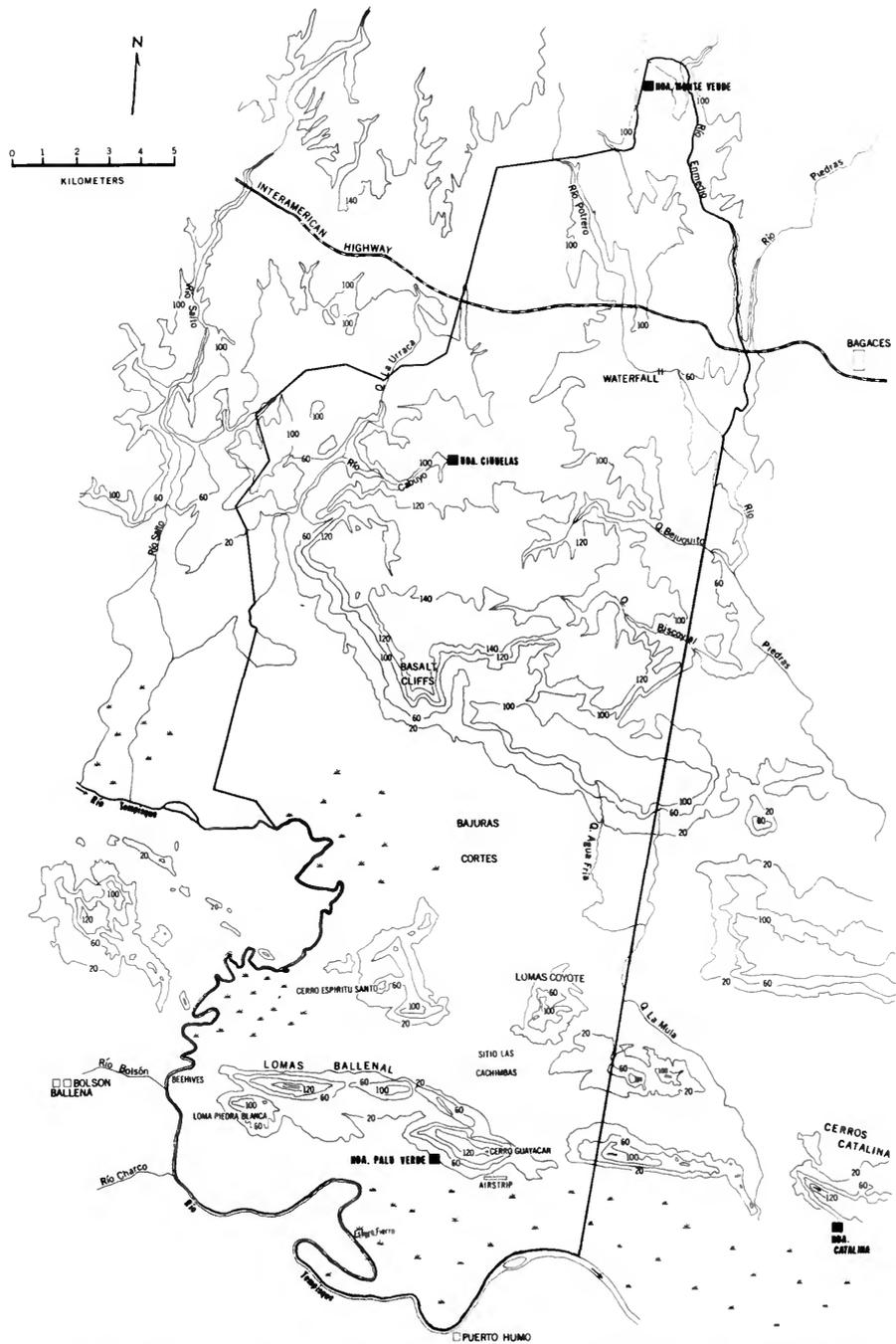


FIGURE 4.—Topography of Comelco property and adjacent Hacienda Catalina (heavy outline = Comelco property; redrawn from map by Organization for Tropical Studies).

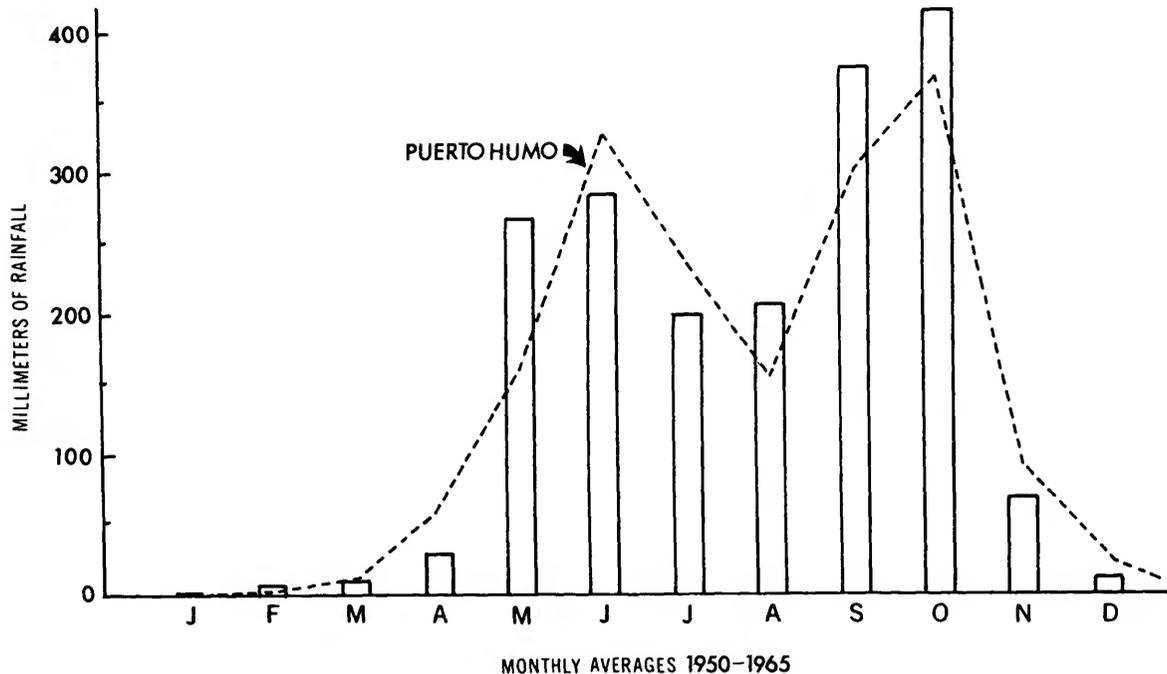


FIGURE 5.—Sixteen-year record of average monthly rainfall for seven stations in lowland Guanacaste (dashed line = Puerto Humo, near Palo Verde (see Figure 4); bars = composite average for 6 other stations; data from Servicio Meteorológico, 1965).

the nearby settlement of Puerto Humo facing Palo Verde across the Tempisque (Figure 4) has a 16-year rainfall average of 1742 mm (about 70 in) annually. Six other stations (Figure 5) with long-term records range from approximately 1650 to 2000 mm (65 to 80 in). Ninety-one percent of the average annual rainfall occurs from May through October, 2 percent from mid-November to mid-April. At Puerto Humo, as at the other stations, the second half of the rainy season is wetter than the first half, with the peak in September-October.

Temperature data for Puerto Humo are available only for 1962-65 (Servicio Meteorológico, 1965). During this period the average annual maximum was 32.4° C, with the month of April averaging the highest (35.6°) and November the lowest (30.4°). The average annual minimum was 22.5° C, with March averaging the highest (24.0°) and November the lowest (21.6°). The average annual mean was 27.4° C, with April averaging the highest (29.7°) and November the lowest (26.0°).

The average monthly maxima, minima, and means for the three measurements follow a similar pattern through the year (Figure 6). Each lies be-

low its annual average from June to January and above it from February to May. From June to January, temperatures remain more or less constant: the greatest amount of variation between the highest and lowest average during this period is only 1.3°, 0.7°, and 1.1° C, respectively. Beginning with the November low, temperatures increase gradually in December and January, rise rapidly through February and reach a peak in March and April, then decline through May. There is thus a fairly clear inverse correlation between the monthly march of temperature and seasonality: temperatures are higher in the dry season and lower in the wet season.

A further correlation presumably exists between dry-season deciduousness and average monthly maximum temperatures well in excess of 30° C. This is the value, according to Holdridge (1972), above which the vegetation drops its net photosynthesis or growth to zero. From about May through December and perhaps part of January both the number of hours and the number of days with temperatures above 30° C would appear to be relatively few during the wet season. During the dry season

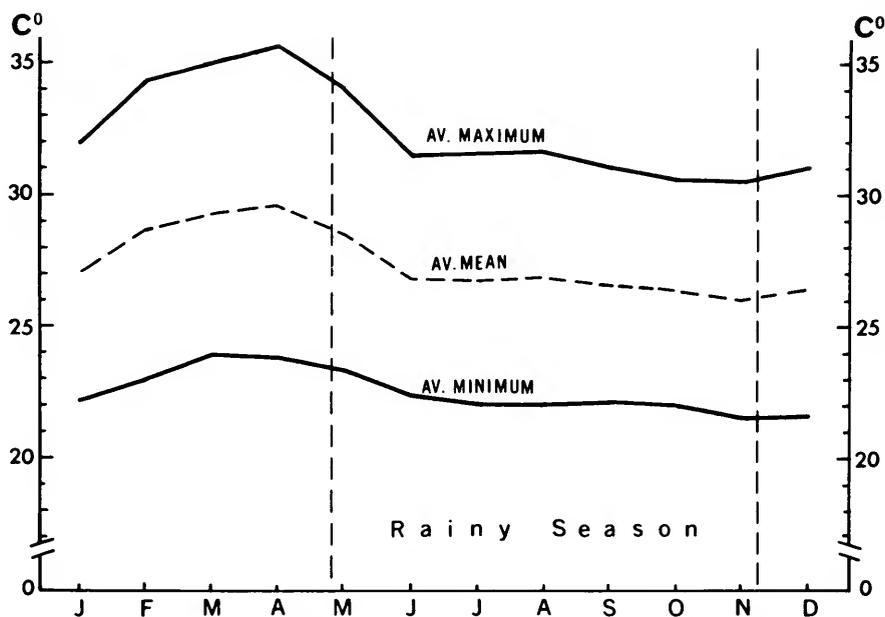


FIGURE 6.—Four-year record of average monthly temperatures at Puerto Humo, near Palo Verde (Figure 4); (data from Servicio Meteorológico, 1965).

there are many hours of high heat combined with strong winds daily for months. This is coupled with the fact that, apart from the edaphically humid associations, sufficient soil moisture for use by the plants does not last long into the dry season. The timing whereby deciduousness coincides with the effective dry period has apparently evolved as a protective mechanism.

Presumably it is these conditions of seasonally high temperature that induce physiological inactivity in the plants composing the dominant vegetation. Responses akin to the "winter dormancy" of the seasonally cold high latitudes may be evoked to defend against respirational losses of photosynthate or to limit water stress induced by excessively high rates of transpiration (Holdridge et al., 1971:7).

GEOLOGY AND SOILS

The material under this heading has been abstracted from Bourgeois et al. (1972). The Comelco Ranch (Figure 4) is divisible into four major geologic groupings: (1) recent volcanic flows and aeolian deposits, basically pumice and ash, on the northern, or upper plateau, portion of Haciendas Monte Verde and Ciruelas; (2) older volcanic de-

posits on descending terraces along the southern edge of Hacienda Ciruelas, primarily pumice and ash on the upper terrace and basalt on the lower terrace; (3) the limestone hills of Palo Verde; (4) alluvial deposits of the Río Tempisque.

The soils are derived from a parent material of limestone and volcanic and alluvial deposits. The surface horizons are gray to black, colors usually associated with organic matter, but here the percentage of such is low; the coloration is due to a carbonaceous material which is resistant to decomposition. Roots lie mostly within the top 100 cm and, where cracks occur, concentrate along their surfaces. Dry-season litter disappears as the precipitation increases again.

The Palo Verde hills have limestone-derived soils textured with clay, which develop cracks in the dry season. Weathering is not deep, and black colors predominate. The organic carbon and nitrogen content is higher than in the surrounding alluvial soils but decreases rapidly with depth. Material from these soils has a great influence on the nearby alluvial soils. The hill forests are fairly open.

The residual soils of the Palo Verde hills occur in two phases: shallow on the upper slopes and

ridge tops, deeper on the lower slopes. On very dry hill sites the shallow soils have well-weathered limestone only in the top 10 cm; nevertheless plant roots extend deep into the unweathered limestone. The deep-phase soils are well drained, with an organic layer in excess of 30–40 cm, and support a forest with an almost closed canopy that inhibits the development of subordinate vegetation.

On strong slopes at the base of the limestone hills, the alluvial parent material is 100 cm deep even adjacent to outcrops. Black and gray colors predominate; ash and pumice particles in the A and B horizons give them a salt-and-pepper appearance. Due to the very high clay content, cracks occur to the full depth of the soil in the dry season. The natural cover is woodland.

Regosolic soils (unconsolidated materials without distinct horizons) occur in the drainage channels originating in the limestone hills. Relief is gently sloping, yet erosion is severe in places. Due to the high water table during most of the year, drainage is poor. Black and gray colors predominate, with pieces of limestone mostly below stone size thinly scattered throughout. The vegetation associated with these soils occurs along the edges of the channels.

The gumbo flats north of the limestone hills are underlaid by limestone that could be a former bed of the Río Tempisque. As with other gumbo soils, these are characterized by predominantly black colors and a high clay content responsible for dry-season cracking. The subordinate vegetation consists of grass and a scattering of cacti.

The meandering Río Tempisque has in the past deposited large quantities of fine materials on either side of the Palo Verde hills and more recently west of the hills. These areas convert to nearly impassable swamps during the larger part of the year. In the dry season the very high clay content results in deep cracks which serve as avenues for root elongation and are important in churning the soil. The color is black, turning to gray as the organic matter decreases and drainage becomes poorer. The gray color usually marks the depth at which the soil keeps moist through the dry season and the cracking begins to stop.

Poorly drained Tempisque soils occupy approximately 40 percent of a wooded plot comprising part of the Lomas Ballenal and adjoining areas below the 20-meter contour (Figure 4). A vine (*Pseudo-*

calymna alliaceum) follows the break in topography between the low-relief Tempisque soils and those upon the lower slopes of the plot.

Tempisque soils also occur on the flats east of the hacienda. These are flooded during the wet season and are extensively subject to cracking, up to 25 cm in width at the surface, in the dry season. The shrinking and swelling of the soils have worked boulders and rock fragments to the surface. Grazing, clearing, burning, and flooding have encouraged an understory primarily of grasses with only scattered overstory trees.

Adjacent to the Río Tempisque the water table usually lies within a meter of the surface, and the soils are poorly drained. Relief is very low, and occasional flooding leaves a thin river alluvium. Here the cracking is not so extensive because of the high water content during the dry season. Where wooded, a low spreading bamboo is included among the principal species.

PHYSIOGNOMY

Holdridge et al. (1971) and Sawyer and Lindsey (1971) reported upon seven study sites, five of them on the Comelco property, that illustrate the variation to be found within the Tropical Dry Forest life zone in Costa Rica. The sites represent the following mature associations with trees under close to natural conditions.

1. Well-developed forest on flat upland with residual shallow and infertile soils and moderate drainage; 90 species in the general area; possibly due to grazing, full potentialities of climatic association not exhibited, but woody vegetation sufficiently developed to be used as a standard of comparison (Plate 18).

2. Well-developed forest on well-drained stream terrace, moderately high water table in wet season; canopy trees mainly deciduous; 62 species in general area; climatically transitional to tropical moist forest.

3. Low open stand of largely one species in a basin area of black clay, ground covered with heavy growth of grass; seasonally flooded, then parched; three species in the area (Plate 33).

4. Low mixed stand dominated by two species in basin area of black clay; seasonally flooded, then parched; many trees and shrubs multitrunked,

forming small to extensive clumps, open ground covered with grass; 12 species in the area (Plate 32).

5. Freshwater swamp forest dominated by one species; high water table all year and occasional flooding in wet season; low-branching trees widely spaced, heavily buttressed, with medium to spreading crowns; 14 species in the area.

6. Mixed stand on flat alluvial plain; high water table all year and occasional flooding in wet season; widely spaced trees and heavy growth of small to medium-sized palms; ground layer very sparse, mainly palm seedlings; 30 species in the area (Plate 5).

7. Well-developed "cathedral" forest on level terrain; moderately high water table, rarely flooded; canopy cover 80 percent, largely evergreen; epiphytes abundant; 28 species in the area (Plates 6, 7).

The sites are especially influenced by the availability of water in different ways and differing amounts and by the occurrence and degree of flooding. In most of the characters studied, the sites differ greatly from one another in species composition, vegetational complexity, and physiognomy. Maximum tree heights range from 9 to 46 m, median heights from 6 to 23 m, and the number of strata from one to three. The heights of the strata are greater at the streamside site (2), as would be expected from the edaphically more favorable conditions, yet the pattern is similar to that at the close-to-climatic upland site (1). The upland site (1) has more and smaller trees than the streamside terrace site (2) or the sites on flat alluvial plain (6) and (7). The latter approach the tropical humid forests in basal area and heights; even greater basal area is noted for the freshwater swamp forest of shorter trees (5). Extreme conditions of seasonally flooded or parched soils produce small, open woodlands (3) and (4). The latter sites and the freshwater swamp site (5) are floristically simple and dominated by one or two species. (See Holdridge et al., 1971, for a list of the trees and shrubs identified in or near each of the above sites and Frankie et al., 1974, for phenological records of tree species on the Comelco property.)

The climatic, or "typical," association of the Tropical Dry Forest life zone is the standard of comparison with other associations in the same life zone and with the climatic associations, wherever they exist, in other life zones. Physiognomically (Holdridge et al., 1971), the Tropical Dry climatic

association is a seasonally deciduous forest, low to intermediate in height, stratified into an uppermost layer of a few and a middle layer containing most of the tree species, a shrub layer and, except in openings, a sparse ground cover (Plates 17–26).

The canopy is composed mostly of dry-season deciduous trees 20 to 25 and occasionally 30 m tall, with wide, often flat-topped crowns which are usually not in lateral contact. Trunks are short and stout, often strongly buttressed and occasionally armed with conical prickles. Leaves are thin, compound in many species, with the leaflets very small in some common bipinnate legumes.

The small-tree stratum consists of trees 10 to 20 m tall, mostly with slender, crooked or leaning trunks and small, open crowns. Leaves are mostly elliptical or rounded, 4 to 8 cm long and either evergreen or deciduous.

The understory is composed mainly of a semi-deciduous to evergreen shrub layer (including tree regeneration) 2 to 3 m tall with a few young trees above 5 m, dense only in openings (Plate 23a). Often multiple-stemmed woody plants armed with spines or prickles and sometimes columnar cacti (Plate 30) are present.

The ground layer is mostly open, with *Selaginella* (spike-moss) occasionally clustered in shady places. Clumps of palms and ground bromeliads may be present. The density of fallen trunks and branches is characteristically very low.

Grasses are abundant in openings and clearings and become increasingly important after repeated dry-season burnings (Plates 29, 32, 33).

Vines, particularly those with woody stems (often more than 5 cm thick), are common. Herbaceous vines are rare or lacking.

Epiphytes are fairly common but are mostly small and inconspicuous.

The Tropical Dry Forest climatic association is thus readily distinguishable in appearance from the Tropical Moist Forest climatic association—termed "tropical rain forest" by other authors—of Holdridge (Holdridge et al., 1971:565). In the Tropical Dry Forest, the canopy trees are generally about 10 m shorter with crowns that are much smaller and not in lateral contact. The canopy is much more open. The canopy trees and the understory trees are more completely dry-season deciduous. Density is lower, and there are fewer tree species per unit area. Thorny and prickly small trees and

shrubs, including cacti, are much more common. Shrubby palms and banana-like herbs are lacking, except along streams. Large-leaved herbaceous vines and epiphytes are uncommon and inconspicuous.

FIELD WORK

The field work was divided among four visits in different years, twice in the latter, or rainiest, part of the wet season and twice in the latter, or driest, part of the dry season. In the wet season, Palo Verde is virtually inaccessible to the visitor who does not arrive by air on the homemade grassy runway (Plate 9*b*). Early each dry season an unpaved road descending from Hacienda Ciruelas has been bulldozed into passable condition by Comelco (Plate 16, 28–30). Vehicles then enter all the way to the “central” (the old hacienda and ranch buildings, Figure 4 and Plates 8 and 9) and, at least until recently, beyond as far as the “beehives” (Figure 4). “An Automule, a vehicle especially designed for rough country” (Organization for Tropical Studies, 1972), was capable of negotiating the road during parts of the wet season and of maneuvering through low-relief mature woodland in the dry season.

The largest wooded tract is situated between Lomas Ballenal and Cerro Espíritu Santo (Figure 4). During the rainy periods it is much too far from the OTS facility (beside the airstrip) and, even on horseback, difficult to reach. At lesser distances are some fire-scarred, browsed and trampled, though still not unduly disturbed patches (including the wooded plot previously mentioned on page 10). To reach these on foot means sloggng through kilometers of sticky mud alternating with deep mire, ozy with cattle and horse droppings, at key crossings and dips. These latter woods are of course much easier to visit in the dry season, but transport is required if one wishes an early start in the main block.

Wet Season (1969)

The first wet-season visit lasted from 13 September to 16 October 1969. I would have preferred an earlier starting date to coincide with or precede the arrival of the first migrants, but OTS urged me to wait until it was no longer preoccupied with summer courses. I put up at the same old hacienda, sturdily constructed of wood and dating from the past century, in which I had spent a night

or two 15 years earlier (Plate 8*a*).

The Palo Verde marshes lie practically at one's feet amid impressive surroundings (Frontispiece). Formed and fed each year anew by rainwater, they were extensive and growing as my visit began (Plate 12). Aquatic and marsh-dependent birds, both migrant and native, were common. The complement of species and individuals, however, was far from complete and still would not be so when I departed in mid-October. In addition to the kinds that were yet to come, other species that were already present (especially some of the ducks and herons) would be greatly augmented by later arrivals.

Late migrants to the marshes included *Ardea herodias* (17 October, the day I left), probably a number of shorebirds, though a few may have been present but overlooked, and most of the ducks. Among native species, *Podiceps dominicus*, *Eudocimus albus*, and *Himantopus mexicanus* would arrive later.

The fact that this stay coincided with the peak of the rainy season in a very wet year might account for the lateness of some species and the scarcity or absence of others. So unrelenting were the rains in early October that for the first time since the early fifties the Río Tempisque completely inundated the valley floor. Creating an eerily hushed, drowned world overnight, the Tempisque had reached and was sweeping majestically past the very foot of the cattle pens (Plate 13).

Green Herons (*Butorides*), Purple Gallinules (*Gallinula martinica*) and jacanas (*Jacana*) came drifting by on scraps of vegetation and debris, while beside them a swimming Common Gallinule (*Gallinula chloropus*) was barely making headway against the current. Least Bitterns (*Ixobrychus*), driven from seclusion and flying about in search of cover, settled on the thin crowns of small trees projecting out of open water. Limpkins (*Aramus*) kept changing from one floating mat to another. Grackles (*Quiscalus*) and redwings (*Agelaius*) were now visible in much larger numbers than suspected. Migrant terns (*Chlidonias*) appeared suddenly and remained a day or two. Like the terns, transient swallows hunted over the open water, sometimes also skimming the surface. A kite (*Rostrhamus*) hovered to pluck a large snail out of an apparently clear expanse of water, but conditions were evidently no longer suitable as the colony soon dis-

appeared. The large white egrets (*Casmerodius*) were no longer stationed apart but stood clumped together belly-deep on submerged islets. Wood Storks (*Mycteria*) preferred the margins of higher ground, as did the whistling-ducks (*Dendrocygna*). For several days I was marooned at the "central."

Migrant land birds seemed little affected by the heavy rains, yet conceivably the ones that were scarce or absent had avoided the area for that reason. Species recorded early in my visit, some of which had surely preceded me, were *Nuttallornis borealis*, *Contopus virens* (and possibly *C. sordidulus*), *Petrochelidon pyrrhonota*, *Vireo olivaceus*, *Mniotilta varia*, *Dendroica petechia*, *Seiurus noveboracensis*, *Oporornis philadelphia*, *Wilsonia canadensis*, *Setophaga ruticilla*, *Icterus spurius*, *Piranga ludoviciana*, and *Spiza americana*.

Relatively late fall migrants, defined as those I did not record until the month of October (earliest date in parentheses), were *Buteo swainsoni* (16), *Buteo platypterus* (4), *Chordeiles acutipennis* (15), *Muscivora forficata* (15), *Tyrannus tyrannus* (11), *Myiarchus crinitus* (13), *Seiurus aurocapillus* (15), *Icterus galbula* (2), *Piranga olivacea* (13), and *Pheucticus ludovicianus* (10).

The following land bird migrants recorded from the lower Tempisque valley (see "Annotated List"), I did not find during this autumn stay at Palo Verde: *Circus cyaneus*, *Falco peregrinus*, *Falco sparverius*, *Zenaidura macroura*, *Caprimulgus carolinensis*, *Archilochus colubris*, *Riparia riparia*, *Catharus ustulatus*, *Vireo flavifrons*, *Vireo philadelphicus*, *Protonotaria citrea*, *Vermivora peregrina*, *Dendroica magnolia*, *Dendroica pensylvanica*, *Dendroica coronata*, *Passerina cyanea*, and *Passerina ciris*.

Dry Season (1970)

I planned my first dry-season visit for the second half of April, six months after the wet-season visit. Normally this period immediately precedes the onset of the rainy season and represents the dry season at its most rigorous. Unfortunately, this was an exceptional year in that rains had interrupted the dry season some two months early. Instead of the parched landscape I had expected, the scene that lay before me on 17 April was one of fresh greenery interspersed with blossoms. Upon my arrival I was informed by the ranch hands that the past

three days had been dry, the implication being that previously it had been wet. I could find out nothing about the intensity or the frequency of the rains or when they had begun.

The evidence was all about that precipitation had been sufficient to activate the dormant vegetation into renewed growth. The hard dry-season road had become so muddy and soft in places that trucks did not dare deliver materials to the OTS facility under construction (Plate 9a). Not only was the trip dangerous but any entering vehicle caught by the imminent wet season would have to be abandoned. On the other hand, there was the evidence that the premature rains, far from replenishing the evaporating "lagoons," had been insufficient to prevent their extinction. As a result, the freshly foliated woodlands and the regenerating pastures stood in strange contrast to the baked flood plain from which the last mudholes were disappearing rapidly (Plate 14).

Among the water birds, a duck (*Dendrocygna autumnalis*) and stilt (*Himantopus*) were present only the day I arrived. After the second day, an egret (*Egretta thula*), another duck (*Dendrocygna viduata*) and the Limpkin (*Aramus*) had gone for good. After the fifth day, another egret (*Casmerodius*), two more ducks (*Anas discors* and *Anas clypeata*), Snail Kite (*Rostrhamus*), a yellowlegs (*Tringa melanoleuca*), two small sandpipers (*Calidris*), and a tern (*Chlidonias*) were no longer seen. By the tenth day, two more herons (*Ardea* and *Butorides*), ibis (*Eudocimus*), spoonbill (*Ajaia*), and another sandpiper (*Actitis*) had disappeared. Apparently the only remaining water birds were Cattle Egrets (*Bubulcus*), tiger-herons (*Tigrisoma*), and storks (*Mycteria* and *Jabiru*).

Species I did not see at all, no doubt because they had already departed, were grebes (*Podilymbus* and *Podiceps*), cormorant (*Phalacrocorax*), anhinga (*Anhinga*), several herons (*Egretta caerulea*, *Egretta tricolor*, *Nycticorax*, *Nyctanassa*, *Ixobrychus*, and *Cochlearius*), ducks (*Cairina*, *Anas acuta*, *Anas americana*, and *Aythya affinis*), both species of gallinules (*Gallinula*), coot (*Fulica*), jacana (*Jacana*), a yellowlegs (*Tringa flavipes*), dowitcher (*Limnodromus scolopaceus*), and, from dried-out woodland, a tiny kingfisher (*Chloroceryle acnea*).

Of the land bird migrants known to occur in the lower Tempisque valley, the following were not recorded during this visit to Palo Verde, presum-

ably because of the late date: *Buteo platypterus*, *Buteo swainsoni*, *Circus cyaneus*, *Falco sparverius*, *Coccyzus americanus*, *Chordeiles acutipennis*, *Caprimulgus carolinensis*, *Archilochus colubris*, *Muscivora forficata*, *Empidonax minimus*, *Vireo flavifrons*, *Vireo philadelphicus*, *Mniotilta varia*, *Protonotaria citrea*, *Vermivora peregrina*, *Dendroica magnolia*, *Dendroica coronata*, *Seiurus noveboracensis*, *Oporornis formosus*, *Oporornis philadelphia*, *Wilsonia canadensis*, *Setophaga ruticilla*, *Icterus spurius*, *Piranga rubra*, *Pheucticus ludovicianus*, *Passerina cyanea*, and *Passerina ciris*.

Late spring migrant land birds—those recorded onward from mid-April—were *Falco peregrinus*, *Zenaida macroura*, *Tyrannus tyrannus*, *Myiarchus crinitus*, *Nuttallornis borealis*, *Contopus sordidulus*, *Empidonax flaviventris*, *Empidonax traillii*, *Riparia riparia*, *Petrochelidon pyrrhonota*, *Hirundo rustica*, *Catharus ustulatus*, *Dendroica petechia*, *Dendroica fusca*, *Seiurus aurocapillus*, *Icterus galbula*, *Piranga olivacea*, and *Spiza americana*.

Unrecorded native land birds were *Cathartes burrovianus*, *Harpagus bidentatus*, *Buteo brachyurus*, *Buteogallus anthracinus*, *Buteogallus urubitinga*, *Geranospiza caerulescens*, *Crax rubra*, *Ortalis vetula*, *Leptotila plumbeiceps*, *Tyto alba*, *Rhinoptynx clamator*, *Anthracothonax prevostii*, *Hylocharis eliciae*, *Dendrocincla homochroa*, *Xenops minutus*, *Progne chalybea*, *Icterus pectoralis*, *Sturnella magna*, *Euphonia hirundinacea*, *Eucometis penicillata*, and *Sporophila americana*. The list seems overly long. Probably most of the species were present but overlooked. Some were possibly nomadic, others were extremely secretive or had indeed become scarce.

Dry Season (1971)

The dry-season survey in 1970, because of the early rains, could have pertained to the wet season physiognomically, to the dry season chronologically or to an intervening transitional period. The matter might be settled, it seemed, if a second attempt were made. This time I planned to arrive earlier in the dry season. I was advised, however, that the annual ranch-wide roundup was to be held at Palo Verde in February. As I envisioned it, the approaches would be crowded with feral cattle and populated by vaqueros from all the haciendas. I scheduled my visit for March, arriving the 3rd and

leaving the 18th. I stayed at the OTS building, which was still under construction and without water.

The woods and pastures were properly dry and bare, as they should be at this time of year. Depressions in the valley floor still contained sizable expanses of shallow water. These were teeming with water birds in greater concentrations than in my wet-season visit. Species now present which I had not seen then were a grebe (*Podiceps dominicus*), ibis (*Eudocimus*), stilt (*Himantopus*) and the following migrants: ducks (*Anas acuta*, *Anas clypeata*, *Anas americana*, *Aythya affinis*), sandpipers (*Tringa flavipes*, *Tringa melanoleuca*, *Limnodromus scolopaceus*), and a tern (*Gelochelidon*).

The only water birds I did not see this dry season at Palo Verde compared to the year before were the frigatebird (*Fregata*), two herons (*Ixobrychus* and *Cochlearius*), and a migrant sandpiper (*Tringa solitaria*) and tern (*Chlidonias*). As to these, *Fregata* is a wanderer from the Gulf of Nicoya; *Ixobrychus*, a secretive species, may have departed or been overlooked; *Cochlearius* appears to be a wet-season resident and dry-season nomad; *Tringa solitaria* and *Chlidonias* reappear as transients later in spring.

Migrant land birds recorded in the second half of April but not now in the first half of March were *Tyrannus tyrannus*, *Nuttallornis borealis*, *Empidonax traillii*, *Riparia riparia*, *Catharus ustulatus*, *Vireo olivaceus*, *Dendroica fusca*, *Piranga olivacea*, and *Spiza americana*. The *Contopus virens-sordidulus* complex was observed a number of times in April, only once or twice in March. *Empidonax flaviventris*, rarely noted in April, was seen repeatedly in March. Species recorded this visit in March but not in the preceding April were *Buteo platypterus*, *Falco sparverius*, *Chordeiles acutipennis*, *Archilochus colubris*, *Muscivora forficata*, *Vireo flavifrons*, *Vireo philadelphicus*, *Vermivora peregrina*, and *Dendroica magnolia*.

Several native land birds that presumably occur more or less regularly at Palo Verde were recorded the year before in April but not now in March: *Harpagus bidentatus*, *Buteogallus anthracinus*, *Buteogallus urubitinga*, *Geranospiza caerulescens*, *Crax rubra*, *Anthracothonax prevostii*, *Xenops minutus*, and *Progne chalybea*. Species seen rather commonly in April but rarely in March were *Momotus momota*, *Thryothorus rufalbus*, and *Guiraca*

caerulea. Species recorded in March but not in April were *Colinus leucopogon*, *Pulsatrix perspicillata*, *Pachyramphus polychopterus*, *Platyrinchus cancrominus*, and *Thryothorus modestus*.

The Snail Kite (*Rostrhamus*) and the parakeet *Aratinga canicularis* were seen commonly and the hawk *Buteo albonotatus* occasionally in March; all three were noted rarely in April. In these instances, at any rate, the fluctuations are more easily understood and seem to be real rather than apparent. For the marsh-inhabiting *Rostrhamus* it is clearly a matter of suitable habitat having been present in March but not in April. With respect to *Buteo albonotatus*, this hawk has been observed at Palo Verde only when it was patrolling the marshes. Hence the joint presence or absence of bird and habitat in the case of the *Buteo* is like that of *Rostrhamus*. It might be added that the highly irregular reports of the marsh-frequenting vulture *Cathartes burrovianus* at Palo Verde also follow a wet-dry pattern. In regard to *Aratinga canicularis*, a typical and normally abundant member of the Arid Pacific Avifauna, it was present in reduced numbers at Palo Verde at the time of year the species becomes common upon the Pacific side of the central plateau (see Slud, 1964:118). Carriker (1910:484) even believed that "it does not descend to the lowlands of the coast region . . . but keeps above an altitude of about 1,000 feet at least."

Wet Season (1975)

The second wet-season visit lasted from 27 August to 17 September 1975. The first part of this period (28 August–6 September) was spent in the vicinity of the "beehives" at the far western end of the property (Figure 4; Plate 8b), the remainder in the general area of the "central." The "beehives" contained a good deal of woodland, much of it infested by bull's horn acacias. The woodland was of two types: a low woods scattered with thickets and herbaceous growth, soft underfoot, shallowly flooded in places by rainwater, and with muddy tidal channels filled twice daily by the adjacent Río Tempisque; and a more open, drier woods away from the river. Also present were impenetrable marshy areas (overgrown by a screen of tall reeds) and abandoned small cultivations. Open wetlands, pastures, and cattle were absent.

A number of species were recorded for the first time at Palo Verde during this stay. At the "beehives" I met with a wood-rail (*Aramides cajanea*), a dove (*Leptotila plumbeiceps*), a greenlet (*Hylophilus*) that was new to me, and an oriole (*Icterus pectoralis*). At the "central" I found an ibis (*Plegadis*), duck (*Dendrocygna bicolor*), dove (*Columbina minuta*), owl (*Rhinoptynx*), and a migrant wood-warbler (*Oporornis formosus*). A hawk (*Buteo brachyurus*), euphonia (*Euphonia hirundinacea*), and tanager (*Eucometis penicillata*) were noted at both places.

Native land birds not recorded during this visit were *Crax rubra*, *Notharchus macrorhynchos*, *Xenops minutus*, *Erebor inquisitor*, and *Onychorhynchus mexicanus*. These were almost surely present but overlooked. In other cases, it would appear from the information on hand that birds such as *Buteogallus anthracinus*, *Coccyzus minor*, *Tachycineta albilinea*, *Sturnella magna*, and perhaps *Turdus grayi* may occur during part of the dry season and part of the wet season.

Native land birds which I observed regularly at the "beehives" but did not find in other parts of the property during this visit were *Leptodon cayanensis*, *Trogon violaceus*, *Dendrocincla homochroa*, *Myiozetetes similis*, *Oncostoma cinereigulare*, and *Turdus grayi*. Species that were uncommon to common at the "beehives" but which I met only once or twice elsewhere on the property were *Buteogallus urubitinga*, *Columbina talpacoti*, *Phaethornis longuemareus*, *Dendrocolaptes certhia*, *Tityra semifasciata*, *Myiodynastes maculatus*, *Myiarchus nuttingi*, *Platyrinchus cancrominus*, and *Camptostoma obsoletum*. The only conclusion to be drawn, in my opinion, is that few of the above species show a definite preference for extensively forested areas over brokenly wooded or semi-open habitats.

Native land birds seen occasionally to regularly elsewhere on the hacienda but (a) not at all at the "beehives" were *Burhinus bistriatus*, *Elanus leucurus*, *Parabuteo unicinctus*, *Polyborus plancus*, *Columba flavirostris*, *Ara macao*, *Tyto alba*, *Trogon elegans*, *Dryocopus lineatus*, *Tyrannus melancholicus*, *Thryothorus modestus*, *Geothlypis poliocephala*, and *Guiraca caerulea* or (b) only once at the "beehives" were *Buteo brachyurus*, *Colinus leucopogon*, *Zenaida asiatica*, and *Pteroglossus torquatus*. Most of these species prefer a "savanna" type of

country or the vicinity of the open marshes to the generally wooded, relatively closed habitats at the "beehives."

Two sets of species serve as indicators of the contrasting ecological conditions mentioned above. The little ground-dove *Columbina talpacoti*, distributed primarily in the country's humid lowlands, was abundant at the "beehives" and rare elsewhere on the hacienda; congeneric *passerina*, distributed primarily over the seasonally "dry" portions of Guanacaste and of the central plateau, occurred abundantly over most of the hacienda but was dominated numerically by *talpacoti* at the "beehives." The flycatcher *Myiozetetes similis*, a widespread species which is least abundant in the Guanacaste lowland, occurred daily at the "beehives" but elsewhere was very scarce; *Tyrannus melancholicus*, usually a common nonforest flycatcher on both slopes of the country, was absent from the "beehives" (now that the bees had been removed) but present at the "central." A number of species not noted at the "beehives" could, however, have been reasonably expected there.

Only one new migrant land bird, *Oporornis formosus*, was recorded for Palo Verde during this stay. Almost all the other land bird migrants were first seen on approximately the same date as or earlier than in 1969, probably because the present visit began earlier. The following species were found considerably earlier in 1975 than in 1969: *Nuttallornis borealis* (5 Sep vs. 14 Sep), *Contopus virens* (5 Sep vs. 13 Sep) and possibly *Contopus sordidulus* (5 Sep vs. 16 Sep), *Empidonax flaviventris* (5 Sep vs. 23 Sep), *Empidonax minimus* (3 Sep vs. 20 Sep), *Hirundo rustica* (10 Sep vs. 23 Sep), *Dendroica petechia* (30 Aug vs. 13 Sep), *Dendroica fusca* (13 Sep vs. 20 Sep), and *Spiza americana* (1 Sep vs. 17 Sep). Species first noted at about the same date in 1975 as in 1969 were *Empidonax traillii* (17 Sep vs. 19 Sep), *Petrochelidon pyrrhonota* (12 Sep vs. 16 Sep), *Vireo olivaceus* (17 Sep vs. 16 Sep), *Oporornis philadelphia* (14 Sep vs. 16 Sep), *Wilsonia canadensis* (13 Sep vs. 14 Sep), *Setophaga ruticilla* (13 Sep vs. 16 Sep) and *Icterus spurius* (12 Sep vs. 15 Sep). Of the preceding, the swallows *Hirundo rustica* and *Petrochelidon pyrrhonota* and the oriole *Icterus spurius* surely arrive earlier than indicated. "Exceptions," that is, species noted in September of 1969—*Coccyzus americanus* (19 Sep), *Mniotilta varia* (15 Sep), *Seiurus noveboracensis* (16

Sep) and *Piranga ludoviciana* (15 Sep)—but not during this visit in 1975, might not be considered so if I had stayed several days beyond the date of my departure on 17 September.

The late fall migrants, defined as the ones not recorded until October in 1969, were probably also late in 1975. At any rate, with one exception none was found during the latter stay. The exception, *Tyrannus tyrannus*, was first seen on 11 October in 1969 and on 12 September in 1975. Probably most of the migrants (listed earlier) that are known from the lower Tempisque valley in winter but which I did not find in autumn at Palo Verde do not arrive there until after the middle of October.

The three species of neotropical migrants (*Legatus leucophaeus*, *Myiodynastes luteiventris*, *Vireo flavoviridis*) differ from each other somewhat in their patterns of occurrence. *Legatus leucophaeus* was detected in neither visit in the fall, hence it may have already left or would soon leave (probably by early September). In spring it was present through both my visits spanning the period 3 March–2 May. In contrast, *Myiodynastes luteiventris* and *Vireo flavoviridis* were present virtually the entire length of my visits in the fall, 27 August–17 October. Both species were sufficiently common to be noticed most days during the first part of this period. After the third week in September, the *Vireo* could still be found more or less regularly, the *Myiodynastes* was noted only twice. In spring, the *Myiodynastes* was present the combined length of my visits, the *Vireo* all but the first week.

In respect to water birds, a total of 37 species, including accidentals, had been recorded in 1969; eight of these were not found in 1975. A total of 34 species was recorded in 1975, 16 at the "beehives" and 31 at the "central"; five of the species were not found in 1969. Several species (*Fulica americana*, *Tringa solitaria*, *Actitis macularia*, *Calidris minutilla*, *Himantopus mexicanus*) were present earlier in 1975, as was I, than in 1969. In view of the fact that over 30 days were spent at Palo Verde in 1969 compared to 20 days (nine of them at the "beehives," a relatively unsuitable place for water birds) in 1975; that the 1969 visit ended a month closer to the first part of the dry season, the peak period for water birds, than did the visit in 1975; and that a dry spell in September 1975 was responsible for the departure of a number of species,

the totals for 1969 and for 1975 are remarkably close to each other.

Remarks

How the bird life of the marshes fares seasonally may be readily anticipated. Individuals and species, especially among the ducks, both native and migrant, are most numerous in the first part of the dry season (mid-November to February) when the "lagoons" are at their deepest and the aquatic vegetation is presumably at its richest. Horses must swim in some places and heave their way through others as their legs sink into the mud or get entangled in the water plants. Already in January the evaporating "lagoons" and marshes leave behind a widening border of soft and slimy, viscous and finally cracked, baked mud. Mixed flocks of ducks and their cohorts rise when disturbed with a rushing noise of wings and may circle about once to a few times. Occasionally the birds re-settle in the the same place but generally they fly onward to another impoundment. As the season advances the "lagoons" shrink to "ponds" that become fewer, smaller, shallower, ever more distant from one another and increasingly overheated and overcrowded. The migrants leave gradually and ultimately return north. Whether the native birds remain locally in the Tempisque area or migrate elsewhere, whether the same individuals return and whether they do so with the rains or wait until the following dry season, is not known.

As conditions become more rigorous, available moisture on land is restricted to puddles along streambeds in shaded places, the vegetative cover thins and becomes less protective. Two little flycatchers, *Todirostrum sylvia* and *Oncostoma cinereigulare*, usually found in bordering bushy growth, responded by moving into less exposed, denser habitat deeper or higher in woodland. Another little flycatcher, *Platyrinchus cancrominus*, which was fairly frequent in forest understory in the wet season and which also has a distinctive little call, I detected only once in the latter part of the dry season. A contrary example is that of *Onychorhynchus mexicanus*, a flycatcher that sallies for butterflies and, like the others, possesses a self-identifying note. In the wet season of 1969, I met two or three birds regularly at a particular forest stream. The species was still there the following two years in

the dry season, in one of which a nest was suspended above the dry streambed (in April). Yet I did not find the species anywhere during my wet-season visit in 1975. These and other instances that may be found in the "Annotated List" herein are insufficient to establish a pattern of seasonal change in the composition of the bird life.

My visits were planned for opposite times of year, in the latter, or wettest, part of the wet season and in the latter, or driest, part of the dry season, when the climatic differences are extreme. I wished to minimize the chances of encountering those native land birds that might enter the "dry" life zone from the adjacent humid life zones, particularly during the semi-annual transitions between wet and dry, and those that, having arrived, might linger through the early or most amenable portion of the wet season or of the dry season. Birds recorded under both kinds of extreme conditions presumably are typical residents of the Tropical Dry Forest life zone. Birds recorded under one set of conditions but not the other would be visitants from the humid life zones or nomadic opportunists that seek suitable habitat locally in or out of the Tropical Dry Forest life zone.

The term "native land birds" was chosen intentionally. It applies to all non-introduced species of land birds (excluding kingfishers) that, irrespective of their local or seasonal movements, occur year-round in Costa Rica. An objective of the project was to try to determine by means of replicated surveys the native land birds that occur year-round at Palo Verde and those that do not. In all visits the typically "dry" species (i.e. the ones known to be confined to the "dry" northwest) proved to be so conspicuous a feature of the landscape that from the birds alone the observer knew he must be located in the country's "dry" province, even in the wet season. This corps of indicator species was complemented to considerable extent by birds that are associated primarily with the country's humid life zones (see "Annotated List"). Ecologically the two elements intermingle and together comprise the Guanacaste lowland avifauna.

It is fortunate perhaps that my visits, or samplings, were repeated at nearly the same times of year but under different conditions in different years. The opportunity was thus afforded to compare the specific composition of the avifauna during a very wet versus a variable, moderately wet

wet-season visit and during a very dry versus a strange, verdantly dry dry-season visit. Seasonal between-habitat shifts by some birds do not alter their status as species that remain on the property within the range of wet-dry conditions to be found in the Tropical Dry Forest life zone.

The "Annotated List" includes 136 species of native land birds that are known from Palo Verde as of this writing. I met with all but four of these during my four seasonal visits. Table 1 lists the species found in each visit. In the following double matrix the number of species found in each visit is in bold-face type along the diagonal running from upper left to lower right in each block; the number of species held in common by any two visits is in roman type to the right of the diagonal; resemblance coefficients are italicized to the left of the diagonal. Two faunal resemblance formulas have been utilized: the Simpson Coefficient in the matrix on the left and the Coefficient of Community in the matrix on the right.

Visit	$\frac{C}{N_1} \times 100$				$\frac{C}{N_t} \times 100$			
	I	II	III	IV	I	II	III	IV
I (1969, Wet)	108	94	95	97	108	94	95	97
II (1970, Dry)	<i>91</i>	103	93	94	<i>80</i>	103	93	94
III (1971, Dry)	<i>89</i>	<i>90</i>	106	91	<i>80</i>	<i>80</i>	106	91
IV (1975, Wet)	<i>90</i>	<i>91</i>	<i>85</i>	112	<i>79</i>	<i>78</i>	<i>72</i>	112

The Simpson Coefficient expresses the number of species held in common (C) as a percentage of the number of species in the smaller (N_1) of any two faunas or samples. This formula tends to emphasize the similarities between the faunas or samples being compared. The Coefficient of Community expresses C as a percentage of the number of different species (N_t) in any two faunas or samples (N_1 and N_2) combined. (N_t is usually written as $N_1 + N_2 - C$.) This formula tends to emphasize the dissimilarities due to differences in size of the faunas or samples being compared. Because the numbers of species found in any of my Palo Verde visits and the numbers of species held in common by any two visits are, respectively, so similar to one another, almost any faunal resemblance formula in the literature would give relatively very similar results.

The only value not in keeping with the others

is the resemblance coefficient between the dry-season visit in 1971 and the wet-season visit in 1975. This may be due to a combination of circumstances which apply only to these two visits: in 1971, the vegetation was the driest of any visit; in 1975 (the last visit), several species were found for the first and only time. By comparison, the dry-season visit in 1970 took place when the vegetation was unexpectedly fresh and green, and its resemblance coefficient with the 1975 wet-season visit is as high as or only slightly lower than its coefficient with any other visit in either matrix.

Eighty-three species were encountered in all four visits. Species found in three of the visits had in most cases probably been overlooked in the fourth. Of the species found in one of the wet-season visits and in one of the dry-season visits, several may be year-round residents (e.g. *Crax rubra*, *Columbina talpacoti*, *Xenops minutus*, *Myiozetetes similis*, *Camptostoma obsoletum*). Species found in both visits in the wet season or in both visits in the dry season (but in neither of the opposite-season visits) probably consist of seasonal visitants and a few residents (e.g. *Tyto alba*). Species only found in one visit (e.g. *Buteogallus anthracinus*, *Columbina minuta*, *Leptotila plumbeiceps*, *Rhinopteryx clamator*, *Euphonia hirundinacea*, *Eucometis penicillata*), if not scarce or infrequently met residents or seasonal or casual visitants, are perhaps statistical victims of the hazards of sampling. Among the 49 kinds of birds not found in all four visits, hawks, with 10 species, most of which were observed very infrequently or at highly irregular intervals, are disproportionately represented. It is difficult to say which of them were indeed absent for periods of seasonal length.

An interesting exercise, it seemed, would be a comparison based on equal lengths of time spent in the field. In the following paired matrix the first wet-season stay, consisting of 31 working days, was divided into two successive 15-day periods (Visits Ia and Ib), omitting the first day. The first dry-season stay (Visit II) was reduced from 16 days to 15, omitting the first day. The second dry-season stay (Visit III) was also reduced from 16 days to 15, omitting the last day. In similar manner the second wet-season stay (Visit IV), consisting of 19 working days, was reduced to 15 days, omitting the last four days (all of them rainless).

Visit	$\frac{C}{N_t} \times 100$					$\frac{C}{N_t} \times 100$				
	Ia	Ib	II	III	IV	Ia	Ib	II	III	IV
Ia (1969, Wet)	95	87	89	86	88	95	87	89	86	88
Ib (1969, Wet)	92	99	89	90	91	81	99	89	90	91
II (1970, Dry)	94	90	102	93	93	82	79	102	93	93
III (1971, Dry)	92	91	91	106	91	75	78	81	106	91
IV (1975, Wet)	93	92	91	86	111	75	77	78	72	111

In contrast to the comparison analyzed by the matrix pair previously discussed, the principal difference in this comparison is the presence of three wet-season samples of equal length instead of two that were longer and different in length; the dry-season samples remain practically the same. The addition of just the one wet-season sample produces the following results. The number of native land birds increases an average of four species each in successive samples (probably because of the observer's improving acquaintanceship with the area). The number of species held in common by all the samples decreases from 83 to 78; five species—*Elanus leucurus*, *Zenaidra asiatica*, *Pteroglossus torquatus*, *Cyanerpes cyaneus*, *Quiscalus mexicanus*—were recorded only in the first half (Ia) or in the second half (Ib) of the stay in 1969 (but were almost certainly present in both). The average number of species per wet-season sample decreases from 110 to 102, and the number of species held in common by any two samples, as might be expected, averages lower than before (89.7 versus 94). The maximum difference in number of species held in common by any two samples remains about the same: 6 in the four sampling periods and 7 in the five sampling periods.

The number of resemblance coefficients increases from 6 to 10. These differ in value from what they were in the preceding matrix pair and from each other in the present matrix pair in relation to the formula used. The Simpson Coefficients average higher (91.2 versus 89.3) than before. The highest coefficient is between the wet season in 1969 (Visit Ia) and the dry season in 1970 (Visit II). As before, the only value not in keeping with the others is between the dry season in 1971 (Visit III) and the wet season in 1975 (Visit IV). The Coefficients of Community average slightly lower (77.8 versus 78.2) than before. The lowest coefficient is again the one between the 1971 dry season (Visit III) and the 1975 wet season (Visit IV). However, two other

low values make an appearance. Both involve wet-season Visit Ia, when it is compared with the dry season in 1971 (Visit III) and with the wet season in 1975 (Visit IV). These two low values illustrate the tendency of the formula to yield lower values when the two faunas being compared are quite different in size and higher values when they are similar in size.

Obviously it is an inherent property of sampling that the number and percentage of species held in common by all samples cannot increase but must inevitably decrease as the number of samples increases. An uncommon, rare, or secretive species recorded in every previous visit need only be absent at the time and place the observer is present in any future visit for this decrease to occur. Further, every "new" species, including those which had been "unaccountably" missing in earlier visits, will contribute to the decrease. Thus, in the case of the four visits, or samples, the cumulative numbers of species at the end of successive visits are 108, 117, 124, and 132; the corresponding percentages of species held in common are 100, 80.3, 71.0, and 62.9. In the case of the five samples, the cumulative numbers of species are 95, 108, 117, 124, and 132; the corresponding percentages of species held in common are 100, 80.5, 71.8, 65.3, and 59.1.

Whether this mounting list consists of casual, irregular, or seasonal visitants or of residents that either fluctuate seasonally or have at times been overlooked depends upon the information available to and the judgment of the observer. The chances are that the number of species he deems resident will rise considerably. If it be assumed that several observers working cooperatively could have encountered a larger number of individuals and of species held in common in all visits, then the percentage of species previously presumed to be seasonally absent would certainly fall.

If the two wet-season visits and the two-dry-season visits, respectively, were to be treated as single units, the native land bird totals would rise to 123 wet-season species and 117 dry-season species, with 108 species held in common. The faunal similarity would rise to 92.3 percent using the Simpson Coefficient and to 81.2 percent using the Coefficient of Community. These values somewhat exceed the highest ones in the corresponding matrices. Progressing from these figures to compilations (i.e. checklists), the species found in a number of

TABLE 1.—Occurrence of native land birds at Palo Verde as sighted by the author on 4 visits (Ia = first half of 1969 wet-season visit, Ib = second half of 1969 wet-season visit, II = 1970 dry-season visit, III = 1971 dry-season visit, IV = 1975 wet-season visit).

Species	Wet		Dry		Wet	Species	Wet		Dry		Wet
	Ia	Ib	II	III	IV		Ia	Ib	II	III	IV
<u>Crypturellus</u> <u>cinnamomeus</u>	x	x	x	x	x	<u>Columbina</u> <u>passerina</u>	x	x	x	x	x
<u>Sarcoramphus</u> <u>papa</u>	x	x	x	x	x	<u>Columbina</u> <u>minuta</u>					x
<u>Coragyps</u> <u>atratus</u>	x	x	x	x	x	<u>Columbina</u> <u>talpacoti</u>			x		x
<u>Cathartes</u> <u>burrovianus</u>				x	x	<u>Claravis</u> <u>pretiosa</u>	x	x	x	x	x
<u>Cathartes</u> <u>aura</u>	x	x	x	x	x	<u>Leptotila</u> <u>verreauxi</u>	x	x	x	x	x
<u>Elanus</u> <u>leucurus</u>	x		x	x	x	<u>Leptotila</u> <u>plumbeiceps</u>					x
<u>Leptodon</u> <u>cayanensis</u>	x	x	x	x	x	<u>Ara</u> <u>macao</u>	x	x	x	x	x
<u>Harpagus</u> <u>bidentatus</u>				x		<u>Aratinga</u> <u>canicularis</u>	x	x	x	x	x
<u>Rostrhamus</u> <u>sociabilis</u>	x	x	x	x		<u>Brotogeris</u> <u>jugularis</u>	x	x	x	x	x
<u>Buteo</u> <u>albicaudatus</u>				x		<u>Amazona</u> <u>albifrons</u>	x	x	x	x	x
<u>Buteo</u> <u>jamaicensis</u>				x		<u>Amazona</u> <u>ochrocephala</u>	x	x	x	x	x
<u>Buteo</u> <u>albonotatus</u>				x	x	<u>Coccyzus</u> <u>minor</u>			x	x	
<u>Buteo</u> <u>magnirostris</u>	x	x	x	x	x	<u>Piaya</u> <u>cayana</u>	x	x	x	x	x
<u>Buteo</u> <u>brachyurus</u>					x	<u>Crotophaga</u> <u>sulcirostris</u>	x	x	x	x	x
<u>Buteo</u> <u>nitidus</u>	x	x	x	x	x	<u>Morococcyx</u> <u>erythropygus</u>	x	x	x	x	x
<u>Parabuteo</u> <u>unicinctus</u>	x	x	x	x	x	<u>Tyto</u> <u>alba</u>		x			x
<u>Buteogallus</u> <u>anthracinus</u>				x		<u>Pulsatrix</u> <u>perspicillata</u>	x	x	x		x
<u>Buteogallus</u> <u>urubitinga</u>	x	x		x	x	<u>Glaucidium</u> <u>brasilianum</u>	x	x	x	x	x
<u>Spizaetus</u> <u>ornatus</u>	x					<u>Rhinoptynx</u> <u>clamator</u>					x
<u>Geranospiza</u> <u>caerulescens</u>	x	x		x	x	<u>Nyctidromus</u> <u>albicollis</u>	x	x	x	x	x
<u>Herpetotheres</u> <u>cachinnans</u>	x	x	x	x	x	<u>Streptoprocne</u> <u>zonaris</u>		x		x	x
<u>Micrastur</u> <u>semitorquatus</u>	x	x	x	x	x	<u>Phaethornis</u> <u>longuemareus</u>	x	x	x	x	x
<u>Caracara</u> <u>plancus</u>	x	x	x	x	x	<u>Eutoxeres</u> <u>aquila</u>		x			
<u>Crax</u> <u>rubra</u>	x			x		<u>Anthracothorax</u> <u>prevostii</u>		x		x	
<u>Penelope</u> <u>purpurascens</u>	x	x	x	x	x	<u>Chlorostilbon</u> <u>canivetii</u>	x	x	x	x	x
<u>Colinus</u> <u>leucopogon</u>	x		x		x	<u>Hylocharis</u> <u>eliciae</u>				x	
<u>Burhinus</u> <u>bistriatus</u>	x	x	x	x	x	<u>Amazilia</u> <u>saucerottei</u>	x	x	x	x	x
<u>Columba</u> <u>flavirostris</u>	x				x	<u>Amazilia</u> <u>rutila</u>	x	x	x	x	x
<u>Zenaida</u> <u>asiatica</u>		x	x	x	x	<u>Amazilia</u> <u>tzacatl</u>				x	
<u>Scardafella</u> <u>inca</u>	x	x	x	x	x	<u>Helimaster</u> <u>constantii</u>	x	x	x	x	x

TABLE 1.—Continued.

Species	Wet		Dry		Wet	Species	Wet		Dry		Wet
	Ia	Ib	II	III	IV		Ia	Ib	II	III	IV
<u>Trogon melanocephalus</u>	x	x	x	x	x	<u>Onychorhynchus mexicanus</u>	x	x	x	x	
<u>Trogon elegans</u>	x	x	x	x	x	<u>Platyrinchus cancrominus</u>	x	x	x		x
<u>Trogon violaceus</u>	x	x	x	x	x	<u>Tolmomyias sulphureus</u>	x	x	x	x	x
<u>Eumomota superciliosa</u>	x	x	x	x	x	<u>Todirostrum cinereum</u>	x	x	x	x	x
<u>Momotus momota</u>	x	x	x	x	x	<u>Todirostrum sylvia</u>	x	x	x	x	x
<u>Notharchus macrorhynchus</u>		x	x	x		<u>Oncostoma cinereigulare</u>	x	x	x	x	x
<u>Pteroglossus torquatus</u>		x	x	x	x	<u>Myiopagis viridicata</u>	x	x	x	x	x
<u>Dryocopus lineatus</u>	x	x	x	x	x	<u>Camptostoma imberbe</u>	x	x	x	x	x
<u>Melanerpes hoffmannii</u>	x	x	x	x	x	<u>Camptostoma obsoletum</u>				x	x
<u>Campephilus guatemalensis</u>	x	x	x	x	x	<u>Progne chalybea</u>		x		x	x
<u>Dendrocincla homochroa</u>		x			x	<u>Tachycineta albilinea</u>	x	x	x	x	
<u>Sittasomus griseicapillus</u>	x	x	x	x	x	<u>Calocitta formosa</u>	x	x	x	x	x
<u>Dendrocolaptes certhia</u>	x	x	x	x	x	<u>Campylorhynchus rufinucha</u>	x	x	x	x	x
<u>Xiphorhynchus flavigaster</u>				x		<u>Thryothorus modestus</u>	x		x		x
<u>Lepidocolaptes souleyetii</u>	x	x	x	x	x	<u>Thryothorus rufalbus</u>	x	x	x	x	x
<u>Xenops minutus</u>		x		x		<u>Thryothorus pleurostictus</u>	x	x	x	x	x
<u>Thamnophilus doliatus</u>	x	x	x	x	x	<u>Turdus grayi</u>			x	x	x
<u>Pachyramphus polychopterus</u>	x	x	x		x	<u>Polioptila albiloris</u>	x	x	x	x	x
<u>Platypsaris aglaiae</u>		x		x	x	<u>Polioptila plumbea</u>	x	x	x	x	x
<u>Tityra semifasciata</u>	x	x	x	x	x	<u>Ramphocaenus melanurus</u>	x	x	x	x	x
<u>Erator inquisitor</u>		x	x	x		<u>Hylophilus sp.</u>					x
<u>Chiroxiphia linearis</u>	x	x	x	x	x	<u>Hylophilus decurtatus</u>	x	x	x	x	x
<u>Tyrannus melancholicus</u>	x	x	x	x	x	<u>Cyanerpes cyaneus</u>		x	x	x	x
<u>Myiodynastes maculatus</u>	x	x	x	x	x	<u>Geothlypis poliocephala</u>	x	x	x	x	x
<u>Megarhynchus pitangua</u>	x	x	x	x	x	<u>Basileuterus rufifrons</u>	x	x	x	x	x
<u>Myiozetetes similis</u>				x	x	<u>Molothrus aeneus</u>			x		x
<u>Pitangus sulphuratus</u>	x	x	x	x	x	<u>Quiscalus mexicanus</u>		x	x	x	x
<u>Attila spadiceus</u>	x	x	x	x	x	<u>Icterus pectoralis</u>					x
<u>Myiarchus nuttingi</u>	x	x	x	x	x	<u>Icterus pustulatus</u>	x	x	x	x	x
<u>Myiarchus tyrannulus</u>	x	x	x	x	x	<u>Agelaius phoeniceus</u>	x	x	x	x	x
<u>Myiarchus tuberculifer</u>	x	x	x	x	x	<u>Sturnella magna</u>		x			
<u>Contopus cinereus</u>	x	x	x	x	x	<u>Euphonia affinis</u>	x	x	x	x	x

TABLE 1.—Continued.

Species	Wet		Dry		Wet
	Ia	Ib	II	III	IV
<u>Euphonia hirundinacea</u>					x
<u>Eucometis penicillata</u>					x
<u>Guiraca caerulea</u>			x	x	x
<u>Sporophila torqueola</u>	x	x	x	x	x
<u>Sporophila americana</u>	x	x			x
<u>Volatinia jacarina</u>	x	x	x	x	x
<u>Arremonops rufivirgatus</u>	x	x	x	x	x
<u>Aimophila ruficauda</u>	x	x	x	x	x

visits in the wet seasons compared to a number of visits in the dry seasons should result in a higher percentage of species held in common than between individual wet-season and dry-season visits. In other words, additional observations should progressively eradicate most of the differences in specific composition between the wet-season and the dry-season avifaunas. The rise in similarity is due at present almost entirely to the very high similarity index of the passerines. The overall similarity index should continue to increase, rather than level out or fall, owing to a delayed rise by the nonpasserine similarity index which does not begin to take place until, as suggested by Slud (1976), long-term observations have sufficiently begun to accumulate.

The similarity in total number of native land birds, species held in common, and resemblance coefficients holds additional interest. The combined wet-season sample was obtained in 50 days of field work, the combined dry-season sample in 32 days. It might seem, therefore, that the dry season is richer in kinds of species: if the dry-season stays had been as long as the wet-season stays they would have produced probably a longer bird list. Effort is expended more efficiently, however, in the dry season as it allows more time per day in which to make observations or to reach a wider variety of habitats. In support of this view, species at first accumulated more rapidly in the dry-season visits but declined in rate sooner than in the wet season visits. On the other hand, damp places covered by herbaceous growth in woods, to cite an example of changing habitat conditions, were non-existent during my visits late in the dry season.

As to the species not held in common, 15 were recorded only in the wet-season visits (left-hand column) and 9 only in the dry-season visits (right-hand column):

<i>Buteo brachyurus</i>	<i>Harpagus bidentatus</i>
<i>Spizaetus ornatus</i>	<i>Buteo albicaudatus</i>
<i>Columba flavirostris</i>	<i>Buteo jamaicensis</i>
<i>Columbina minuta</i>	<i>Buteo albonotatus</i>
<i>Leptotila plumbeiceps</i>	<i>Buteogallus anthracinus</i>
<i>Tyto alba</i>	<i>Coccyzus minor</i>
<i>Rhinoptynx clamator</i>	<i>Hylocharis eliciae</i>
<i>Eutoxeres aquila</i>	<i>Amazilia tzacatl</i>
<i>Dendrocincla homochroa</i>	<i>Xiphorhynchus flavigaster</i>
<i>Hylophilus</i> sp.	
<i>Icterus pectoralis</i>	
<i>Sturnella magna</i>	
<i>Euphonia hirundinacea</i>	
<i>Eucometis penicillata</i>	
<i>Sporophila americana</i>	

The difference of six species between the two columns is of course the same as that between the combined wet-season and the combined dry-season totals. The preponderance of hawks and the near absence of passerines in the dry-season column and the good representation of passerines in the wet-season column are possibly related to this difference and may be indicative of real seasonal differences. It should be pointed out, however, that the majority of the species were found only once, most of the others rarely or irregularly and only in one or at most in two of the visits. Eight of the wet-season birds were not encountered until the last visit. At least some of these will probably be found in future dry-season visits and removed from the list. It appears likely, too, that the list would be further reduced for no other reason than if the seasonal totals were to approach each other in size.

In the wet-season column, only the oriole *Icterus pectoralis* is known to be restricted to the country's northwestern quadrant (but not to the "dry" life zone). The others are birds of the humid life zones, yet the majority also occur occasionally or regularly in the Guanacaste lowlands in the dry season. This leaves a handful that could conceivably be regular wet-season visitors to Palo Verde. In the dry-season column, not one, as a species, is confined to the Guanacaste lowland. I find it hard to accept as fact that *Buteogallus anthracinus* is really so infrequent as my few observations make it appear to be in the dry season. Furthermore, I would have expected it and *Harpagus bidentatus* and *Buteo albonotatus* as more apt to be present in

the wet season. Of the two hummingbirds, *Amazilia tzacatl* is probably as scarce as the record shows. Perhaps it occurs occasionally when blossoms appear on the leafless branches in the dry season. *Hylocharis eliciae* I thought would be present in greater number and through much of the year.

All in all, it would seem that the native land avifauna at Palo Verde remains about the same in size and in number of species held in common in different wet seasons, in different dry seasons and in the wet and dry seasons. Despite the very short geographical distances, few wide-ranging species of the humid life zones are known to be seasonal at dry-forested Palo Verde. Guanacaste thus differs to some extent from dry northeastern Venezuela, reported upon by Friedmann and Smith (1950, 1955) and referred to below. The present findings make one wonder how often or successfully have elements of humid-forest populations, now separated by dry forest, filtered through the intervening climato-vegetational gap even during the wet season.

The only bit of information having to do with avifaunal seasonality in the Central American dry Pacific lowlands, I found in Monroe (1968:22) for Honduras. There his tropical deciduous (monsoon) forest

corresponds best to the Arid Lower Tropical Zone and to the Tropical dry forest life-zone (formation). . . . Typical monsoon forest . . . is a most interesting habitat to observe with relation to seasonal changes. In the rainy season it has the general appearance of a typical rain forest; the avifauna [for which there is no species list], however, is very depauperate by comparison, consisting mainly of species that occur also under more arid conditions, as would be expected. In the dry season, the forest complexion changes completely, with a loss of most of the leaves of the canopy and a concomitant drying out of the understory and the humus.

Monroe (1968:396) names 37 resident land birds that are "characteristic primarily of arid lowland habitats, some species of which occur also in the deciduous forest." Of these, 32 are identical to, and another four are congeneric with, species in the Guanacaste lowland. In addition, Monroe (1968:391) lists 60 native land birds as characteristic of his "Tropical Zone, but which exhibit a wide tolerance for arid or humid conditions" and in most cases "inhabit open situations, forest edge, or the like, and are not typical of heavily forested regions, although many may be found in more open portions of rain and deciduous forest. They occur on

both versants, usually ranging to low elevations on both slopes (although a few do not occur below 500 meters on the Pacific drainage). . ." All 60, it is implied, are permanent residents; 53 of these are identical to and another two are congeneric with species known to occur in the Guanacaste lowland.

The above two lists of Monroe include most of the native land birds in "arid" (wet-dry) Pacific Honduras and many that inhabit northwest Pacific Costa Rica. These two well-separated areas have obviously similar climates, habitats, and land birds. Both have their forest avifaunas as markedly xeric as their non-forest avifaunas.

Elsewhere, observations compiled over several years are available for dry northeastern Venezuela. There the junior author in Friedmann and Smith (1950, 1955) gathered data on the climate, vegetation, and relative abundances and reproductive periods of the birds. The rainfall averages only 60 percent of that in Guanacaste, with the bulk concentrated in the same May-November period, and the "prevailing northeasterly wind blows almost continually through the dry season" (Friedmann and Smith, 1950:419). The rainy season is not separated into two peaks as in Guanacaste, despite the similar latitude.

The reader is cautioned by the junior author (Friedmann and Smith, 1955:463), in words that strike home, that "part-time observations by one man, even over a period of approximately 8 years, cannot equal the accumulated work of . . . [a] number of observers" and "a form that is rare within the area, of difficult field identification, or shy and retiring, may be reported in only one, two, or more scattered months without implying absence from the study area during the remaining months." The majority of the breeding forms have no known migration, yet, as in Guanacaste, "a seasonal fluctuation in numbers indicates local and perhaps extended movement" (Friedmann and Smith, 1955:466).

The annual cycle of wet and dry seasons is an important factor affecting breeding (Friedmann and Smith, 1955:468): "At first glance it might seem that the breeding species curve closely approximates the rainfall curve, as does the upward curve of the trees in leaf. . . . However, the upward curve of breeding species precedes those of rainfall and vegetation." Breeding activity becomes "much

greater in March and April, although the climate and soil have become extremely dry. In fact, the April peak represents many forms nesting in arid, still barren woods which will not be well in leaf before June."

In southwestern Ecuador, under still drier conditions accompanied by an enormous yearly variation in rainfall, Marchant (1958) found that the Equatorial Arid Avifauna consists of (a) characteristic residents, always present and no doubt best adapted to the arid conditions, (b) species that arrive at widely varying dates in the wet season to breed and have rarely or never been noted at other times of year, (c) intermediate species that

certainly or probably remain in the district but are greatly augmented by arrivals after the rains have started in the first part of the year, (d) species that probably or certainly belong to this fauna but are not common enough for their status to be determined, and (e) North American migrants, dominated by charadriiform birds. Excluding (a), which is the same as the situation at Palo Verde, and (e), which is very different, the categories in the above outline generally apply to the Guanacaste avifauna, the seasonal occurrence of which is still not fully known and the regulation of which depends on climate-associated factors that are poorly understood.

Annotated List

The avifauna of the dry Guanacaste lowlands has been reported upon seldom and never comprehensively. The earliest account, by Nutting (1883) at Hacienda La Palma on the mainland side at the head of the Gulf of Nicoya, treats 95 species, only 69 of which are native land birds. Underwood (1896) published an annotated list of species, often without precise locality, for north-central Guanacaste. As he collected principally on the lower slopes of Miravalles Volcano and vicinity, only occasionally extending his trips to Bagaces at lower elevation, many of the species pertain to the humid life zones. Wetmore (1944), in northern Guanacaste, divided a month's collecting trip between Liberia in the lowlands and Hacienda Santa María near the cool continental divide. Of the 92 species he recorded in the vicinity of Liberia, only 57 are native land birds. More recently, a colorfully illustrated brochure dealing with selected species at Hacienda La Pacifica, near Cañas, was prepared by Suter (1969).

The "Annotated List" includes all the species of birds which to my knowledge have been recorded up to 1975 at Palo Verde in particular and the lower Tempisque valley in general. Species in brackets either require substantiation at Palo Verde or have been reported from neighboring localities in the lower Tempisque valley: Catalina, Bolsón, and Ballena. Except for a few confined to the mangroves at Catalina, most of these species should eventually be found at Palo Verde. The annota-

tions are intended to supplement rather than repeat the information in my report on the birds of Costa Rica (Slud, 1964).

Palo Verde and Catalina (Figure 4) were formerly part of an enormous property under single, then shared, and subsequently divided ownership. Until recently, that is before Catalina converted to producing sugar cane, the two comprised an ecological unit on the left bank of the lower Río Tempisque down to the Río Bebedero. Years ago I stayed at Catalina twice in the early dry season (9–22 January 1951; 26 November–5 December 1954) and regularly entered parts of Palo Verde. At Catalina I found 14 species not included among the 246 known at present from Palo Verde. Of the combined total of 260 species in the Catalina-Palo Verde area, I have personally met there with all but two of the land birds and seven of the water birds. At least another 12 species of land birds, generally of a more mesic sort, have been taken upriver at Bolsón and Ballena.

The species list of 272 for the lower Tempisque valley is a minimal total. Other native species which might be expected, not necessarily as residents, have been reported at Hacienda Ciruelas overlooking the Tempisque flood plain (Figure 4) and at Taboga and Bebedero a short distance away in the same life zone. The number of migrants should rise, too.

A number of scientific names have been changed since my "Birds of Costa Rica" appeared in 1964.

Those that occur in this report are listed below, followed (in parentheses) by the ones that have been replaced:

Egretta caerulea (= *Florida caerulea*)
Egretta tricolor (= *Hydranassa tricolor*)
Geranospiza caerulescens (= *Geranospiza nigra*)
Caracara plancus (= *Polyborus plancus*)
Gallinula martinica (= *Porphyrula martinica*)
Tringa flavipes (= *Totanus flavipes*)
Tringa melanoleuca (= *Totanus melanoleucus*)
Capella gallinago (= *Gallinago gallinago*)
Calidris pusilla (= *Ereunetes pusillus*)
Calidris mauri (= *Ereunetes mauri*)
Calidris minutilla (= *Erolia minutilla*)
Columba flavirostris (= *Patagioenas flavirostris*)
Zenaida macroura (= *Zenaidura macroura*)
Columbina passerina (= *Columbigallina passerina*)
Columbina minuta (= *Columbigallina minuta*)
Columbina talpacoti (= *Columbigallina talpacoti*)
Melanerpes hoffmannii (= *Centurus hoffmannii*)
Campyphilus guatemalensis (= *Phloeocastes guatemalensis*)
Myiarchus panamensis (= *Myiarchus ferox*)
Tachycineta albilinea (= *Iridoprocne albilinea*)
Catharus ustulatus (= *Hylocichla ustulata*)
Basileuterus rufifrons (= *Basileuterus delatryi*)
Basileuterus fulvicauda (= *Phaeothlypis fulvicauda*)
Molothrus aeneus (= *Tangavius aeneus*)
Quiscalus mexicanus (= *Cassidix mexicanus*)
Euphonia affinis (= *Tanagra affinis*)
Euphonia hirundinacea (= *Tanagra lauta*)
Thraupis episcopus (= *Thraupis virens*)
Sporophila americana (= *Sporophila aurita*)

In the accounts that follow, native species are associated with the wet season, with the dry season, or with both. Long-distance migrants are identified with the terms "autumn," "winter," and "spring," used in the North American sense. "Autumn" migrants occur in Guanacaste in the latter part of the wet season from August to November, "winter" visitants in the first half of the dry season (November–February) and "spring" migrants in the second half of the dry season (March–May). Terms of abundance are based on daily records of presence or absence at Palo Verde and reflect my experience with the species in Guanacaste and elsewhere in the country.

Crypturellus cinnamomeus (Rufescent, or Scrub, Tinamou). This, the only tinamou at Palo Verde, is a woodland inhabitant that seldom ventures into openings. In the wet season I saw it rarely and heard it seldom in 1969; in 1975, it called regularly. In the dry season it called often and could be seen from time to time, much more frequently in my April visit than in March.

Podiceps dominicus (Least Grebe). This little grebe is surely a seasonal visitant. In the wet season I did not find it in 1969; in 1975, it was present but scarce. I had found it early in the dry season (December and January) in the Catalina–Palo Verde area, frequenting the lake-size impoundments choked with aquatic plants. Recently, Paul Opler found the species at Palo Verde in January and February. Later in the dry season, I noted two individuals there early in March when the pools were shrinking, none in April when they were largely dry.

Podilymbus podiceps (Pied-billed Grebe). This grebe was common during both my stays in the second half of the wet season. Several times I observed an apparently mated pair, one of them upon a floating nest, the other swimming nearby. Adults with chicks were present in the latter part of September. Four partially grown, black-and-white streaked young accompanied a parent in early October. Later that month I noted a display in which two birds with very rapidly fluttering wings pattered over the surface and skidded into a glide that terminated in a sudden dive. From this couple I heard a heavy whinny. In the dry season, I had previously recorded the species in the Catalina–Palo Verde area in December and January. More recently, Paul Olper found it at Palo Verde in February. Later I saw it there, only twice, in March but not in April.

Phalacrocorax olivaceus (Olivaceous, or Neotropic, Cormorant). This species was commonly seen perched, swimming, or flying about both in my wet-season visits to Palo Verde and, previously, in my early dry-season visits to Catalina. Later in the dry season at Palo Verde, I found cormorants at irregular intervals in March but not at all in April, when suitable habitat had disappeared. Birds in flight kept opening the bill slightly and closing it.

Anhinga anhinga (American Anhinga or Snakebird). This species, similar to the last in seasonal status, was far more striking in appearance and actions whether perched or in the air. Several at a time could usually be seen afoot on branches or posts. Drying their plumage, they extended the wings with the remiges spaced apart and the alula projecting upward like a thumb, spread the tail and held it raised at right angles with the

trunk, and erected the contour feathers, exposing each to the sun and air. A vigorous wing-fanning that affected the entire body hastened the process and enlivened the pose. Sometimes they panted rapidly, the gular skin fluttering, reptile-like. The seemingly slow, flapping and sailing flight was sufficiently swift to enable anhingas to keep pace with or gradually outdistance the steadily beating flocks of *Bubulcus* (Cattle Egrets) that some of them accompanied downriver in the late afternoons in the wet season. Usually the anhingas soared singly, but I noted a small group circling lazily with *Coragyps* (Black Vultures).

Fregata magnificens (Magnificent Frigatebird). Occasionally, birds strayed inland from the Gulf of Nicoya to Palo Verde and beyond. As a rule they showed up singly, sailing and wheeling slowly overhead.

Ardea herodias (Great Blue Heron). Not until 17 October 1969 did one of these southbound migrants make its autumnal bow at the Palo Verde marshes. In past visits to the area I found the species from the end of November to January. More recently Paul Opler met with it at Palo Verde in January and February. In spring I saw it there regularly in March but seldom in my April visit, near the end of the dry season.

Casmerodius albus (Great Egret). A conspicuous and common species, it was apt to occur almost anywhere on the flood plain that a sufficient supply of open water and food was present. During my wet-season visit in 1975 (unlike the one in 1969) it was at first common, then declined markedly as the marshes suffered a temporary drought in September. During my dry-season visits, it was abundant in March but disappeared in April. This large heron, even when wading belly-deep, specialized in capturing small fishes. These it obtained with a lightning thrust of the beak, seldom missing and rarely letting its catch escape. A wriggling minnow pinched precariously by the tail would be released, grasped again before it entered the water, then juggled up the bill and down the throat. Two fishes held in the beak at the same time were easily bolted down together. A katydid was handled before being swallowed as though it were a fish. Sometimes a wading bird extended its neck upward at a slant. From this position, too, the bird stabbed downward success-

fully. I did not ever see one attracted to the insects pinwheeling over the water's surface. Occasionally a bird with its neck outstretched, crane-like, would fly a short distance or even soar for a little while.

Egretta caerulea (Little Blue Heron). This heron increased in number during the course of my visits in the latter part of the wet season and remained common into the second half of the dry season: a pattern of arrival and departure expected from a migratory or nomadic population. In March the water-filled dips were shrinking almost visibly, yet birds could be found daily; in the second half of April, I saw none. This heron did not wade. Instead it stabbed at small invertebrates in low cover on wet ground near the "lagoons," and the pickings were apparently rich. Single individuals and groups accompanied the late-afternoon flocks of *Bubulcus* (Cattle Egrets) swarming downriver in the wet season.

Egretta tricolor (Tricolored, or Louisiana, Heron). This native heron was another whose pattern of occurrence could have been that of a nomadic resident seasonally augmented by migrants. In the rainy season I did not see it until the beginning of October, then only three more times, perhaps the same individual or two, until my departure two weeks later. Evidently it increases in number towards the end of the rainy season and remains through the greater part of the dry season. In March it could still be found daily; at mid-April it was no longer present. This heron, appearing habitually nervous or alarmed, did not always obtain its very small prey proficiently as it took little preparatory aim and sometimes missed. Occasionally a bird held its kinked neck to one side and from this odd position struck downward at a slant. Or, with the neck partly outstretched, one would dash forward "excitedly" to thrust at an item in the water. So slightly is the bird built that a struggling minnow made the entire bill vibrate.

Egretta thula (Snowy Egret). This species was similar in status to the preceding. In the wet season, I did not find it until well along in September, when other native water birds were already present, some of them in good numbers. Later, in October, some of these egrets attended wading

or swimming cattle in the flooded pastures. Twice I saw one riding the back of a steer neck-deep amid aquatic plants. In contrast to *Bubulcus* (Cattle Egrets), this species walked and stood upon drifting mats of vegetation. The species was still common, as were most other open-country water birds, in the latter part of the dry season. In March, it was frequenting the shallow pools, running through the water after small prey and sometimes skimming the surface. At mid-April under very dry conditions, it was present only at the beginning of my stay.

Butorides virescens (Green Heron). This small heron could be seen daily in my wet-season visits. Normally solitary, it flew in small groups when flooded from its haunts in October 1969, and again during the dry spell in September 1975. In my dry-season visits I noted a bird only three times in March and once in April.

Bubulcus ibis (Cattle Egret). In contrast to its humble beginnings there in 1954 (Slud, 1957), the species was extraordinarily abundant each of my visits to Palo Verde onward from 1969. Also, for the first time in Costa Rica, I saw it ride upon livestock (once on a steer and once on a horse). Daily in the rainy season, these egrets began to leave the marshes by 3:30 in the afternoon. Off in the distance group after group, aggregating thousands of individuals, could be seen winging their way down the Río Tempisque until dusk. In the dry season, birds spent the night on trees in marshy spots that remained in the pastures facing the hacienda, and I noted no concerted movements along the Tempisque. Birds not attending livestock (mostly cattle) found food in ground cover as did *Egretta caerulea* (Little Blue Herons). Prey included invertebrates, lizards, and a small snake or eel, which a bird grasped behind the head, shook for several minutes, then swallowed still alive. Members of a group were apt to fly en masse, simultaneously veering to one side or the other. Perched in the open they would cover the crown of a low tree like white flowers (Plate 12a) or line themselves along a row of fence posts. At times they frequented the foliated crowns of young trees fronting woods on nearby dry land, whence a nasal "kruk" revealed their presence. Some still retained their breeding dress

in September when others were losing the buff in the plumage and the intense hues of the soft parts.

Nycticorax nycticorax (Black-crowned Night-Heron). This secretive species was noted occasionally at the Río Tempisque or as one flew from the protection of one small tree to another in the flooded pastures facing the airstrip.

Nyctanassa violacea (Yellow-crowned Night-Heron). Sightings of this species were as infrequent as of the preceding. At either season I met with it only along the overgrown banks of the Tempisque. In the first half of February, Paul Opler found it restricted there, too. Apparently this night-heron has not been observed in the tree-scattered cattle lands.

Tigrisoma mexicanum (Bare-throated Tiger-Heron). Owing to its arboreal habits and preference for wet edges, streamlets, and groves, this tiger-heron occurs year-round at more kinds of places at Palo Verde than do any of the open-country herons. That it is active at night as well as by day is suggested by its relatively large, bulging eyes. I have seen it swim, walk up slanting limbs, perch on slender stubs, and balance itself upon wind-blown bare branchlets in the tops of trees. Unfortunately, a bird come upon unexpectedly may "stupidly" remain exposed, nervously flicking its tail, an easy mark for anyone wishing to maim or destroy it. The usual utterances include low notes reminiscent of the mutter of neighboring howler monkeys, roaring growls, heavy *Cochlearius*-like "wuk" 's and, when disturbed, a smooth low "ruk."

The species was in reproductive condition during my wet-season visits (September–October). In 1969, an active nest, constructed of sticks and largely hidden by foliage, was placed below the crown of a tall spreading tree at the edge of the marshy pasture facing the hacienda. Courting individuals were in evidence at the same time. A spotting-scope enabled me to observe one afoot upon a flat-topped stump far out in the open marsh. Presumably a male, it was noted as a rule partway through a lengthy display that could last another 20 minutes. It might be discovered, for example, stretching up stiffly to a somewhat forward-slanting pose with the wings neatly in place;

the white line along the bend of the wings, down either side of the front of the neck and in front of and above the eyes, now bright and sharp; the normally small chestnut "shoulder"-patch, now a broad belt nearly encircling the base of the gray neck and separating it from the dirty buff of the under parts; the bare skin of the throat, golden to orange-yellow in hue. Occupying another stump, a second individual with a small chestnut "shoulder"-patch and lemon-yellow throat skin was probably the female.

Suddenly the posterior portion of the first bird's bare, bright gular skin inflated into a sharply angular bulge and jerked forward to about the middle of the mandible, then back to the original position. Evidently the throat skin was forced outward by the hyoid apparatus, the rhomboidal shape of which it momentarily assumed. The two-part convulsion lasted about a second and was repeated an average of 25 times and a maximum of over 40. The bird was too far away for associated sounds to be distinguished. As the sequence drew to a close, the long axis of the body gradually sank partway from the perpendicular, the beak a bit more. Retracting its neck into an S-loop, the bird now oscillated sinuously from side to side. Next the partly open beak was lowered toward the flat top of the stump, at which it made nibbling motions. This was accompanied by the bird's stepping about on the little platform while holding the smoothly rounded wings slightly away from the body and concealing the short tail. The nibbling pantomime filled the interlude between performances.

On another occasion the first bird lowered the base of its neck to the top of the stump, causing the tail end to be raised high yet shielded from view by the arched broad wings. Relaxing the pose the tiger-heron then flew toward the second bird, which responded by flying to another stump. Having arrived at the vacated stump, the first bird elongated itself stiffly upward, spasmodically, and engaged in a slow weaving process which involved both the body and the now thickly inflated neck.

During my second wet-season visit I observed a pair of courting birds much closer. They were standing some 15 feet up on a crooked, slanting

limb atop a truncated and deformed dead tree at a galleried brackish inlet meandering over the open valley floor. The limb was the display platform. Like mirror images, they stood opposite each other with crisscrossed necks. In size, pattern and coloration they appeared virtually identical. One, however, was the lead performer. The other, as if following cues, started but only completed parts of the routine. The first bird, presumably the male, was jerking his rhomboidal throat-bulge up and down, as described. A heavy sawing sound accompanied each downward movement for the duration of the sequence. The second bird, presumably the female, also had a prominent bulge, but it moved little, and the accompanying sounds were weak grunts. Another phase of the display started similarly as the two birds faced each other with crossing necks. Again the first bird took the lead, combining nibbling motions with a throaty cackling. Only when his beak was passing through the mane-like feathering of her neck did the female nibble and cackle.

This tiger-heron can stalk almost as stealthily and fish for minnows nearly as well and patiently as *Casmerodius*, even striking laterally at movements in the water. One that I watched intermittently for hours had been obtaining tiny items that could hardly suffice a bird of its size. Finally it lunged into the boggy vegetation and pulled out a struggling, dark gray, rat-like animal. So tightly was the victim gripped by the sturdy beak that it resembled a flattened toad, immobilized but for the thrashing short legs. Letting it drop into the muck, the bird stabbed it viciously, picked it up in the beak and squeezed it around the head and neck until soon the animal hung motionless. The bird engulfed it head first, its throat sac swelling as the sodden carcass passed down the gullet, and immediately resumed its hunting.

Ixobrychus exilis (Least Bittern). This small, light-bodied species was present during both my wet-season visits, well ahead of some other herons or any of the migrant ducks. Evidently it remains at Palo Verde at least until February, when found there by Paul Opler. I have no report for other times of year. It would appear likely that nomadic or seasonal native birds make up most of the local population, migrants perhaps the rest. Occasion-

ally I spied a bird in low flight over the reedy portions of the inundated fields. However, when passing through the tall-grass wet meadows on horseback, I was amazed at the number that flushed from this simple, uniform habitat. Again, when the Río Tempisque rose in flood, this usually secretive species driven from shelter consisted of many more individuals than one would have imagined present. Flying about over open water, they settled upon any available, exposed perch.

Botaurus pinnatus (Pinnated Bittern). At Palo Verde, Paul Opler drove one from concealment in the dry season (February 1974) as he waded the length of the marsh fronting the airstrip. This is the second locality from which this neotropical bittern has been reported on the Pacific slope. (See Dickerman, 1971, for the first.)

Cochlearius cochlearius (Boat-billed Heron). I found a small group at Palo Verde in my visits in the wet season but not in the dry season. The species was apparently restricted to the trees at the outlet of a stagnant small stream, the Estero Fierro, where it enters the Tempisque.

Mycteria americana (Wood Stork). The species was present each of my visits: not uncommonly in the wet season, abundantly in March but in greatly reduced numbers in April in the dry season. This stork preferred the open marshes, though occasionally I met one at a sheltered little stream or muddy tidal inlet. It hunted as a rule in small parties of up to a half dozen birds rather than the large numbers previously reported in Guanacaste (Slud, 1964:45). Striding side by side, members of a party dipped their bills into the water in unison at the completion of a step, then lifted them out, rhythmically. Those wading beyond "knee"-depth necessarily submerged the bills more deeply, up to the eyes. Several birds were apt to speed up the pace for several steps to produce a dancing, teetering effect in the rate of advance. Unexpectedly, one or more might halt in mid-stride to stand immobile, with the tip of the beak lowered into the water in front, the toes of one half-bent leg touching or breaking the surface in back, up to minutes at a time. Again, a group would freeze in position, each member facing a different direction, like a tableau. Birds also proceeded in linear formation.

Hunting birds were apt to thrust a wing out to one side, at the same time pivoting the body slightly in the opposite direction. Foraging was usually accompanied and no doubt abetted by shaking one pink-toed foot under water, well behind the immersed tip of the beak. Prey appeared to consist mainly of small items, such as little fishes, small mammals, and winged insects. Gripped like a specimen at the end of long forceps, the wriggling or fluttering morsel would be eyed for a moment. Even as the bird juggled the item upward to be gobbled alive, it was already turning back to its work. The hunting areas were repeatedly patrolled and swept with remarkable thoroughness.

These storks soared singly and in small groups, by themselves and sometimes with vultures (*Corygyps*). The usual flapping and sailing type of flight was once altered almost unrecognizably as a band of eight birds passed straight by on "purposefully" steady beating wings. This took place during the mid-September lull in the rainy season in 1975, a period in which the contracting marshes were being abandoned or avoided by other species, too.

Jabiru mycteria (Jabiru). This great stork, like the preceding species, was present each of my visits: uncommonly in September to commonly in October in the latter part of the wet season, commonly to abundantly in March but in much reduced numbers in April in the latter part of the dry season. The only nest I noted was situated in a semi-isolated tree in a soggy pasture near the Río Tempisque. Two adults were standing on it 3 October 1969. The next day I observed the two birds come to the ground, approach each other and engage in what appeared to be nibbling motions but that could have been bill-rattlings I was too far away to hear. Raising their beaks toward the horizontal and holding them a little to one side, the two birds passed them one over the other, like a crossing of swords. This interaction, though taking place afoot, would otherwise appear to correspond to the "greeting on the nest" described in Argentina by Kahl (1971:164). In March 1971 an immature was present in the same nest. Already adult-size, the bird was standing on the nest and exercising its white-patched dusky wings.

Though a solitary Jabiru can sometimes be found standing idly in a dry pasture, I have seen the species hunt only in wet places. The customary foraging mode is to keep moving and now and then probe the muddy earth a few inches deep with the beak slightly open, usually once or two to three times, occasionally many times, in succession. When wading at "knee"-depth or the full unfeathered length of its legs, the stork immerses its beak completely. Two that I watched one afternoon during a very wet part of the rainy season at Palo Verde were preying chiefly on eels. These were obtained in acrobatic, zigzag pursuit among the bushes and half-drowned tufts. Working the coiling victim between the great mandibles, dropping it several times and picking it up, the bird would then bolt it alive. The sac at the base of the columnar neck, where the black skin meets the red, functioned as an elastic collecting bag. Welts crawling over its surface traced the snake-like writhings within.

By mid-afternoon the bulging sac dangled and bounced at every step. So engorged was one of the birds that the swelling had risen into the loose black skin higher up the neck, expanding it in back, while the distended crop parted the feathering lower down in front. The other stork was occupied with a snail, dropping it several times, chipping away the shell, and picking it up again before gulping it down. Now the first bird was struggling to extricate still another large eel from the inundated base of a weedy clump. My view was partially blocked as the bird evidently was dispatching it with powerful vertical stabs. The seemingly interminable killing process lasted at least a quarter of an hour. The bird, already replete, labored to swallow the final foot of the victim's length. The closed beak of the Jabiru, incidentally, features a narrow separation between the mandibles that extends back from near the tip for half their length, an ideal arrangement for gripping slithery or slimy, elongated prey and keeping it away from the face and neck.

In the dry season, especially in my March visit, adults and young were present by the score and were feasting on fish. Knowing somehow it had probed successfully, a Jabiru would struggle to dislodge a muddy mat of vegetation from which it proceeded to extract a solid-bodied, short-finned

fish up to 10 inches long. Another might be lunging repeatedly at some other kind that resembled a catfish. A fish too difficult to swallow would be dropped and punctured with the bill until made more pliable.

Eudocimus albus (White Ibis). This ibis occurred irregularly during my wet-season visits. I did not see it in 1969; in 1975, I noted single birds occasionally and once a group of a dozen or so. Evidently the species increases in numbers as the wet season ends, judged by the fact that I met with it regularly in the Catalina-Palo Verde area early in the dry season. At Palo Verde, it was abundant in March when the impoundments were still extensive and broadly edged with mud. By the second half of April few wet places remained, and I saw it only twice. The birds foraged rapidly, shallowly dipping the tip of the bill into and withdrawing it from the mud. Those that were wading made sudden side-to-side sweeps with their bills in the manner of *Ajaia*. Food items were evidently recognized through a tactile sense. Birds took to the air in groups and veered flock-like in flight.

Plegadis falcinellus (Glossy Ibis). The species was found at Palo Verde by Paul Opler (*in litt.*), who saw several adults that were standing in the dry-season marshes 5-15 February 1974. It was also recorded by Stiles and Smith (1977:93): "Regular in winter at Palo Verde . . . , where at least 15 have been seen during Jan.-Mar. each year since 1974, although Stiles saw none in Mar. 1971." In the wet season (9 September 1975) I noted overhead a loose group of about 24 individuals, presumably of this recently spreading species, rather than the doubtfully recorded *P. chihi* (Blake, 1977:201), flying up the Tempisque valley at dawn. The birds alternately flapped and sailed like pelicans, the flapping motion passing through the group like a wave from front to back. The next morning eight ibises again flew up the valley. This time the members kept behind one another along one diagonal of a V. This is the only locality on the Pacific slope of Costa Rica from which the species seems to have been definitely reported.

Ajaia ajaja (Roseate Spoonbill). Spoonbills were to be seen regularly, though as a rule only singly and in flight, in my wet-season visits. Their numbers no doubt increased toward the end of the wet

season as they remained high through March in the dry season. Few were present when I visited in the second half of April. From one bird I heard a set of heavy rubbing sounds not unlike those given by the owl *Pulsatrix perspicillata*.

Dendrocygna viduata (White-faced Whistling-Duck).

The species was present each of my visits to the Palo Verde marshes, one of the few places in the country it is known to inhabit. I found it with some frequency only in the wet season, usually in twos or in small parties of eight to ten, sometimes amalgamated into a group of 25 or more individuals. In my late dry-season visits I met with it only three times.

Dendrocygna bicolor (Fulvous Whistling-Duck).

The species was first observed in Costa Rica during the dry season in early 1974 at Palo Verde: "20, 35 and ca. 50 were seen at Palo Verde in Jan.-Feb. 1974, 1975 and 1976. The species is apparently increasing in Costa Rica, but there is as yet no evidence of breeding; only adults have been seen . . ." (Stiles and Smith, 1977:93). Paul Opler (*in litt.*) found between 10 and 20 birds 5-15 February 1974 in the dry-season marshes. The recent appearance of this duck in Costa Rica may be related to the "explosion" farther north that began in late 1949 and continued into the seventies (Palmer, 1976:20).

During my wet-season visit in 1975, I observed the species three times (12-16 September) during a dry spell when most water birds were abandoning the marshes. Twice I noted two birds and once a group of five keeping mostly to the deeper, open water of a trenchlike depression down the middle of the valley floor. The birds worked their way along it slowly, diving continually and bobbing to the surface like corks. These observations, made in the wet season, may pertain to a roving group that had remained in the country.

Dendrocygna autumnalis (Black-bellied Whistling-Duck).

This native duck was present barely past the middle of April, near the end of the dry season, when the last few birds and the remaining pools both vanished shortly after my arrival. At other times it occurred almost everywhere in and near the Palo Verde marshes. Some might be standing decoratively along a row of partly drowned fence posts, pumping their folded wings.

Others would be dispersed in ones and twos on stumps and trees away from the "lagoons." Birds were almost constantly flying about day and night. They were especially noisy when selecting trees on which to roost after dark, mixing squeaky ripples with the usual call.

The nesting period appears to coincide with the wet season. In September-October 1969, subadults were present in good numbers. Concealed by the aquatic vegetation, except where their heads and necks rose above it, they kept apart in pure groups from the mature birds abundantly nearby. Yet as late as 12 October I flushed an adult almost under foot from a ground nest hidden by tall grass in a pasture overlooking the marshes. The nest contained 14 white eggs, many of which appeared to have jagged holes. Upon examination the "holes" proved to be angular bits of discolored leafy matter adhering to the undamaged shells.

Cairina moschata (Muscovy Duck).

Muscovies were noted regularly in the Palo Verde area except when the habitat had virtually disappeared in the latter part of April. Breeding evidently takes place in the rainy season as the cowboys brought in for the table over a dozen well-grown flightless young in October. Wetmore's statement (1944:33) that the calls of a circling flock of this species at Liberia roused him from sleep may have been a slip of the pen for *Dendrocygna autumnalis*. According to Johnsgard (1965:100), the male is practically lacking in voice, the female apparently has only a simple quack. Personally, I have heard from this normally silent species only low, hoarse, heron-like "quok" 's given by female-plumaged birds in flight and a heavy "wuffing" sound produced by a fluttering individual. A bird on a limb, evidently worried by my presence, exhibited exaggerated nods and a side-to-side shaking of the tail.

Anas acuta (Common Pintail).

This migrant duck is an abundant winter visitant in the Guanacaste lagoon country. I did not note it at Palo Verde during my autumn visits, indicating that the species may not yet have arrived. In spring I saw it only twice in March, when other water birds were still very common, and not at all in April.

Anas discors (Blue-winged Teal).

Autumn migrants were seen at Palo Verde after 22 September. Not

until the following month did the species begin to occur in the groups whose aggregate numbers make it so numerous in winter. In spring, it was very common in March, when the flooded-field environment was still extensive. In the second half of April, stragglers remained only the first few days of my visit.

Anas cyanoptera (Cinnamon Teal). The only report for Palo Verde is by Stiles and Smith (1977:93): "Stiles saw a full-plumaged drake at Palo Verde 22 Jan. 1974, and two more on 27 Jan. 1974 in a large flock of Blue-winged Teal (*A. discors*). None were found there in Jan.-Feb. 1975 or 1976 despite intensive searches. No previous Costa Rican report." There are, however, at least two previous reports. One was of a Costa Rican specimen (Zeledón, 1885:114) in the collection of the United States National Museum (which collection is housed in the National Museum of Natural History, Smithsonian Institution). The other was listed in a revised catalog of birds in the Museo Nacional de Costa Rica prepared by Zeledón (1887:132) with the collaboration of Anastasio Alfaro and Robert Ridgway. Apparently the present location of the specimens is not known.

Anas clypeata (Northern Shoveler). At Palo Verde the migrant shoveler arrives from the north apparently late in the season as I still had not seen one by mid-October. In the past at the Catalina-Palo Verde area I met with it in winter (end of November to January); more recently, Paul Opler found it at Palo Verde in February. In my March visit a number were commonly in view in shallow open water. Some even remained for a few days in my April visit, when most other kinds had left because of the unsuitable conditions.

Anas americana (American Wigeon or Baldpate). Previously I had found this duck wintering not uncommonly in the Guanacaste lagoons in the first part of the dry season (end of November to February). At Palo Verde, the species had not yet arrived when my wet-season stay ended on 17 October. In my March visit the marshes were teeming with water birds. Baldpates were present only the day I arrived; their absence the rest of the month was unexpected. I found none in my April visit.

Aythya affinis (Lesser Scaup). The status of this migrant duck in lowland Guanacaste parallels that

of the preceding species. Apparently it does not arrive until considerably later than my departure in mid-October 1969. In the past I had believed it to be a scarce or erratic winterer in the Catalina-Palo Verde area. More recently, Paul Opler observed it at Palo Verde on 11 January 1971 and thought it to be common. Later the same year I also found it there once, in early March, a group of nine birds only one of which was an adult male.

Oxyura dominica (Masked Duck). The only report from the lower Tempisque valley is by Paul Opler, who saw a female-plumaged bird in February 1974 on the patchily overgrown surface of the seasonal marsh fronting the airstrip at Palo Verde. Elsewhere in the northwestern lowlands the species has been recorded from Bebedero (Slud, 1964:52) and Taboga (Orians and Paulson, 1969:427).

Sarcoramphus papa (King Vulture). At Palo Verde, as in the northwest Pacific quadrant generally, on each of my visits I have regularly seen *Sarcoramphus* in the air and from time to time perched in open view. Paul Opler found two on a dead deer in the open range. I came upon three of these vultures and some two dozen *Coragyps* (Black Vultures) feeding amicably together on the carcass of a calf in a large pasture.

Coragyps atratus (Black Vulture). This vulture was abundant at Palo Verde. Birds were apparently in breeding condition in the rainy season, 1969. As they dived and wheeled in aerial courtship, an airplane-like drone was produced by the air rushing through their pinions. One caught my attention as it alighted on the fence rail of a corral on which another vulture was already present. First it beat its wings downward from the horizontal through a short arc to create a sound like heavy breathing. Next it stood with the head and tail drooping and the wings partly spread and deflected downward. Suddenly the bird flapped its wings, then lowered its head and turned it rearward so that it was upside-down with the beak pointing at the under side of the body. After holding this pose for a while, the bird resumed the drooping posture and stood motionless.

The cowboys blamed this vulture, no doubt with good reason, for killing newborn calves by peck-

ing and pulling at the umbilicus and the anal opening. Twice I encountered very young calves at bay, one of them alone, the other separated a little from the adult that was presumably its poor guardian of a mother. Encircled by the emboldened vultures, each calf was bloody in the above-mentioned places. Another time I found the vultures tearing into a calf that had been freshly killed, probably by them.

Cathartes burrovianus (Lesser Yellow-headed Vulture). At Palo Verde, I noted a single adult in flight in March 1971 and again in September 1975. Another was seen by Gard Otis (*vide* Paul Opler) in February 1974.

Cathartes aura (Turkey Vulture). Like *Coragyps*, this species occurred daily at Palo Verde but in smaller numbers.

Elanus leucurus (White-tailed Kite). Regarded as a migrant through Costa Rica in 1958, the species has established itself as an open-country resident of the lowlands on either slope and on the central plateau. In Guanacaste it was first reported in the Taboga area (Slud, 1965), where I saw a pair in copulation on a tree in the month of January. Later the species was noted near Cañas in July and Liberia in August (Wolf, 1966). In 1967, it was found throughout the year at Taboga (Orians and Paulson, 1969). In 1969–1971, I observed a bird occasionally on the Tempisque flats each of my visits to Palo Verde.

Later, on my return to Palo Verde at the end of August 1975, two individuals were present daily at the marshes and small trees fronting the airstrip. This kite utilized its graceful, sweeping flight to reconnoiter for prey at almost any time of day. Having located an item, the bird hovered well above it, maintaining itself stationary by its beating long wings held in a V above the back. It even hung suspended in a strong wind up to two minutes at a time. As a rule the hovering bird descended in stages before dropping feet-first in a controlled fall or an accelerating dive, usually to the ground but sometimes at the crowns of trees. More often than not the bird did not complete its dive, probably because the prospective item had moved out of sight, and flew off to repeat the process either close by or some distance away. So far as I could see, prey is oblivious to a

motionless object high above it and unable to cope with a kite plummeting out of the sky.

One that I saw hovering above the airstrip disappeared out of sight as it descended. Soon it reappeared with a Squirrel Cuckoo (*Piaya cayana*) in its claws and flew to the top of a small tree where, looking about all the while, it hurriedly plucked and ate. Another time, a hovering kite dropped from sight into some bushy, shrubby growth. It arose with a brown, long-tailed rodent about the size of a small rat in its talons. By the time I located it on a fence post through the spotting-scope, the bird had beheaded the victim and was gouging bloody gobs out of the opening. Drawing itself high, the bird stretched out the elastic gut which, together with the attached organs, it devoured. Next the kite plucked hairs and pelt from around the decapitated area. Perhaps tiring of this, it gulped down the throat-filling carcass, front end first. The exquisite creature remained on the post another half-hour, looking alertly about in the light of the setting sun.

I did not see other birds dash for cover as a scouting kite would swing by in flight. On the one hand, I noted a kite and an egret (*Bubulcus*) serenely perched on the crowns of adjoining trees; on the other hand, an adult jacana instead of fleeing rose up noisily at an approaching kite and made it change direction. In 1970 I witnessed a short-lived aerial encounter in which a kite dived aggressively at a Bay-winged Hawk (*Parabuteo*). Possibly the hawk had invaded the nesting territory of the kite, perhaps the kite did not fear the hawk when both were in the air. In 1975 a kite that had taken a small rat was tearing it apart on a fence post, when there was a sudden uproar from the water birds. The next moment a *Parabuteo* came dashing at the kite, which dropped its prey into the marsh as it sought to escape. Neither bird, incidentally, returned for the rodent.

Leptodon cayanensis (Gray-headed Kite). This hawk was observed with some frequency at Palo Verde (an average of once every few days), soaring or in powered flight more often than perched. The number of individuals was surely smaller than the sum of the sightings. The species is dependent on woodland, a habitat to which its rounded,

short, broad wings are adapted. The species uttered the three kinds of cry previously reported (Slud, 1964:55-56).

Chondrohierax uncinatus (Hook-billed Kite). A perched bird sighted in the dry season at Palo Verde (F. G. Stiles, pers. comm.) supplements observations made elsewhere on the Comelco ranch (Paul Opler, *in litt.*; Slud, 1965:3). The species has also been reported from the lowlands at the head of the Gulf of Nicoya: Taboga (Orians and Paulson, 1969:427) and Hacienda La Palma (Nutting, 1883:403).

Harpagus bidentatus (Double-toothed Kite). The species had not been known in the northwestern lowlands prior to my 1965 report (Slud, 1965:12). There, at a high water-table, evergreen woods in the Taboga area near the end of January (Plate 7), I observed a pair high in the densely foliated trees. The female plucked and flew off with a slender twig, returning soon for another. The male, too, was attempting to break off a twig. At Palo Verde, I met the species in a semideciduous woodland twice during my March visit: an adult and an immature together searching the upper branches of big trees, and a quietly perched adult.

Rostrhamus sociabilis (Snail, or Everglade, Kite). The species was a fairly common inhabitant of the Palo Verde marshes as long as accumulations of water, aquatic vegetation, and the snails on which it primarily feeds were sufficiently present. During my first wet-season visit, individuals were noted daily until the Río Tempisque inundated the valley floor, after which they disappeared. During my second wet-season visit, snails as well as snail-eating Limpkins (*Aramus*) were present, but not the kites. In my dry-season visits they occurred irregularly and uncommonly in March. In April the only one I saw, early in my stay, was scouting the nearly dry pastures and did not alight.

When hunting, this kite as a rule utilized both feet to seize a large snail, transferred it to the beak in flight, then held it in one foot after settling on a perch. Other prey is sometimes taken. For example, I saw a kite snatch a small yellowish "serpent," most likely an eel, from the surface vegetation it customarily patrolled for

snails. Flying to a stump, it picked pieces out of the living creature with its beak.

Buteo albicaudatus (White-tailed Hawk). At Palo Verde large hawks were occasionally noted sailing past at considerable height. I identified this species once, in April 1970, as it soared above the valley floor. Paul Opler recorded it in January 1971. These appear to be the only reports from the Tropical Dry Forest life zone. The statement that "the species is centered in the Pacific northwest, where it can be met from time to time in the dry-forested lowlands" (Slud, 1964:59) needs clarification. Thus, the species would appear to be resident in the Nicoya Peninsula south of the Tempisque depression and east of it from approximately the Inter-American highway to the slopes of the continental divide.

Buteo jamaicensis (Red-tailed Hawk). Red-tailed Hawks occur irregularly in lowland Guanacaste. One belonging to the native race *costaricensis* was recorded at Hacienda La Palma by Nutting (1883:404). Another, not identified as native or migrant, was sighted near Taboga (Orians and Paulson, 1969:427). At Palo Verde, the only one I saw, an immature, was wheeling high above the meandering Tempisque in the month of March.

Buteo albonotatus (Zone-tailed Hawk). This seldom seen species has only been noted flying singly over the Palo Verde marshes in the dry season: once in February by Paul Opler, several times (probably the same individual) by me in March when the marshes were still wet and once in April when mostly dry. Superficially this hawk resembled a *Cathartes* vulture both in appearance and mannerisms of flight as it quartered the open marshes. Several times a bird drew near prospective prey during its lengthy patrols, but I never saw one make an attack.

Buteo swainsoni (Swainson's Hawk). In autumn I noted a single bird flapping leisurely over the ranch house in the rain during the late afternoon on 16 October 1969. In spring, Paul Opler observed a migrating flock of 50 or more on 13 April 1971.

Buteo platypterus (Broad-winged Hawk). This migrant was encountered in woodland from time to time after the beginning of October. In winter I had found it at Catalina, hence do not doubt

it occurs at that time of year at Palo Verde. In spring I met with it throughout my visit in March but not at all in April.

Buteo magnirostris (Roadside Hawk). The species is a common inhabitant of open woodland and wooded edges over the Pacific northwest. At Palo Verde it was the most abundant hawk as well as the noisiest.

Buteo brachyurus (Short-tailed Hawk). Previously I had noted this hawk (in the black phase) at the beginning of the dry season at Catalina. At Palo Verde it remained unrecorded until my wet-season visit in 1975, when I observed it repeatedly between 26 August and 16 September. White-phase individuals, probably the same one or two, soared singly over the OTS building on sunny afternoons. Once I saw two birds, a white-phase and a black-phase, soaring together in the vicinity of the "beehives."

Buteo nitidus (Gray Hawk). This resident hawk could be seen or heard almost daily at Palo Verde, though represented by probably no more than a pair or two. The species was nesting during my dry-season visit in March.

Parabuteo unicinctus (Bay-winged, or Harris', Hawk). A resident, this hawk was represented by several vocal, conspicuous individuals each of my visits. Whether sitting erect on high perches, flapping and sailing or soaring overhead, they occurred only over the open valley floor and its periphery. Nutting (1883-404) shot a bird carrying off a chicken and considered it an inveterate poultry thief at Hacienda La Palma. At Palo Verde, in 1969, I observed one holding a dead fowl on the ground near a tree in the marshy pasture below the corrals. Alternately it plucked feathers and devoured strings of flesh. Night was coming on when the hawk gripped its prey with one foot and with the help of fluttering wings dragged the carcass towards the tree. Again the hawk plucked and ate, but now in an apparently disturbed, indecisive manner. At the approach of a steer it flew up into the tree. It had become too dark to observe further activity, if any.

The typical cry of the adult was an angry sounding, lengthened, heavy, harsh note that rapidly lost intensity. A hoarse scream of the sort associated with a *Buteo* was also given. From a sub-

adult I heard three unclearly screamed, undistinctive "oo-eek" 's. In my wet-season visit in 1975, I heard a call which at first I did not attribute to this normally harsh-voiced species. Consisting of rhythmical sets of usually five or six, sometimes up to 10, simple peeping notes, it was uttered with monotonous regularity by any of several adults and subadults spaced well apart on trees in the boggy pastures. The peeps must have unusual carrying power as they seemed to be issuing from all around me in a patch of woods, though they originated somewhere outside. At times a set of peeps sounded shrill, other times lisping. Stronger peeps uttered singly and out of context approached the *Buteo*-like scream in quality and power.

[*Busarellus nigricollis* (Black-collared Hawk or Fishing Buzzard). The species has been recorded from Bolsón and Catalina on either side of Palo Verde. The chance that this sluggish, conspicuous hawk might have been overlooked at Palo Verde is small. More likely the apparent requirement of an accumulation of fresh water bordered by large-limbed trees was not met.]

Buteogallus anthracinus (Common Black-Hawk). This species and its sympatric congener, *urubitinga*, I found regularly at neighboring Catalina in the early fifties. At Palo Verde, they ranged in status from uncommon to absent. The present species, *anthracinus*, I identified definitely only twice, both times during my dry-season visit in March, at the same spot: a patch of woods shading a gully with shallow, stagnant water. Whether near the coasts or inland, *anthracinus* seems to prefer gallery-type settings of this sort, especially in the seasonally dry Pacific northwest.

Buteogallus urubitinga (Great Black-Hawk). I met with this species at Palo Verde from time to time in the wet season, seldom in March and not at all in April in the dry season. This large hawk was conspicuous from a distance as it stood upon an isolated low tree or upon a fence post in the open range. Several times I found one in woodland, where the bird was apt to reveal itself by voice. An immature that permitted a close approach had few tail bands and could thus have been mistaken for the preceding species had it not uttered the characteristic whistling scream of this one. The scream, incidentally, often has one

or two breaks. Soaring birds utter an excited-sounding rapid "pipipipipip."

Spizaetus ornatus (Ornate Hawk-Eagle). The only previous report for lowland Guanacaste was by Nutting (1883:404), who considered this hawk uncommon at Hacienda La Palma. At Palo Verde the species is probably a highly irregular visitor. I observed one there once, in the wet season, as it leisurely wheeled from sight high in the sky. My attention had been drawn to it by its frequently given cry.

Circus cyaneus (Northern Harrier or Marsh Hawk). In the past I had found this wintering migrant early in the dry season at Hacienda Catalina. More recently, Paul Opler found it later in the dry season, in February, at Palo Verde. I did not see it there in autumn, perhaps because I was too early, or in spring, when I may have arrived too late.

Geranospiza caerulescens (Crane Hawk). Most likely it was the same few individuals that I encountered at irregular intervals in both wet-season visits and in March in the dry season. I did not find it in April. A cry that was new to me I traced to a bird in the canopy of a medium-size tree in woodland. An iterated two-note "ah-ahl," it brought to mind the much stronger note of its neighbor, the forest-falcon *Micrastur semitorquatus*.

Pandion haliaetus (Osprey). This migrant seems to have been recorded in lowland Guanacaste only near Santa Cruz and Cañas on either side of the Tempisque basin. At Palo Verde a bird was observed several times 5-15 February 1974 by Paul Opler.

Herpetotheres cachinnans (Laughing Falcon). Though represented by few individuals, the serpent-eating "guaco" could be seen or heard almost daily each of my visits to Palo Verde. One that I spied in flight was clutching the head of a slender snake the rest of which trailed from its claws like a streamer. The bird disappeared behind some vegetation then emerged after a while and, still grasping its prey, flew off to a heavy horizontal limb some 15 feet above the ground. After picking listlessly at the head and neck, the bird draped the snake over the limb so that it hung evenly down either side, then de-

parted. I thought it had gone for good, but after more than three hours the bird returned. This time it tore out pieces hungrily, again from the head region. Soon the bird stopped eating the snake piecemeal and proceeded to swallow it whole, starting with the head and completing the gulping process in stages. The bird then wiped its bill on the rough bark with biting motions.

Micrastur semitorquatus (Collared Forest-Falcon). This resident raptor was detected more regularly in the wet seasons than in the dry and more often by voice than by sight. My notations refer to a bird making a short run along a branch; another, alternating *Buteo*-like sails and a few flaps, attempting unsuccessfully to seize a small bird in the open and immediately returning to cover; a heavier than normal smooth note; and two ways of uttering the series of "pahl" notes (see Slud, 1964:71), making them sound either "insistent" or "wheedling." Sometimes the "pahl" lacked the consonant at one end or the other.

Caracara plancus (Crested Caracara). During my visits in the rainy season, adults of this common resident were keeping in pairs. They greeted each other with vibratory heron-like bass croaks or with ripples that alternated with either a light or heavy chatter. Fledged young were still receiving parental attention in the latter part of September 1969 when I noted a pair copulating, high on a slender stub in a treetop. Another adult giving its resonant bass rattle was promptly joined by a young bird flying into the same tree. The latter produced an insistent hoarse peeping, quite unlike the subdued asthmatic scream given once to several times that I had been hearing from other young birds.

An adult with a large blackish lizard in its talons landed on the airstrip and was joined almost immediately by another adult. The owner lifted the carcass in its beak and carried it off a few steps at each hesitant approach of the second bird. After a while the two caracaras engaged in a mutual display. Standing on the ground obliquely opposite one another, each bird tossed its head to the rear so that the crown rested on the upper part of the back, at the same time uttering the bass croak. The first bird continued to guard its prey and drag it away when the sec-

ond bird came near. The lizard had by now come apart. The first bird carried off the stout long tail, the second bird pounced on the remainder. Each bird, its crop protruding like a yellow golf ball, kept tugging at and devouring gobbets out of its portion of the carcass.

Falco peregrinus (Peregrine Falcon). The Peregrine is a scarce but apparently regular visitant whose arrival probably coincides with the close of the rainy season. I had found it toward the end of November and in January at Catalina, Paul Opler met with it more recently in February at Palo Verde. In spring, I observed it at Palo Verde in early March and again at the end of the third week in April. At the latter date, when the last of the dips were drying out, a bird in the open stood drinking from a sun-heated puddle, soupy with mire and droppings from surrounding cattle.

Falco sparverius (American Kestrel or Sparrowhawk). Apparently this migrant arrives in the lower Tempisque valley past the middle of October. It was not uncommon from the end of November to January when I was at Catalina. At Palo Verde, Paul Opler found it more recently in January and February. In spring I noted it there occasionally in March but not when I visited in the second half of April.

Crax rubra (Great Curassow). This ruthlessly hunted species I stumbled upon, so to speak, twice in the rainy season and once in the dry season (March). One meeting was with a male that kept uttering his lingering whistle as he stepped warily through shaded ground cover in mixed open second growth behind the woodland border.

Penelope purpurascens (Crested Guan). The species was encountered fairly often each visit, as a rule in small arboreal groups, rarely on the ground, in woodland. Sometimes the birds were quiet, other times they uttered grinding grunts mixed with honking yelps. In the latter part of the dry season (March), a bird flushed from a nest in a small tree just outside disturbed open woods. The nest, a cup of sticks containing three large white eggs, occupied the globular cavity formed by a circle of multiple sapling-like limbs that had sprouted from the top of a live stump four

and one-half feet above the ground. So tightly was the nest enclosed by vertical bars that the brooding parent must have been virtually imprisoned.

[*Ortalis vetula* (Plain Chachalaca). I did not find chachalacas at Palo Verde, although these birds surely have occurred there, at least until recently. The species seems to have been recorded in Costa Rica only by Austin Smith at Ballena (Slud, 1964:76) and by me at Catalina and the Santa Cruz area in the lower Tempisque drainage.]

Colinus leucopogon (Spot-bellied Bobwhite). This is one of the common birds in the country's northwestern quadrant. Nevertheless it was not recorded by Nutting at La Palma, by Wetmore at Liberia, by me at Catalina, or by Paul Opler at Palo Verde. At Palo Verde in the dry season, I saw and heard birds a number of times in April, none in March. In the wet season, the species, including a covey I stumbled upon in a pasture, was silent in 1969. In 1975, this quail was calling commonly as I left the airport on the central plateau. Arriving at Palo Verde, however, I did not hear it until the second half of my stay. The only covey I met, a small one, was frequenting shrubbery a short distance inside open woodland.

Aramus guarauna (Limpkin). Limpkins were numerous at Palo Verde, at least from after the start of the rainy season through March in the dry season. They were noisy even after dark, when the cries of one were picked up by others the length of the marsh, like dogs barking in succession down a village street at night. A pervasive cry, given probably by a particular individual or two, resembled an overwrought braying, another was like the honking of geese. In my visit that began at mid-April, proper habitat for this species had almost vanished, and I recorded it only upon my arrival. In April of the following year, Paul Opler observed more than 40 Limpkins which had left the desiccated marsh and were seeking food in crevices in the baked mud of inhospitable *Parkinsonia* habitat.

Aramidés cajanea (Cayenne, or Gray-necked, Wood-Rail). At Palo Verde I saw the species only once, during the rainy season of 1975, in low wet woods beside the Río Tempisque in the neigh-

borhood of the "beehives." Two other observations from dry-forested Guanacaste come from Paul Opler, at Hacienda Ciruelas above the Tempisque flood plain and at Hacienda La Pacifica near Cañas, while I recorded another at Hacienda Santa Rosa, not far from Nicaragua.

Porzana flaviventer (Yellow-breasted Crake). There are two previous Costa Rican reports, both recent, from Taboga and near Cañas, respectively, in Guanacaste. A third has been added by Paul Opler at Palo Verde, where in February 1974 he flushed three birds from the cattails (*Typha*) at the edge of the marsh in front of the OTS station.

[*Laterallus ruber* (Ruddy Crake). At Palo Verde in September 1975 as I was crossing an inundated field of tall grass on horseback, a small, dark red-brown rail rose into low flight for a few moments before dropping back into cover.]

Gallinula chloropus (Common Gallinule). In both rainy-season visits the species was observed in small number, though it disappeared when the reeds it inhabits were flooded by the Tempisque in October 1969. In the dry season I saw it regularly the first half of my stay in March, at least until the reed beds were purposely set afire. Bird and habitat were both absent during my visit in April.

Gallinula martinica (Purple Gallinule). Except that it was more common, this gallinule was similar in status to the preceding species. Birds were still present, however, after the flooding by the Río Tempisque, their climbing abilities probably enabling them to survive. Compared to *Gallinula*, it was a poorer swimmer that sat much deeper in the water. It was abundant in the wet, reedy fields, a habitat which *Gallinula* apparently did not enter.

Fulica americana (American Coot). The marshy, watery habitat appeared suitable for coots in the wet season in 1969, but I noted only one bird, at the beginning of October. Yet in the wet season of 1975, when other water birds were abandoning the temporarily drying marshes in September, a group of several remained. Probably the species begins to arrive in good numbers as the rains end and remains abundant through March, when I found it very common.

Like most of the other water birds it was absent in my April visit.

Jacana spinosa (Middle American, or Northern, Jacana). Jacanas were abundant in the Palo Verde wetlands in the rainy season and in March in the dry season; habitat and bird were both absent in April. The species was breeding in the wet season. A copulating male observed in the act was at the same time ejaculating vocally and flailing his wings; the subdued female, her neck extended forward and her lower back covered by the long toes of the male, kept opening and closing her beak silently. The lively immatures, joined together in "playful" groups, brought mosquitoes to mind as they fluttered about with long, dangling legs, drooping necks, and straight bills hanging downward.

[*Charadrius vociferus* (Killdeer). This migrant plover regularly frequents muddy corrals in the Guanacaste cattle country. In the lower Tempisque valley I had found it wintering at nearby Hacienda Catalina. The species was also observed by Paul Opler at Hacienda Ciruelas on the escarpment overlooking the Tempisque lowlands. At Palo Verde I did not find it in autumn or spring, but it should be expected there in winter.]

Chavadius wilsonia (Wilson's Plover). I have one observation of a single bird, most likely a migrant, on the mud in front of the corrals at Palo Verde at the beginning of December 1954.

Tringa flavipes (Lesser Yellowlegs). I did not find this migrant in my autumn visit to Palo Verde as it had probably not yet arrived. In winter, I had collected it at Catalina, and more recently Paul Opler observed it at Palo Verde in January. In spring, I noted birds on successive days around the middle of March at Palo Verde. These may have been transients as Paul Opler recorded 75 at about the same time. Overwintering individuals may have been included.

Tringa melanoleuca (Greater Yellowlegs). This yellowlegs was considerably more abundant than the smaller *flavipes*. In my March visit I saw it daily. Almost the size of its wading neighbor, *Himantopus*, it chased after and sometimes skimmed the pools for prey as did the latter. At the end of the dry season, when very few wet

places remained, I saw it once at the beginning of my stay in mid-April. As yet there are no autumn or definite winter records for the area.

Tringa solitaria (Solitary Sandpiper). This common migrant probably arrived at Palo Verde before the second week in September when I saw individuals almost daily. At Catalina I had found it at the beginning of the dry season. More recently at Palo Verde, Paul Opler recorded it in February. In spring, Opler noted it there in early March, and I found it (only twice) the fourth week in April. Particularly in the very wet period of 1969, birds demonstrated their spectacular aerial abilities, enhanced by the long- and narrow-winged proportions so suggestive of a large swift. It was at this time, too, that two of them slowed their veering, sweeping flight to engage in oddly retarded, mutual pursuits round and about the cattle pens.

Actitis macularia (Spotted Sandpiper). At Palo Verde this wintering sandpiper, perhaps ahead of any other migrant water bird, was already present at the end of August. Thereafter I met it regularly the rest of my stays in the wet season. In spring it was common when I visited in March. In the latter part of April it was still present, though I noted it only at several-day intervals.

Limnodromus scolopaceus (Long-billed Dowitcher). Previously I had collected this migrant in January 1951 in the Catalina-Palo Verde area, where several individuals were keeping together on recently exposed mud. Under similar conditions in the second week of March 1971 at Palo Verde, Paul Opler and I separately observed a trio which we assumed to be this species because of the inland habitat. The ones that I saw were keeping together, wading belly-deep at times and constantly probing. Twice I drove them into flight, but they remained silent.

Capella gallinago (Common Snipe). Two different years in the past I found snipe wintering at Hacienda Catalina in the first part of the dry season. More recently, Paul Opler met with this migrant in February at Palo Verde. I know of no autumn or spring report.

Calidris pusilla (Semipalmated Sandpiper). At Palo Verde, Paul Opler informs me that he identified

this "peep" at close range in April 1971 and again in February 1974. Neither this species nor the next had been recorded in lowland Guanacaste other than along the coasts.

Calidris mauri (Western Sandpiper). Paul Opler informs me that he also observed this species closely and well in February 1974 at Palo Verde. I saw a *Calidris*, either of this or the preceding species, together with a group of *C. minutilla* in the muddy corrals in front of the ranch houses in September 1975.

Calidris minutilla (Least Sandpiper). This "peep" is a regular winterer in the northwestern lowlands. At Palo Verde I found it several times in autumn (September-October) and spring (March). It was present for two days when I arrived in mid-April, then disappeared. Usually the birds occurred as wandering small groups of six to twelve individuals at muddy edges. In the wet season they headed invariably for the slushy corrals.

Himantopus mexicanus (Black-necked Stilt). Little is known about the breeding or seasonal movements of this species in Costa Rica. At Palo Verde in the wet season, I had not seen it by the time my stay ended on 17 October 1969. In 1975, small groups were present the first part of September—that is, until the onset of a temporary dry spell. Evidently the species increases in numbers as the rains end and remains common in March or even later, as long as conditions are suitable. The birds were active, flying about in groups or wade-running and skimming for small prey, and noisy, uttering reedy cackles.

Lobipes lobatus (Northern Phalarope). An unusually bright, winter-plumaged individual alighted briefly on the open water of a flooded pasture 16 October 1969. This is the second record for the Costa Rican mainland, more than 75 years after the first.

Burhinus bistriatus (Double-striped Thick-knee). A characteristic inhabitant of the Guanacaste cattle lands, it was encountered irregularly at Palo Verde, once not for a period of two weeks. This may not have been an unusual pattern of occurrence. Neither Nutting (1883) nor Wetmore (1944) included the species in their reports, though it surely occurred in the areas they worked. A ter-

restrial bird, it is capable of accomplished, steady and buoyant, whipping flight. It utters, apparently in response to being disturbed, a short bill-rattling sort of sound introduced by a smooth note. This introductory note, something like "oo," may change to a nasal gibber. Agitated into flight, the bird is apt to give a many-note curlew-like cry.

Larus atricilla (Laughing Gull). I found this species once, in the Catalina-Palo Verde marshes early in the dry season in 1954. In 1974 Paul Opler observed two or three of these gulls flying over the Palo Verde marsh in February.

Larus pipixcan (Franklin's Gull). This species occurred together with *L. atricilla* during my early dry season visit to the Catalina-Palo Verde area in 1954. No gulls of any kind have been reported there in autumn or spring.

Chlidonias niger (Black Tern). Coincident with the flooding of the Tempisque valley in October 1969, a flock of winter-plumaged individuals appeared for two successive days, then just as suddenly vanished. The terns foraged to and fro over the valley floor as a low-flying strung-out group, dipping to the surface like swallows and making shallow dives while gliding laterally. In contrast, a sighting in spring, again of a winter-plumaged flock, took place late in the dry season (19 April), when the last of the sloughs were drying into cracked mud.

Gelochelidon nilotica (Gull-billed Tern). I noted the species once, in the dry season (12 March 1971), when a small group of adults and immatures made an appearance over the partially flooded fields. Scouting about and swooping to the surface of the water, the birds never came to rest. This March sighting antedates "the only Costa Rican spring records" of Stiles and Smith (1977). Also in the dry season, Paul Opler saw an adult flying over the open marsh in February 1974. These reports from Palo Verde are the only inland ones for the entire northwest.

Rynchops niger (Black Skimmer). A skimmer was seen on the Río Tempisque near Palo Verde on 21 November 1973 by K. Leber *vide* Stiles and Smith (1977:95), who provide no other details.

Columba flavirostris (Red-billed Pigeon). This pigeon is apparently seasonal in lowland Guana-

caste, where it appears in flocks in the agricultural lands onward from the end of the rains into the early part of the dry season. Previously I had recorded it at nearby Catalina in late November and early December. In the cattle lands at Palo Verde, I would expect it to occur irregularly at best from November to February. My visits to Palo Verde fell outside these months. I saw it there once in September 1969, a lone bird high on an isolated tree in a soaked pasture, and in September 1975, again a lone bird, flying across the marshes. Elsewhere in the lower Tempisque drainage the species seems to have been recorded only at Bolsón (Carriker, 1910:392).

Zenaida macroura (Mourning Dove). In the patchily wooded cattle lands and cultivated areas of the Pacific northwest, the species is well represented in the dry season by wintering migrants from North America. It was wintering at Catalina during my visits there in the past, hence it almost surely winters at Palo Verde, too. In both spring visits to Palo Verde, I met with a group of birds only at the boggy border of a small, wooded tract hardly above the level of the nearby Río Tempisque. I did not find this dove there in autumn, because it probably had not arrived or was not yet present in noticeable numbers.

Zenaida asiatica (White-winged Dove). At Hacienda La Palma on the mainland side of the head of the Gulf of Nicoya, Nutting (1883:408) noted that the species was "common in the dry season, but disappears in the wet season." At Palo Verde during both dry-season visits the species was in breeding condition and ubiquitous, perched or flying about singly and in groups, and almost incessantly noisy. In the wet season of 1969, I saw it only twice, either time a single bird in flight; in 1975, it was common, whether in ones, twos, or small flocks, but not noisy.

Scardafella inca (Inca Dove). Inca Doves were always abundant at Palo Verde. Birds were calling constantly during the wet season, including one near the top of a 50-foot bare-limbed tree. Another upon a branch performed a simple display in which it alternately lifted and lowered the tail, partly fanned with the bright markings exposed. This was accompanied by clucking sounds regularly broken into by a growling note.

Columbina passerina (Common Ground-Dove).

This species, even more abundant at Palo Verde than the preceding, was reproductively active at opposite times of year. In my dry-season visits (March, April) I frightened a bird from a nest containing two white eggs in the hollow top of a fence post, another from a "nest" on the ground, also with two white eggs, in a low tuft of thin dry grass in a pasture. Also in the dry season (April), north of Puntarenas, it seems worth mentioning, I had noted at eye level a nest that contained a gray fledging, an egg, and a brooding female. She flopped to the ground and staged a wing-fluttering palsied crawl which effectively distracted my attention. As an extra touch she stumbled, as though disabled.

The species was courting and nesting also in the wet season. In fact, an incubating female sat in a trashy nest under the eaves at the very entrance to the OTS building. Birds occurred singly and in twos, whether in the semi-open or amid ground cover, shrubbery, and trees in disturbed woods. Males pursued females in the cleared areas as well as upon a road in woodland and through the branches of nearby vegetation. A pussyfooting male attempting to approach the retreating female would draw in his neck and lower his head. Thus hunched, he alternately vibrated either of his folded wings and uttered a hoarse, guttural "ower." Commonly associated with this dove was a sound, like that of a dog wringing itself dry, produced by the cambered short wings as birds suddenly sprang into flight.

Columbina minuta (Plain-breasted Ground-Dove).

I did not meet with this species at Palo Verde until my wet-season visit in 1975. I found only two birds, a male and a female, both on the same day. They were well separated from each other in the small trees dotting the wet pastures between the ranch house and the Río Tempisque. Each was in the company of the ubiquitous *C. passerina*. Presumably I could have found other *minuta* in this, apparently its preferred, habitat by spending more time in it. Anyplace else, every likely *Columbina* turned out to be *passerina*.

Columbina talpacoti (Talpacoti Dove). Though the species has been reported regularly from the seasonally dry northwest, I did not meet with it at Catalina. At Palo Verde it was virtually absent

from the general vicinity of the "central." Exceptions were a pair in the shrubby semi-open near watering troughs and an occasional individual in the riverside vegetation facing Puerto Humo. On the other hand, the species became increasingly abundant, outnumbering if not replacing *passerina*, in the wooded approaches to and in the disturbed neighborhood of the "beehives."

Claravis pretiosa (Blue Ground-Dove). This dove was resident in small numbers at Palo Verde, primarily in woodland. I noted it regularly by sight, usually a single bird in flight at edges and openings, and also by sound. Wetmore (1944:40) found it in similar surroundings near Liberia. Nutting (1883) did not record it at Hacienda La Palma nor did I at Hacienda Catalina, though the species was almost surely present at both places.

Leptotila verreauxi (Verreaux' Dove). The species was uniformly abundant in and beside woodland at Palo Verde. Evidently it penetrates the relatively open woods in the dry-forested northwest far more deeply than it does the denser forests of the more humid life zones.

Leptotila plumbeiceps (Gray-headed Dove). "Two males collected by C. F. Underwood at Bolson, on the Tempisque River, December 18 and 23, 1970" (Carriker, 1910:402) and a specimen taken recently at Taboga by Foster (1975:306) were the only past records for Guanacaste. At Palo Verde I found the species low in the woods at the "beehives" during my wet-season visit in 1975. I was led to it by its iterated note, something between "warm" and "womb." It differed in degree from the slightly and unevenly two-part, hollow note of omnipresent *verreauxi*.

[*Geotrygon montana* (Ruddy Quail-Dove). Several times in leafy woodland during my wet-season stay at Palo Verde in 1969, I attributed to this species a call of two measured "coot's," the first pitched slightly higher than the second. It brought to mind the two note call I had been hearing daylong and which I succeeded in seeing a bird on the ground actually give at the same time of year (September), well after the reported reproductive period, at the wet-dry Baranca Site several miles north of the town of

Puntarenas (Slud, 1965:17-24). Bearing a resemblance to the "aw"-tinged "hoop" of *Claravis pretiosa*, it was usually doubled and either repeated for a while or not. This call was obviously different from the single note assigned to the species by Skutch (1949:4), Goodwin (1967:260), Wetmore (1968:59) and Edwards (1972:77), or that I had known it to give. Incidentally, another apparently unrecorded cry (which I heard elsewhere in the country) was a frightened bleat from an unharmed bird in the hand.]

Ara macao (Scarlet Macaw). The species occurred usually in raucous companies or sometimes as an isolated duo each of my visits in 1969-1971. In 1969 a pair returned daily at dusk to roost in a hollow limb near the old ranch house. In 1975 all that remained was a lone trio making daily rounds. Once in the dry season I observed a single bird sailing out of sight on motionless wings a couple of hundred feet up in the air. It could have passed for a frigatebird (*Fregata*) in silhouette. I had not seen the species do this before. Wetmore (1944:41-42), near Liberia, reported three birds high in the air which he believed might be flying from Rincón de la Vieja Volcano to the mountains of the Nicoya Peninsula: "In distant flight they travel high in a direct line with steadily moving wing beat when the long, streaming tail gives them a curious outline."

Aratinga canicularis (Orange-fronted Parakeet). This is one of the typical, abundant species that characterize the country's northwestern quadrant. At Palo Verde, I noted it with fair frequency, usually in flight. It occurred much more commonly and in larger groups in the wet season than in the dry. In the dry season I saw it only from time to time in twos or in small groups of up to six or so. It is in the dry season that flocks occur upon the central plateau at least as far as the capital city of San José.

Brotogeris jugularis (Tovi Parakeet). The species was noted regularly wherever there were trees each of my visits. In the wet season it was the third member of its family in abundance, after *Amazona albifrons* and *Aratinga canicularis*. In the dry season it greatly outnumbered the *Aratinga*.

Amazona albifrons (White-fronted Amazon-Parrot). The most abundant and noisiest member of its family at Palo Verde, it was nearly always somewhere within sight or sound, whether in twos, threes, small groups, or flocks.

Amazona ochrocephala (Yellow-headed Amazon-Parrot). The species, represented by the yellow-naped *auropalliata*, was present almost daily as paired individuals, probably the same few, made their rounds.

Coccyzus americanus (Yellow-billed Cuckoo). Single individuals of this migrant cuckoo were recorded a number of times in woodland and in the semi-open only in my autumn visit, onward from 19 September 1969. Having found it in winter at Catalina and other places in the Pacific northwest, I would expect it at Palo Verde at that time of year, too, as well as in spring.

Coccyzus minor (Mangrove Cuckoo). The Mangrove Cuckoo may not be resident in the lower Tempisque valley. At any rate, I have no record of it there in the wet season. In the past I found it not uncommon in the Catalina-Palo Verde area in the early part of the dry season. At Palo Verde, later in the dry season (March and April), I saw the species only twice in either of my visits. It occurred singly in shrubs in pastures and at woodland edges.

Piaya cayana (Squirrel Cuckoo). Though few in numbers this species was a typical woodland-based inhabitant that could be encountered almost daily at Palo Verde. A pair was copulating in October.

Crotophaga sulcirostris (Groove-billed Ani). This was one of the commonest birds at Palo Verde. No doubt it will largely disappear with the cattle when Palo Verde becomes a national park.

[*Tapera naevia* (Striped Cuckoo). The species is scarce in the lower Tempisque valley, having been recorded only from Bolsón (Carriker, 1910:567). Apparently it is less uncommon not far off in the Bebedero-Taboga area. I know of no other occurrence in the Guanacaste lowlands north of the head of the Gulf of Nicoya.]

[*Dromococcyx phasianellus* (Pheasant Cuckoo). In all of the Pacific northwest the species has been known only by two old specimen records from Bolsón and Bebedero (Carriker, 1910:568). In ad-

dition, the late Rex Benson told me some years ago that he had seen one walk out of beach scrub near the town of Puntarenas.]

Morococcyx erythropygus (Lesser Ground-Cuckoo).

Almost entirely on the basis of its voice, I identified this secretive cuckoo as common in the dry season and uncommon in the wet season. In addition to its self-identifying regular call, the species was apt to utter repeatedly a note which I variously transcribed as "eee-uk," "wwek" or "üüp." A minor-pitch, mouth-puckered, *Tapera*-like ventriloquial whistle, given singly or as a set of two or several notes spaced apart from one another, it was sometimes followed by the regular call. During a wet-season encounter with two adults and a fledged young, I heard one of the parents produce a mechanical type of sound that was new to me: a repetitious weak bill-snapping, like the cracking of knuckles.

Tyto alba (Barn Owl). I saw and heard the species only in my wet-season visits. Paul Opler recorded it in February in the dry season. The bird is probably resident at Palo Verde.

[*Otus* sp. In February 1974 at Palo Verde, Paul Opler identified by voice a screech-owl that was probably *O. cooperi*.]

Pulsatrix perspicillata (Spectacled Owl). In my wet-season visits and in April in the dry season the "olopopo" was common and could be heard many nights. Both at morning and evening twilight it uttered as in an undertone a heavy, weakening "wuff wuff wuff wuff" which advertised its presence. Usually this owl occurred in pairs and could be seen in the daytime. Two birds, incidentally, that were sitting on a branch side by side had the lower underparts plain in one, conspicuously barred in the other. During my March visit I neither heard nor saw the species in its accustomed haunts or anyplace else.

Glaucidium brasilianum (Ferruginous Pygmy-Owl).

This resident owlet was as a rule detected by sound rather than by sight both night and day, more often in March than during any other visit. Usually it occurred singly in trees outside forest, steadily whistling up to 30 ventriloquial "poo"'s at a rate of two to three per second. Occasionally I saw a bird in thickety growth behind the woodland border, including one that a hummingbird

(*Amazilia saucerrottei*) was pestering. Disturbed, it moved the short tail jerkily to one side or the other in a manner oddly reminiscent of a euphonia.

Rhinoptynx clamator (Striped Owl). I saw one of these dark-eyed horned owls early one morning in September 1975. It was perched on a low branch in a small leafy tree in a wet pasture dotted with *Parkinsonia*. Its head kept turning to face me as I passed.

Chordeiles acutipennis (Lesser Nighthawk). Migrating individuals were noted two successive late afternoons in mid-October as my wet-season stay was ending. In winter, I had found it at nearby Catalina, and Paul Opler met with it more recently at Palo Verde. In spring the species was present in my March visit. Several days at dawn I saw a bird return from the open marsh and vanish in the murk against a wooded slope. Another was perched perpendicular to, rather than horizontal with, the limb of a bare-branched tree in dry open woodland in broad daylight. I did not meet the species in the latter part of April, because it had probably passed northward.

Nyctidromus albicollis (Pauraque). The species is resident and common at Palo Verde.

[*Caprimulgus carolinensis* (Chuck-will's-widow). I did not record this migrant in my autumn and spring visits to Palo Verde. Previously I had found it in winter at Hacienda Catalina and would expect it at Palo Verde at that season, too.]

Streptoprocne zonaris (White-collared Swift). In the past I had recorded this far-ranging swift at the beginning of the dry season at Hacienda Catalina. At Palo Verde, I noted it, for the most part, only occasionally. During my wet-season visit in 1975, however, flocks were seen a number of days. The species undoubtedly occurs there the year round.

[*Phaethornis superciliosus* (Long-tailed Hermit). To my knowledge, the species has been recorded in the lower Tempisque valley only at Bolsón (Carriker, 1910:520); elsewhere in the Tropical Dry lowland, only at Taboga (G. H. Orians, *in litt.*)]

Phaethornis longuemareus (Longuemare's Hermit). This hummer was noted usually singly and only in woodland, rarely in the dry season and occa-

sionally in the wet season. In my wet-season visit in 1969, I came upon a small singing assembly.

Eutoxeres aquila (Common Sicklebill). Early in October 1969 one of these stout-bodied streaked hummingbirds dashed past me from a flowering shrub in thinned woodland. This is the only report for the country's northwestern quadrant.

[*Phaeochroa cuvierii* (Cuvier's Hummingbird). Reports from the drier parts of the Guanacaste lowlands are few compared to those from the more humid parts. The species has been recorded upriver at Bolsón (Ridgway, 1911:364) and Ballena (UMMZ 150101) and at Hacienda Ciruelas (Paul Opler, *in litt.*) overlooking the lower Tempisque valley. Though not found at Catalina or Palo Verde, it surely occurs there, if only seasonally and in small numbers.]

Anthracothorax prevostii (Prévost's Mango). In the wet season, the species was noted seldom in 1969 and not at all in 1975; in the dry season, occasionally in March but not in April. The few times I did find this hummer, it was usually along the overgrown banks of the Río Tempisque. Elsewhere, the species had shown this marked preference along the similar-appearing Río Frio at Los Chiles on the Caribbean versant. At Palo Verde, a bird or two were also seen at flowering, semi-isolated large trees in a pasture, sometimes hovering to capture tiny insects around the outer foliage.

Chlorostilbon canivetii (Fork-tailed Emerald). Individuals were noted singly and infrequently at breaks in or at the edge of thinned woodland, at nearby low shrubby growth, and once well out in arid "savanna."

Hylocharis eliciae (Elicia's Goldentail). Previously I had recorded this hummingbird early in the dry season at Catalina. At Palo Verde, I found it once, in March.

Amazilia boucardi (Mangrove Hummingbird). This hummingbird was common in the mangroves of the Río Bebedero when I visited Catalina in the early fifties. At Palo Verde, Charles H. Lankester collected the one bird he saw at the Río Tempisque in June 1906 (Carriker, 1910:524). The only likely habitat for the species there is the dense growth lining the banks of the Río Tem-

pisque, the Palo Verde side of which I searched in vain.

Amazilia saucerrottei (Saucerrotte's Hummingbird). One of the common residents at Palo Verde, it occurred both inside and outside woodland. As do many other hummingbirds, it sometimes engaged in fly-catching hovers at the periphery of arboreal foliage.

Amazilia rutila (Cinnamon Hummingbird). This hummingbird was apt to frequent the same places as the preceding species, except that it tended to occur outside shaded woodland. It was nesting in the rainy season.

Amazilia tzacatl (Rieffer's Hummingbird). At Palo Verde I observed the species once, in March, a lone bird at a cultivated patch beside dry open woodland in the vicinity of the "beehives." Other reports from the Tropical Dry Forest life zone are few. Over the Pacific northwest as a whole, the number of reports rises from areas with high water-table conditions or with increased annual precipitation.

Helimaster constantii (Constant's Starthroat). This was an uncommon to scarce nonforest resident at Palo Verde, where presumably the same few individuals kept to the same few places. The species habitually hovered to catch tiny insects in the air.

Archilochus colubris (Ruby-throated Hummingbird). The species winters commonly to abundantly throughout the dry-forested northwest. At Palo Verde it apparently does not arrive until late autumn. At any rate, I did not find it by the time I left on October 17, perhaps because it was not yet present in sufficient numbers to be noticed. In spring it was fairly common in March but had already departed when I visited in mid-April. (For a discussion of this species elsewhere in Guanacaste see Wolf, 1970.)

Trogon melanocephalus (Black-headed Trogon). This trogon was a common resident in and near woodland in all my visits. It occurred singly, in pairs, and, more often and more conspicuously, in small groups traipsing about in follow-the-leader style. Members of a party would leave a stopping place one by one, the last bird pausing the longest before bringing up the rear.

Trogon elegans (Elegant Trogon). The species inhabited the more heavily wooded portions of Palo Verde. Particularly in the dry season it was heard far more often than seen. In the wet season, when the bird was quiet, I recorded it infrequently. The unbirdlike call was a simple set of three or four iterated harsh notes. In quality it brought to mind a monkey, such as the neighboring *Cebus capucinus* (White-faced Capuchin). A flushed bird was apt to utter a trogon's typical cackle.

Trogon violaceus (Gartered Trogon). The least common trogon at Palo Verde, it occurred along edges and at openings leading into woods. Like the preceding species, it was seen in the dry season much more often than in the wet season. The iterated note resembled and was given at about the same rate as that of the pygmy owl *Glaucidium brasilianum*. More like a "pwup" than the owl's "poo," it also differed in sounding double-stopped.

Megaceryle torquata (Ringed Kingfisher). Occasionally I noted one of these large kingfishers along the Río Tempisque in either rainy season visit and in March in the dry season. I did not see it in April.

[*Megaceryle alcyon* (Belted Kingfisher). I found this migrant early in the dry season years ago at neighboring Catalina. No doubt a bird or two winter regularly at the Catalina-Palo Verde lagoons. There is no autumn or spring report from the lower Tempisque valley.]

Chloroceryle amazona (Amazon Kingfisher). I sighted this kingfisher once, in my March visit, at the Río Tempisque, along which it is probably resident.

Chloroceryle americana (Green Kingfisher). The species is almost surely resident at Palo Verde. I saw it only once, in April, at a stagnating streamlet close to the Río Tempisque.

Chloroceryle aenea (Pygmy Kingfisher). This diminutive kingfisher I encountered occasionally in ones or twos in the wet season and a few times in the dry season—in March, but not in April. It was apparently restricted to low-canopy woodland that was boggy and partially flooded in the wet season. In the dry season the floor of these woods was dry, except for a tidal channel in one such patch and

the overflow from a cattle trough at another. In addition to the songbird-like "tsweep," birds uttered a descending little rattle, something like that of *Sittasomus*.

Eumomota superciliosa (Turquoise-browed Motmot). In the wet season the species kept quietly behind the woodland edge and was seen seldom. In the dry season, birds were much commoner visually and vocally. One of the sounds given was a resonant squawk.

Momotus momota (Common Motmot). Unlike the preceding motmot, which could generally be seen in the open, at least in the dry season, this one almost always kept in concealment behind the woodland border. Usually it made itself known by voice, otherwise the species might have escaped detection. Nevertheless it was not so scarce as expected, if only because I had failed to record it at Catalina.

[*Galbula ruficauda* (Rufous-tailed Jacamar). In the lower Tempisque valley, the species has been recorded at Bolsón (Carriker, 1910:577). I did not find it in the Palo Verde-Catalina area. Elsewhere in the adjacent Guanacaste lowlands it is known from Bebedero, Taboga, and Hacienda La Palma.]

Notharchus macrorhynchos (White-necked Puffbird). At Palo Verde a bird or two, if sought patiently, could usually be rediscovered by sound in a patch of low woods that was seasonally boggy or dry. The self-identifying note, a descending, soft, mewling whistle, "wówww," issuing through the closed bill, was uttered about every fifteen seconds for many minutes at a time.

Pteroglossus torquatus (Collared Araçari). The araçari was uncommon at Palo Verde, where I found it less infrequently in the dry season than in the wet. The reduction in numbers in the dry-forested lowlands, where I saw it at most in threes, compared to the species' group-size assemblages and abundance in the humid formations, evidently went hand in hand with the decreased ebullience, increased secretiveness, apparent nomadism, and virtual confinement inside shaded woodland.

Dryocopus lineatus (Lineated Woodpecker). This was the least common of the three species of woodpecker that inhabit the dry-forested northwest.

One sighting involved a bird on the ground near a brook in a thinly wooded patch; it was tossing aside leaves, presumably in search of prey.

Melanerpes hoffmannii (Hoffmann's Woodpecker).

This noisy, abundant species occurred in trees almost everywhere in the semi-open and at woodland borders. In addition to pecking wood it had the habit of clinging head downward, stretching its neck for berries. An adult was seen feeding a young bird at the end of April.

Campephilus guatemalensis (Flint-billed Woodpecker).

At Palo Verde this powerful woodpecker rarely strayed from woodland, where its resounding double rap could be heard almost daily. Possibly the species moves about locally. At any rate, Nutting (1883:398) found it suddenly common at Hacienda La Palma some time after his arrival. The young bird, which may not be noticeably red on the face and throat, is distinguishable from *Dryocopus* in having the two white stripes on its back close together, in lacking white lines across the face, and in appearing topknotted rather than crested.

Dendrocincla homochroa (Ruddy Dendrocincla).

The species conceivably is nomadic at Palo Verde, where I found it only in my rainy season visits. Usually I noted a lone bird silently attending army ants in boggy low woods. The only prey I clearly saw it capture amid the swarm was a large spider.

Sittasomus griseicapillus (Olivaceous Woodcreeper).

At Palo Verde, this infrequently met resident was usually heard rather than seen as it traveled about in woodland.

Dendrocolaptes certhia (Barred Woodhewer).

This large woodhewer was an uncommon resident at Palo Verde. Usually it occurred singly, also as a group of three. Generally I met it attending army ants, once in silent company with a lone *Dendrocincla homochroa*. The species was not nearly so noisy as in places where it is more abundant. When "ernking" in an undertone it was hardly distinguishable vocally from the greenlet *Hylophilus ochraceiceps* with which it occurs in the more humid life zones.

Xiphorhynchus flavigaster (Ivory-billed Woodhewer). I identified this woodhewer once, in my April

visit, by its distinctive descending call as it issued several times from hillside woods.

Lepidocolaptes souleyetii (Thin-billed Woodhewer).

This was the common woodhewer at Palo Verde. In the country's humid formations it is primarily an inhabitant of the semi-open. Here it occurred also at woodland edges and penetrated open woodland.

Xenops minutus (Plain Xenops). This woodland inhabitant is scarce in the Tempisque valley, where previously known only from Bolsón (Carraker, 1910:644). At Palo Verde I found it once in the wet season and twice in March but not in April in the dry season.

[*Taraba major* (Great Antshrike). Apparently the only place in lowland Guanacaste that this large antshrike has been reported is Bolsón (Ridgway, 1911:30) in the lower Tempisque valley. Elsewhere in the seasonally arid northwest, I met with it at Boca de Barranca, near the town of Puntarenas.]

Thamnophilus doliatus (Barred Antshrike). The species, detected primarily by voice, was found most days in the rainy season but much less frequently in the dry season. The habitat lay almost exclusively in overgrown edges bordering woodland. This antshrike was probably represented by relatively few individuals.

[*Pachyramphus cinnamomeus* (Cinnamon Becard).

This becard remains unrecorded from Palo Verde. I did find it nearby, however, at Hacienda Catalina, the only Pacific locality on record north of the entrance to the Gulf of Nicoya. There it was virtually confined to the mangroves together with *Amazilia boucardi*, *Myiarchus panamensis*, *Sublegatus arenarum*, *Vireo pallens*, and the resident form of *Dendroica petechia*.]

Pachyramphus polychopterus (White-winged Becard).

At Palo Verde this resident was noted regularly in and beside woodland in the wet season and in April, but not in March, in the second half of the dry season. Previously I had found it early in the dry season at Catalina. In addition to its usual call, this species uttered a set of several thin, wistful notes, quite different from anything I had heard from it on the Caribbean side. Had I not seen the bird I would have attributed the call to the congeneric *cinnamomeus*.

Platypsaris aglaiae (Gray Becard). This becard is no doubt resident at Palo Verde, though I did not find it there in March. In September 1969 a family group composed of two adults and at least two female-plumaged young was moving through the foliage of medium-size trees. Having stopped, a bird would look around, then reach to seize an item of prey with its bill. The only sound given was a weakening, plaintive, minor "tsür." In September 1975 I met the species much more often. Birds uttered arrestingly sharp, rapid squeaks terminating with a diagnostic "ritsee"; a snorting ripple tapering into an "eee"; a sharp, strong "tseep" or "tsee-r," given alone or doubled; and a note that lay between the "tseep" and the minor "tsür."

Tityra semifasciata (Masked Tityra). A resident at Palo Verde, it could be seen from time to time, mostly outside woodland. I met it more frequently in the dry season than in the wet season.

Erotor inquisitor (Black-crowned Becard). The species was noted seldom at Palo Verde, where it appears to be an uncommon resident.

Procnias tricarunculata (Three-wattled Bellbird). A female-plumaged bird that I saw perched at Palo Verde in the course of a brief sidetrip from Catalina in early December 1954 is the only report of this altitudinal migrant in the lower Tempisque valley.

Chiroxiphia linearis (Long-tailed Manakin). This was a very common, widespread, freely calling species at Palo Verde. It kept inside woodland and shaded second growth, seldom entering the semi-open. A tailless fledging was being attended by a female in September.

Muscivora forficata (Scissor-tailed Flycatcher). This striking species did not make its autumn appearance until mid-October. In winter it was apparently as common at Palo Verde (*fide* Paul Opler) as I had found it to be at Catalina. It was still abundant at Palo Verde in March, when it was constantly moving about in groups, as though preparing to migrate. The bird was no longer present when I arrived in mid-April. Here might be added an observation I made in the dry season (late January 1965) at Cañas. Birds were fly-catching aerially, without pausing to perch, inside the town toward the end of day,

just as I had seen the congeneric *tyrannus* do at Buenos Aires in the southwest.

Tyrannus tyrannus (Eastern Kingbird). I observed this transient only once in each autumn visit: 11 October 1969 and 12 September 1975. From an overhanging tree on the bank, the latter individual was making long sallies out over and down toward the surface of the Tempisque river. In spring, the species had not yet arrived when I visited in the first half of March. During my stay in the second half of April to the beginning of May, it occurred regularly in small groups that were usually noted in flight.

Tyrannus melancholicus (Tropical Kingbird). The species varied considerably in frequency, from uncommon to abundant, each of my visits. In the wet season it uttered an early morning call of three or four notes that differed from the dawn song described by Skutch (1954). Something like "tsitfr tsitirrr," it was of similar quality but not so sharp as the usual raspy twitter. In October 1969 when the boggy pastures turned into "lagoons," Tropical Kingbirds hunted over the open water, employing a hovering type of flight as they looked downward like terns in search of prey. A number of these birds used to congregate around the beehives (then still in operation), sallying leisurely to pick off the bees on the wing. In 1975 the beehives had already been removed, and I did not record a kingbird from that end of the property.

Legatus leucophaeus (Piratic Flycatcher). A migrant in Costa Rica, this neotropical species was noted regularly beside wooded areas during both my dry-season stays at Palo Verde. It became increasingly common as my April visit was drawing to a close. The species was apparently no longer present, though perhaps only silent, both times I arrived in the latter part of the wet season.

Myiodynastes luteiventris (Sulphur-bellied Flycatcher). This largely neotropical flycatcher is, like the preceding species, a migrant in Costa Rica. At Palo Verde it was frequent in spring. In autumn I met with it regularly from the end or August to mid-September, when it had mostly stopped calling. Thereafter I detected it seldom until my departure in mid-October. The birds preferred the outer edges of woodland and the

treed semi-open. Once I saw two birds high up on the thin tips of branches in a pasture with few trees, a setting in which to have expected *Nuttallornis*. Even when in "waves," the birds acted for the most part as independent individuals.

Myiodynastes maculatus (Streaked Flycatcher). The species was fairly common each of my visits to Palo Verde, where it occurred at edges, cuts, thinned woody growth, and patches of open woodland. Despite Skutch's belief (1960:374-376) cited by Wetmore (1972:399) that in Costa Rica it is a migrant which arrives at the end of February or the beginning of March and departs by late September, the species is present year-round (Slud, 1964:245). During the supposed period of absence, specimens have been recorded, primarily in the country's northwestern quadrant, at Liberia (30 Oct), Hoja Ancha (3 Nov), Pigres (6 Nov), Filadelfia (26 Nov), Tempate (4 Dec), Mojal (8 Dec), Bolsón (13 specimens, 12-28 Dec), Las Trojas (Jan), Bebedero (26 Jan, 1, 24 Feb), San Lucas (several, 6 Feb), Hda. Taboga (immature, 6 Feb), Hda. Miravalles (12 Feb), San Carlos (20 Feb), Hda. Tenorio (21 Feb). In addition, there are my sight observations for Palo Verde (15 Oct), Catalina (26 Nov-5 Dec), Santa Rosa (13-18 Dec), the Barranca Site (18-20 Jan), Taboga (Río Higuerón and Río Lajas, 24-31 Jan). Others have been found at Santa Cruz (5 Jan) *vide* Burt Monroe, Jr. (*in litt.*), and at Hdas. Ciruelas (3 Dec, 17 Feb) and La Pacífica (13 Jan) *vide* Paul Opler (*in litt.*), I noted the species also in the southwest: Buenos Aires (7-25 Jan), Vijagual (26 Jan-1 Feb), Boruca (2-6 Feb), and the lower Coto Brus valley (15-23 Feb). This is not to say that movements or fluctuations may not perhaps take place in the southwest, where Dr. Skutch resides.

Megarhynchus pitangua (Boat-billed Flycatcher). At Palo Verde this common species could be found daily in or out of woodland.

Myiozetetes similis (Social Flycatcher). The species was regularly present in small numbers, up to three at a time, at the "beehives" during my wet-season stay in 1975. Elsewhere on the property it was mostly absent, except for a straggler in the vicinity of the ranch houses and scattered individuals along the shores of the Tempisque.

Pitangus sulphuratus (Great Kiskadee). Like the similar-appearing *Megarhynchus*, this species was seen daily but in greater numbers and almost exclusively outside woodland. I saw a pair repeatedly gather nesting material in September 1975.

Myiarchus crinitus (Great-crested Flycatcher). At Palo Verde I first noted this wintering migrant the third week in September. In spring I met with it most days in March and up to the 20th of April, then not again until 1 May. The last bird could have been a transient from the south.

Myiarchus nuttingi (Nutting's Flycatcher). *M. nuttingi* and its larger, commoner counterpart, *M. tyrannulus*, were both met regularly at Palo Verde. *Nuttingi* tended to occur inside woods, *tyrannulus* almost exclusively outside woods, with the two overlapping at the woodland border. They are best distinguished by voice. *M. nuttingi*, in addition to its diagnostic double-note cry (Slud, 1964:249), uttered more commonly a single note that was different from anything given by *tyrannulus*. It impressed me at different times as a rasping "squip" or "squirp," a loud, sharp "skweek" or "skwihk" and a squeaky, sharp "peep" or "peesp."

Myiarchus tyrannulus (Brown-crested Flycatcher). One of the characteristic birds of the country's northwest, this *Myiarchus* was abundant at Palo Verde. It occurred in trees in most places outside woods and along wooded edges. Distinctive sounds given routinely were an iterated rough "wit," modified at times into a watery "pwik," and a self-identifying "pickarick." Mornings in the wet season it uttered a raspy, flycatcher-like "drrink yer beer." The Costa Rican population, *brachyurus*, continues northward along the Pacific coast to El Salvador, where it is "confined during the breeding season to mangroves" (Dickey and van Rossem, 1938:368). The mangrove habitat of *M. tyrannulus* at the end of its range in El Salvador parallels the ecological distribution of the congeneric *panamensis* (below).

[*Myiarchus panamensis* (Panama Flycatcher). This plain-colored *Myiarchus* occurs at neighboring Catalina, where I met it in the mangroves near the Río Bebedero at the head of the Gulf of Nicoya. It is not known from Palo Verde, which

lacks the habitat. In Costa Rica, at the western end of its range (extending eastward to northwestern Venezuela), the species is restricted to the mangroves along the Pacific coast. In Panama it is "most common at the border of woodland, and in brushy pastures, ranging also at the inner margins of mangrove swamps, and through open gallery forest over inland hills" (Wetmore, 1972:427). According to Lanyon (1978:555), *M. panamensis* deserves specific separation from the Amazonian *M. ferox*.]

Myiarchus tuberculifer (Dusky-capped Flycatcher).

This common species was met almost daily in the treed semi-open near woods, along woodland borders, and sometimes inside open forest.

Attila spadiceus (Polymorphic Attila). The species occurred exclusively in wooded surroundings at Palo Verde. I noted it much more frequently in the dry season, when the birds called freely, than in the wet season, when they were mostly silent. In March, a nest three feet above the ground in the hollow of a tree behind the woodland border contained four greenish eggs, heavily spotted reddish brown on the large end. A nest recorded by Wetmore (1972:440) in Panama contained three eggs that were similarly spotted but on a pinkish buff ground. Removal of this species from the Cotingidae to the Tyrannidae follows Meyer de Schauensee (1970:269) and Wetmore (1972:438).

Nuttallornis borealis (Olive-sided Flycatcher). In autumn I first noted this migrant early in September and occasionally thereafter. In spring I did not find the bird in March, probably because it was too early for the return migration. In the second half of April, I saw single, probably transient, individuals at several-day intervals. One was giving the species' typical three-note call, sometimes omitting the first syllable.

Contopus virens (Eastern Wood-Pewee). This migrant appeared the first week in September and was seen several times thereafter, usually in small "waves." Some gave the self-identifying two-part song, others were generally recognizable by the smooth appearance of the upper parts contrasting rather smartly with the yellow-tinged under parts. A violent rainstorm did not interrupt the birds' fly-catching sallies. Later in autumn and in spring they were silent, and I did not attempt to distinguish this bird from the next.

[*Contopus sordidulus* (Western Wood-Pewee). I identified this pewee uncertainly in autumn and spring (the latter part of April). It may have been too early for transients in March, when I saw only one individual that might have been this species. None of the birds uttered a distinguishing cry. I did meet with it years ago at Catalina, early in the dry season.]

Contopus cinereus (Tropical Pewee). I met this native pewee fairly often in the wet season, infrequently in the dry season. It occurred singly, for the most part along woodland edges. One that perched at eye level above army ants in swampy woodland in the wet season was the only attendant other than a wren (*Thryothorus pleurostictus*). At the end of the dry season (April) a bird flirting with spread tail like a redstart (*Setophaga*) presumably was engaged in a courting antic not mentioned in the "life history" by Skutch (1960). In Panama, according to Wetmore (1972:460), this pewee will rarely be distinguished from the migrants. In Costa Rica, even apart from voice, it can be distinguished by its *Empidonax*-like proportions and coloration—brownish upper parts and yellowish lower under parts with contrasting white throat—and the habit of almost invariably vibrating its tail upon alighting.

Empidonax flaviventris (Yellow-bellied Flycatcher).

This migrant was noted infrequently in autumn and in spring, almost always behind the woodland border. A late spring observation (18 April) signified perhaps that most of the local wintering population had already departed, that the bird was on passage from the south, or that the Tempisque valley was a route not favored by northbound transients.

Empidonax [traillii]. In the absence of singing birds it may have been *traillii*, taken previously at Bolsón (Carriker, 1910:699), rather than *alnorum* that appeared at Palo Verde. At any rate, members of the complex occurred in migration in the semi-open near woodland. In the fall I noted it from time to time in September-October. In spring it was not present during my visit in March. I found it with increasing frequency in the latter part of April and the beginning of May, when I departed.

Empidonax minimus (Least Flycatcher). At Palo Verde I identified this migrant *Empidonax* with

certainly only in the rainy season of 1969, when I observed calling individuals 20 September and 14 and 15 October, inside and outside woodland. The species may not be so scarce in Costa Rica (Slud, 1964:256) as it is irregular, occurring frequently in certain years. In the 1964-65 season, for example, I met calling birds several times: 7-12 October, a "wave" of individuals spaced apart in thickets along wooded borders and occasionally in woods in the area of San Isidro del General; 31 October, at Rincón de Osa beside the Golfo Dulce; the last week in January, at two edaphically humid sites of the Taboga area in the dry Guanacaste lowlands.

Onychorhynchus mexicanus (Northern Royal-Flycatcher). Royal-Flycatchers could be found more or less regularly during three of my four visits to Palo Verde. They kept to the woods, as a rule in the vicinity of stream bottoms, whether wet or dry. Usually the bird was met singly; three were the most I saw at a time. One drew my attention as it sallied for butterflies.

Platyrinchus cancrinus (Mexican Spadebill). This tiny woodland inhabitant was detected from time to time, usually by its characteristic cry, in both wet-season visits. In the dry season I met it only twice in my April visit and not at all in March. I cannot believe, however, that the species had abandoned the area or even that its numbers had been drastically reduced.

Tolmomyias sulphurescens (Yellow-olive Flatbill). A very common resident at Palo Verde, it occurred mostly in the vicinity of woodland edges, less often inside open forest.

Todirostrum cinereum (Common Tody-Flycatcher). The species was a common inhabitant of shrubby patches up to the very edges of neighboring woodland. Sometimes it also occurred at thinned or low places inside open forest. In such a situation (in April) I met several individuals that were calling and chasing one another about.

Todirostrum sylvia (Slate-headed Tody-Flycatcher). More secretive and difficult to see than its congener *cinereum*, this species also tended to occur in denser thickety growth inside and alongside the woods. In March I noted two birds unusually high, some 30 feet up, in the vine-tangled canopy

of a small tree, busily flicking both wings simultaneously.

Oncostoma cinereigulare (Bent-billed Tyrant). In contrast to its essentially nonforest habitat in the country's humid formations, this little flycatcher occurred regularly inside woodland and along its borders, sometimes rising from the understory into low trees, at Palo Verde. It foraged by making instantaneous flits at the nearby foliage. The flit, really a leap and a rapid flutter accompanied sometimes by a hummingbird-like whir, was usually directed diagonally upward at the underside of a leaf. For a bird with a downbent bill this would appear to be the efficient way to seize prey from underneath.

[*Elaenia flavogaster* (Yellow-bellied Elaenia). The only record of the species in the lower Tempisque valley is an old one at Bolsón (Carriker, 1910:720), upstream from Palo Verde. I know it from only three other places in lowland Guanacaste: Taboga, Hacienda Guachipilín, Hacienda Orosi.]

Myiopagis viridicata (Placid Flycatcher). This flycatcher was nearly as common as *Tolmomyias sulphurescens* (Yellow-olive Flatbill), a neighbor whose haunts it shared a little outside and up to the borders of woodland. The present species, however, also occurred inside woods. So similar might the two sometimes appear that the difference in their tails—longer and in line with the long axis of the body in *Myiopagis*, shorter and cocked in the *Tolmomyias*—became the distinguishing feature. The two also resembled each other vocally. Especially when *Myiopagis* uttered its "tchreez" three times, it produced a call that was similar in quality and pattern to the lighter one of the *Tolmomyias*. Though the contrary has been stated (Slud, 1964:270), the species can forage by hovering momentarily in front of leaves.

[*Sublegatus arenarum* (Scrub Flycatcher). South of Costa Rica this widely distributed neotropical flycatcher is primarily an inhabitant of lowland scrub and open woodland, though it also occurs in mangroves. In Costa Rica, the northern terminus of its range, the species is only known from the mangroves along the shores of the Gulf of Nicoya. In the past I met with it at Catalina. Along with several other species restricted there to the mangroves, *Sublegatus* is not known from

Palo Verde. Its geographic pattern of ecological occurrence on the Pacific slope of Central America virtually duplicates that of *Myiarchus panamensis* and of *M. tyrannulus*.]

Camptostoma imberbe (Beardless Tyrannulet). I noted this tyrannulet irregularly in all my visits. It was more vocal in the dry season, hence gave the impression of being more common than in the wet season. Usually it occurred singly, generally at wooded borders but also inside patches of open woodland. Flicking its wings and tail, it often searched among the branches almost as industriously as a small vireo. In addition to its characteristic little "peeúk," the bird uttered repetitively a weakly whistled, metallic, level "weebie" (or "feebee"), also a single "fee" or several in succession.

Camptostoma obsoletum (Temminck's Tyrannulet). A southern Pacific-slope species, this tyrannulet has a complementary distribution to that of the congeneric *imberbe*. It is poorly known from typically dry-forested Guanacaste in general. In my first three visits to Palo Verde (1969–1971) I observed one once, late in the dry season (15 April), as it briefly visited some densely foliaged trees at a break in woodland. In the wet season of 1975, I found it several times, mostly at the "beehives" at the far end of the property. The birds uttered several successive minor "pee's," either on a level plane or as a descending set that brought *Pachyramphus cinnamomeus* to mind. Here might be included a vocalization I heard at the Barranca Site in the lowlands north of Puntarenas: a simple "weep," lighter than that of *Myiarchus tuberculifer*, given alone or preceding either an unclear "tlenk lenk lenk lenk" or an *Ornithion*-like series of notes similar to those mentioned above.

[*Tyranniscus vilissimus* (Paltry Tyrannulet). This is a rare species in the Guanacaste lowlands. In the lower Tempisque valley, it has been recorded only at Bolsón (Carriker, 1910:722).]

Progne chalybea (Gray-breasted Martin). At dusk on 9 October 1969, an apparently wandering or migrating flock of some 50 individuals settled in the rain as if to roost atop a semi-isolated tree at the edge of the flooded pastures. Early the next morning the birds had already gone. I saw the

species twice more during this visit, both times single birds. In the wet season in 1975 I met the species, only once, as a perched group of three. In the dry season I saw a bird once in March and none in April. The favored lookouts were bare-topped trees, whether along a wooded edge overlooking the marshes or isolated in a regenerating clearing or an open pasture.

Petrochelidon pyrrhonota (Cliff Swallow). Both in autumn (September and October) and in spring (March and April) this transient was probably much commoner than my occasional identification of a bird high in the air might indicate.

Hirundo rustica (Barn Swallow). In autumn this wintering migrant was not recorded regularly before the second half of September, when, represented perhaps largely by transients, it became common. Undeterred by the heavy rains, the birds ceaselessly continued their aerial hunting. During both my visits in spring, the species, again represented to unknown extent by transients, was abundant.

[*Stelgidopteryx ruficollis* (Rough-winged Swallow). Resident Rough-winged Swallows, recognized by the white rump, I recorded rarely at Hacienda Catalina. At Palo Verde I looked for them in vain.]

Riparia riparia (Bank Swallow). I noted this transient in the latter part of April but not in March, when it had probably not yet returned northward. It almost surely occurred in autumn, but I could not positively distinguish this species from others in the stream of high-flying swallows.

Tachycineta albilinea (Mangrove Swallow). Mangrove Swallows frequented the accumulations of shallow open water and sometimes even patrolled dried-out pastures. During my wet season visit in 1969 and in both dry season visits the species was present in small numbers. To my surprise, I did not find it during my wet season visit in 1975. At no time was there any sign of nesting.

Calocitta formosa (Magpie Jay). An indicator species of the Pacific northwest, this large jay was a common resident at Palo Verde. Occurring as a rule in small groups, it trooped along woodland borders and visited semi-isolated trees, including those beside the ranch houses. Here I saw one push its bill like a chisel to peel bark from a

branch; another, sally successfully for a katydid; a third, burst out of the dense foliage of a citrus tree with the hemispherical nest comb of a colonial wasp in its beak, alight, extricate the larvae from the exposed cells and swallow them.

Campylorhynchus rufinucha (Rufous-naped Wren).

This common resident in the country's north-western quadrant was aptly characterized by Nutting (1883:389-390):

Less fond of low, dense, shubbery than most of its kind, it often nests at a considerable distance from the ground. It is fearless, almost impudent, in its manner, and somewhat inclined to play the bully, in a small way. . . . This Wren seems to be particularly fond of solitary trees along the edge of forest, where he can always be seen hunting his food much in the same manner as do the Titmice of the north. Their number is so great that the woods continually resound with their lively song.

At Palo Verde it occurred almost everywhere except the interior of woodland. Birds moved about in the trees in twos and threes or family-size groups in follow-the-leader fashion, alertly looking left or right every half second. One of the chatters brought to mind that of the congeneric *zonatus* on the Caribbean side, except it was not so rough or rapid.

Thryothorus modestus (Plain Wren). The species hardly penetrates the dry-forested lowlands in Guanacaste. This report from Palo Verde is the only one for the lower Tempisque valley. There I saw or heard birds few times in the wet season and once in the dry season (April).

Thryothorus rufalbus (Rufous-and-white Wren). A woodland resident at Palo Verde, the species was detected more or less regularly by its soft song in all my visits. In March, when the woods were very dry, I did not hear one until a full ten days after my arrival and then only once again.

Thryothorus pleurostictus (Banded Wren). A characteristic dry-forest species, this resident was abundant inside woodland and in shaded cover on the outside. Once in the wet season I noted a bird that had been attracted to army ants in muddy low woodland; the only other attendant was the flycatcher *Contopus cinereus*. The species sang almost incessantly each of my visits. One of the songs, a long-continued choppy affair, included cricket-like rippling sounds of the sort given by neighboring *Campylorhynchus rufinucha*.

Turdus grayi (Gray's Robin). The few data at hand make it appear that this native robin is uncommon to rare in the Guanacaste lowlands and local or seasonal in the lower Tempisque valley. I did not record it at Hacienda Catalina early in the dry season. At Palo Verde I met with it in both dry-season visits, more often in April than in March. Individuals probably remain through the wet season into September, when I found it in 1975 (but not in 1969). The birds were secretive and few in number, at most uttering the call note in the wet season but also the song occasionally in the dry season. I saw them as a rule singly, also in twos (an adult and a subadult at the end of August), in woodland, at wooded edges and nearby in the semi-open.

Catharus ustulatus (Swainson's Thrush). This migrant thrush was seen a few times, once as a small "wave," only during my visit to Palo Verde in the latter part of April. There is apparently no previous report of the species in the lower Tempisque valley. Elsewhere in the Guanacaste lowlands, autumn records are few. In winter (December), I saw several individuals, singly, at Santa Rosa, between Liberia and the Nicaraguan border.

Poliophtila albiloris (White-lored Gnatcatcher). Restricted to the Pacific northwest, this gnatcatcher was present in seasonally unabated abundance at Palo Verde. It occurred almost exclusively in the semi-open, up to the woodland border.

Poliophtila plumbea (Tropical Gnatcatcher). Countrywide in distribution, this gnatcatcher rivaled *albiloris* in abundance at Palo Verde. Occurring regularly inside woods, ecologically it complemented *albiloris* of the neighboring semi-open. The two often met along the woodland edge. It was rather easy to distinguish one from the other by appearance and voice, not by their day-to-day habits.

Ramphocaenus melanurus (Long-billed Gnatwren). The species inhabits both the humid and the dry life zones. At Palo Verde I met it singly as a rule, either inside or alongside woodland and also in protective cover outside woodland. In the dry season the bird uttered a vocalization which was new to me. It consisted of a simple series of several (up to nine or so) successively higher

pitched whistles. Once it was given from up a tree, an unusual place for this gnatwren.

[*Cyclarhis gujanensis* (Rufous-browed Peppershrike). Though recorded a number of times inland from the shores of the Gulf of Nicoya (Slud, 1964:308), the peppershrike is rarely encountered in typical dry-forest surroundings. Years ago I observed a bird, once, at the edge of mangroves at Hacienda Catalina. There is no report from Palo Verde.]

[*Vireo pallens* (Mangrove Vireo). The species was resident in the mangroves at Catalina. I did not find it at Palo Verde, which lacks the habitat.]

Vireo flavifrons (Yellow-throated Vireo). This migrant apparently does not arrive in the Pacific northwest until late autumn. At Palo Verde it still had not appeared when I departed on 17 October 1969. In spring, I saw birds daily in March. Surely included among these were individuals that had been wintering there: the species is known to winter in the Guanacaste lowlands, including nearby Catalina. When I visited in mid-April, the bird was no longer present.

Vireo olivaceus (Red-eyed Vireo). A migrant from the north, it is transient in the lower Tempisque valley as in most of the country. In autumn I noted it at Palo Verde from mid-September onward, but with decreasing frequency, into October. In spring I failed to find the species in March. I did see it later, only twice, in the second half of April, the month in which it reappears most commonly in Costa Rica. Elsewhere I found one in winter (December) at Santa Rosa in the northern Guanacaste lowlands.

Vireo flavoviridis (Yellow-green Vireo). At Palo Verde I recorded the spring arrival of this breeding migrant on 11 March, when individuals were already singing recognizably. In April, birds seemed to be everywhere, many of them breaking out with a rapid set of several successively weaker, double-note, typically *Vireo*-like phrases. This outburst was often accompanied by a spreading of the tail and a twisting of the crissum to either side, as in display. In autumn, the species was singing with decreasing frequency by early September 1975. In 1969, *flavoviridis* occurred together with *olivaceus* and came to outnumber it in October.

Vireo philadelphicus (Philadelphia Vireo). Philadelphia Vireos were noted only during my March visit, singly as a rule but once as a small group. These spring birds probably had been spending the winter at Palo Verde as I had previously found the species at that time of year at neighboring Catalina. Its absence during my visits in autumn (to mid-October) and in late spring (second half of April) agreed with its reported status as a migrant that arrives in the country late in the fall and leaves before mid-April (Slud, 1964:312).

Hylophilus decurtatus (Gray-headed Greenlet). An abundant resident, this active species could be seen and heard daily as it moved through the trees in small pure groups both inside and a little outside woodland. In habits, appearance, and voice the birds at Palo Verde were indistinguishable from those in the country's humid life zones.

[*Hylophilus* sp. During my rainy season visit in 1975, two greenlets that were new to me were foraging leisurely amid the foliage of a leafy tree in boggy low woods at the "beehives." Visually, the two were alike and could have passed for neighboring *H. decurtatus*, except for being unicolorous greenish above and completely lacking the latter's gray "hood" and whitish eye-ring. They could, in fact, have passed for *H. minor* of eastern Panama. Vocally, the birds kept repeating a measured, toylike "tlink tlenk" that was responsible for drawing my attention to them in the first place. Not only was this iterated little utterance distinctive in its own right but it bore no resemblance to anything I had ever heard from gray-headed *decurtatus*. Their occurrence as an isolated "pair" and relatively slow-paced activity also set them apart from gregarious and lively *decurtatus* (above).]

Cyanerpes cyaneus (Red-legged Honeycreeper). This honeycreeper was unexpectedly scarce at Palo Verde. Meetings with it took place outside woodland proper, either inside or at the borders of scrubby, sparsely treed tracts. I noted it seldom in the wet season. One observation was of a pair with two fledglings (4 September); another, a female-plumaged group that included dark-winged individuals and was taking tiny berries. In the dry season I saw it occasionally, including a pair with a begging immature on 1 May.

Mniotilta varia (Black-and-white Warbler). The only bird I saw at Palo Verde was an autumn migrant searching limbs in a grove of tall leafy trees. The species no doubt winters in the lower Tempisque valley, as I found it at that time of year at neighboring Catalina.

[*Protonotaria citrea* (Prothonotary Warbler). Though not reported from Palo Verde, this warbler may occur there during transience. In winter it has been recorded upstream at Bolsón (Carriker, 1910:817), and I found it downstream in the mangroves at Hacienda Catalina.]

Vermivora peregrina (Tennessee Warbler). This migrant warbler had not appeared at Palo Verde by the time I left in the third week of October 1969. Farther north at Liberia, Wetmore (1944:71) found it on 25 October, apparently the earliest fall date for the Guanacaste lowlands. As a winterer the bird is common to abundant throughout the dry-forested northwest. In the lower Tempisque valley, I had met with it early in the dry season at Catalina, Paul Opler observed it later, in February, at Palo Verde. In spring at Palo Verde, I noted it irregularly, both singly and as a small flock, in March but not at all in the second half of April.

Dendroica petechia (Yellow Warbler). This wintering migrant (belonging to the *aestiva* group) was the dominant nonforest warbler at Palo Verde during each of my visits. It was still passing through in mid-September, when a small "wave" appeared on the 14th, and individuals could be seen well up in the trees the next day. In spring, birds were singing by 19 April, a few days after my arrival. [The distinctive resident population (belonging to the *petechia* group) which inhabits the mangroves at Catalina, I did not find at Palo Verde.]

Dendroica magnolia (Magnolia Warbler). Previously I had seen this uncommon or irregular migrant early in December at Catalina. At Palo Verde, twice I observed individuals, only in March, which could have been wintering there. They exhibited an unusual, side-to-side twisting of the tail in the manner of some euphonias.

[*Dendroica coronata* (Yellow-rumped Warbler). I did not find the "Myrtle" warbler at Palo Verde in autumn or spring. It is surely bound to occur

there in winter as at that time of year I had collected one downriver at Catalina and another in the vicinity of Santa Cruz on the peninsular side of the Tempisque basin.]

Dendroica fusca (Blackburnian Warbler). This migrant was noted in transience outside woodland around mid-September in both wet-season visits and again rather late in spring (19 April). I know of no other report from the Guanacaste lowlands proper. Elsewhere in the northwest, however, I found the species once in autumn on the mainland side of the entrance to the Gulf of Nicoya.

[*Dendroica pensylvanica* (Chestnut-sided Warbler). In the lower Tempisque valley this migrant has been recorded once, in mid-December, at Bolsón (Carriker, 1910:808), and also overlooking the valley at Hacienda Ciruelas (Paul Opler, *in litt.*). Apparently avoiding the typically dry associations, the species is known to have occurred at several places in the northwestern lowlands under more effectively humid conditions.]

Seiurus aurocapillus (North American Ovenbird). At Palo Verde I met this migrant once in autumn (15 October); in spring, three different times in March and three successive days in the latter part of April. The observations were made inside and at the border of woodland. This species almost surely occurs also in winter.

Seiurus noveboracensis (Northern Waterthrush). I observed this waterthrush in woods several times during the fall migration onward from the middle of September. In spring I saw the species twice in March, not at all in my April visit. In winter it has been found farther up the Tempisque valley at Bolsón (Carriker, 1910:805), and I met with it farther down at Catalina. Undoubtedly it winters at Palo Verde, too.

[*Seiurus motacilla* (Louisiana Waterthrush). This waterthrush was identified at Palo Verde in February 1974 by Paul Opler on the basis of the color of the eye-stripe and of the underparts, features which do not necessarily remove it from the range of variation shown by *S. noveboracensis*. Previously, I had identified one by its tawny flanks the last week in August near the waterfall at Hacienda Ciruelas (Slud, 1965). The species should be expected at Palo Verde, perhaps only during migration.]

Oporornis formosus (Kentucky Warbler). I saw a bird only once and then not until 17 September during my wet-season visit in 1975. It was keeping to the understory in woodland.

Oporornis philadelphia (Mourning Warbler). Previously I had found this migrant warbler wintering at Catalina. At Palo Verde I observed it a number of times in autumn (mid-September to early October), always in low cover outside woodland. I did not meet with it in spring. These seem to be the only reports for the northwest Pacific lowlands.

Geothlypis poliocephala (Central American Yellowthroat). The species was resident but not common at Palo Verde. It was most noticeable the first two weeks in September during my wet-season visit in 1975, when individuals were singing leisurely and at length. The song perches were fairly well up a tree in savanna-like surroundings or sometimes beside the woodland edge.

Wilsonia canadensis (Canada Warbler). The Canada Warbler is a transient in Costa Rica. At Palo Verde it occurred only in the fall, arriving near the middle of September in both my wet-season visits. In 1969, one to several individuals could be seen almost daily inside or outside woodland the first ten days of my visit, then only twice more until I departed in mid-October. I find no other report for the Guanacaste lowlands.

Setophaga ruticilla (American Redstart). I noted this migrant a few times, only around the middle of September, in each wet-season visit. The species will surely be found in winter at Palo Verde, having been reported then at neighboring Bolsón and Catalina, as well as in spring.

Basileuterus rufifrons (Rufous-capped Warbler). This resident was the only member of its family to occur commonly in woodland each of my visits. For the most part, it was a noisy inhabitant of the middle and lower strata.

Molothrus aeneus (Red-eyed Cowbird). The status of the species in the dry-forested northwest could be that of a wanderer. At Palo Verde I saw a bird a couple of times in dry pastures beside the Río Tempisque in the latter part of April and once at a swampy opening near the Río Tempisque in the vicinity of the "beehives." Elsewhere in lowland Guanacaste, I find it recorded only from

Bebedero and Hacienda La Palma at the head of the Gulf of Nicoya.

Quiscalus mexicanus (Great-tailed Grackle). The "sanate" is probably resident in the area. In my wet-season visits to Palo Verde, I met with it only twice, a single bird and a group in a treetop near the cattle pens, in 1969. In 1975, birds stopped more or less regularly in the trees lining the Tempisque during their late-afternoon flights downriver, presumably to a communal roost. In the dry season, Paul Opler recorded it in January and February. Later, in March and April, I found it not uncommon, particularly on the open valley floor beside the Tempisque.

Icterus spurius (Orchard Oriole). In 1969, this early migrant was already present when I arrived in mid-September, and I saw it commonly until the flooding by the Tempisque in October. In 1975, I encountered only a single group at the overgrown bank of the Río Tempisque opposite Puerto Humo. The species probably winters at Palo Verde as it is known to do so elsewhere in the Guanacaste lowlands, including nearby Catalina. I did not see it in either of my visits in spring.

Icterus pectoralis (Spot-breasted Oriole). Though widely reported from the dry-forested Pacific northwest in the literature, the species had been known in the lower Tempisque valley only from the twin localities of Ballena (UMMZ 150666) and Bolsón (Carriker, 1910:829). At Palo Verde, I did not find it until my wet-season visit in 1975. Two male-plumaged individuals were foraging together silently in the trees of an open copse between an overgrown marsh and the bend of the Río Tempisque at the "beehives."

Icterus galbula (Northern Oriole). I first noticed "Baltimore" orioles at the beginning of October, when they soon became common. These autumn birds uttered a chatter much like that of a neighbor, the wren *Thryothorus pleurostictus*. Presumably the species is common in winter. I had found it in the past at Catalina and Paul Opler more recently at Palo Verde. In spring, I saw it regularly at Palo Verde in March. In my April visit it was present through the 21st, then disappeared.

Icterus pustulatus (Streak-backed Oriole). Judging by past records, *I. pustulatus* widely overlaps the

range of congeneric *pectoralis* in the country's Pacific northwest. *I. pustulatus*, however, has not been recorded south of the head of the Gulf of Nicoya, at least on the mainland side. Further, *pustulatus* is the one normally seen in the drier parts of Guanacaste; in the lower Tempisque valley, *pustulatus* is widespread and common, *pectoralis* is rare. At Palo Verde, *pustulatus* was one of the very common, nonforest, arboreal residents. Whether alone or in twos, it was visually and vocally conspicuous each of my visits. Often a bird drew my eye as it interacted with another individual. I dared not always guess the sex of a partner: in this species intensity of hue is not necessarily a reliable indicator.

In the wet season, birds were singing and displaying. Song was of two sorts: one, sparrowlike chirrups joined into either a simple singsong or a not dissimilar set of jerky up-and-down, yet fairly sweet and rather leisurely given, chirking notes; the other, an unhurried, clear "weet meet-you" (the "weet" or the "meet-you" either doubled or not) that brought to mind a sweet-singing grosbeak. The chatter was also of two kinds: one, essentially a broken single note, was heavy, even, and short; the other, a smooth wren-like churr, was associated with courting birds. Display began as one bird settled near another already in place, say, on a barbed-wire fence. The new arrival arched its head and neck upward and back, simultaneously raising the tail and bringing it forward, until the bird appeared bent like a bow. This it repeated several times, like an exercise.

In the dry season, the "meet-you" had changed into a lazy "weeta weeta" type of song. The jerky, measured singsong was now intermixed with musical notes and not unlike one given by its Caribbean congener *mesomelas*. In March, I observed two birds in the branches of a tree, this time in mutual display. They took turns in stretching the body upward at a slant, then depressing the front part of the body and elevating the hindquarters. With the legs as fulcrum and the body stiff and straight from tip of bill to end of tail, the birds alternately teetered up and down like seesaws. In my April visit, they had apparently formed into pairs, and individuals were singing, fighting, or toting nest material. Among items entering the

diet, large insects played a conspicuous though perhaps seasonal part. At any rate, birds were picking at big grasshoppers, including one pulling the legs off a katydid.

Agelaius phoeniceus (Red-winged Blackbird). In the wet season of 1969, I occasionally spied a male flying low over the aquatic vegetation or rising to pester a Snail Kite (*Rostrhamus*). Slogging through a waterlogged pasture adjacent to the Tempisque, I witnessed the strange sight of a mixed flock of young males and female-plumaged individuals "leapfrogging" along en masse as the birds in back flew over low and kept replacing those in front. After the river inundated the valley floor in October, I noted the species very infrequently. In 1975, when it was not so wet, the birds were rather common and there was no need to wait patiently in hope of seeing one. Early in the dry season redwings had been seemingly few in number and widely scattered at Catalina. At Palo Verde, Paul Opler met with the species later, in January and February. Still later, both in March and April, I found scores of individuals, mostly adult males, concentrated at an overgrown marshy spot traversed by a meandering streamlet close to the Tempisque. Heard from a distance, they produced a confused, noisy hubbub. Closer, their resonant "oke-alee"'s, turning buzzy on the last syllable, became recognizable.

Sturnella magna (Common Meadowlark). In the fifties I found the species more or less regularly during my early dry-season visits to Hacienda Catalina. At Hacienda Ciruelas, overlooking the Tempisque valley, I noted several birds at an extremely dry time of year, in April. At Palo Verde, the only bird I saw in my wet-season visit in 1969 had taken refuge in a partially submerged tree in the deeply inundated fields facing the hacienda. In February, Paul Opler found this species common in the drying sedges situated between the seasonal marshes and the river.

Euphonia affinis (Scrub Euphonia). This euphonia was a common nonforest resident at Palo Verde. Sometimes it occurred in the woodland canopy, and once (30 September) I noted a pair gathering nest material above a streamlet in a patch of low woods. Apparently the species is not entirely frugivorous as I saw a bird with a large grass-

hopper in its bill. In addition to the thinly whistled "be-be" call, so suggestive of a chickadee's (e.g., *Parus carolinensis*), it gave a mouth-puckered "chee-chee" (or "tsee-tsee"), a wistful minor whistle, and a conversational, rapid, "spinking" chatter like that of a small finch. Birds also uttered a weak twittering song, a rapid flycatcher-like "ts-tsairoo" (the "air" long and buzzy), and an unclear four-note call of the sort given by the Caribbean *E. gouldi*.

Euphonia hirundinacea (Bonaparte's Euphonia).

The distribution of this euphonia thins out in typically dry-forested areas in the northwest. In the lower Tempisque valley, it had been reported previously only from Bolsón. At Palo Verde, I did not meet with it until the wet season of 1975. This time I found a few birds, both singly and in twos, in two well-separated wooded tracts. My attention was first drawn to the species by a bell-like "pik-ik" given repeatedly by a subadult male.

[*Thraupis episcopus* (Blue Tanager). Though this is a common tanager in many of the disturbed parts of the country, it is found seldom in the dry-forested portions of the northwest. In the lower Tempisque valley, it has been reported only from Bolsón (Carriker, 1910:857).]

Piranga rubra (Summer Tanager). In the northwestern lowlands, this migrant arrives regularly, but apparently late and in small numbers, in autumn. Wetmore (1944:77) recorded it on 24 October near Liberia. I first saw one (a changing male) on 16 October at Palo Verde. Previously I had found it wintering at Catalina, hence I assume it does so, too, at Palo Verde. In spring it could be seen most days during the first half of my stay in March but seldom thereafter. It was not present the second half of April.

Piranga olivacea (Scarlet Tanager). I noted this transient at Palo Verde on 13 October and on 18 and 19 April, each time in woodland. The fact that the species evidently passes through the northwestern lowlands, if only in small numbers, both in spring and in fall seems not to have been previously noted.

Piranga ludoviciana (Western Tanager). During my autumn and spring visits to Palo Verde, I saw a bird only once (15 September). I suspect that the

species occurs regularly in winter in the Catalina-Palo Verde area as I had seen it there early in the dry-season (beginning of December).

[*Habia rubica* (Red-crowned Ant-Tanager). In all of the dry-forested Guanacaste lowlands the species has been recorded only at Bolsón (Carriker, 1910:843) in the lower Tempisque valley and at Bagaces (Carriker, 1910:842) in the Bebedero drainage. Apparently its true range in the northwest lies on either side of the Tempisque depression.]

Eucometis penicillata (Gray-headed Tanager). An inhabitant primarily of the Pacific slope in Costa Rica, the species is at its sparsest in the lower Tempisque valley, whence recorded previously from Bolsón. At Palo Verde, I found it only in my wet-season visit in 1975, when it was not rare. I met with it several times, both singly and as a small group, in separated patches of woodland.

[*Saltator coerulescens* (Grayish Saltator). In the Pacific northwest, the species has been known primarily from the shores of the Gulf of Nicoya inland to the Tempisque and Bebedero drainages, also from a scattering of places mostly outside typical dry-forest surroundings. Along the lower Tempisque it has been recorded only from Bolsón (AMNH 123730).]

Pheucticus ludovicianus (Rose-breasted Grosbeak).

At Palo Verde, I saw one of these migrant grosbeaks once, in autumn, taking refuge on a small tree in an inundated marsh. Previously I had found it in winter (early dry season) at Catalina.

Guiraca caerulea (Blue Grosbeak). Records of the resident race, *lazula*, in lowland Guanacaste are few. In the lower Tempisque-Bebedero drainage, it is apparently known only from Palo Verde, where I met with it, and Taboga, where recorded by M. S. Foster (*in litt.*). At Palo Verde I found single birds of either sex a few times in the wet season in 1975 (but not in 1969) in low ground cover in pastures. In the latter part of the dry season I found one once, a singing male, in March. The song was sprightly but neither mellow nor particularly musical. In April I met the species three times. At least two pairs were present, the males of which were singing, as usual, from arboreal perches. The diagnostic metallic "chink" was given at both times of year.

Passerina cyanea (Indigo Bunting). At Palo Verde I noted this migrant only in March, a small group composed entirely of female-plumaged individuals. The birds were loitering in a bit of disturbed open woodland, keeping low in the cover of young second growth but sometimes well up in the trees. In winter, the species has been recorded upstream at Bolsón (Carriker, 1910:886), and I would expect it then at Palo Verde, too.

[*Passerina ciris* (Painted Bunting). This migrant is known in winter from Catalina (where I met with it) and Bolsón (Carriker, 1910:885) on either side of Palo Verde, also above it at Ciruelas (P. Opler, *in litt.*).]

Spiza americana (Dickcissel). During my autumn (wet-season) visits to Palo Verde, Dickcissels appeared in flocks and sometimes singly throughout the month of September. In spring, I noted returning birds only once (19 April). At a corresponding date (18–21 April) they were reported migrating by the thousands at Hacienda Taboga (Orians and Paulson, 1969:430). A little later (1 May), Nutting (1883:391–392) encountered a large flock at Hacienda La Palma. On the Caribbean slope I observed a procession of small groups, often only three or four birds at a time, migrating the first week in April 1965 through the San Carlos lowland near Nicaragua. Evidently Dickcissels pass northward through Costa Rica in aggregations in spring. Whether they reappear annually in similar abundance or on the same dates or at the same places is not known.

Sporophila torqueola (White-collared Seedeater). This is the common *Sporophila* in the seasonally dry northwest. At Palo Verde, it was common in the wet season. Males were singing freely, often from conspicuous perches, on bushes and shrubs and as high as 40 feet in the crowns of trees. One that had been singing and fluttering his wings at a female sharing the same telephone wire was in turn pursued by her. Each time he maintained his distance by flying off a bit farther.

In the dry season, a small flock that lacked even a single bright male could generally be found at a grassy and shrubby, dry opening in March. The one adult male that I saw this trip was frequenting taller, leafier growth chosen by a group of

Passerina cyanea (mentioned above). In the latter part of April, however, I saw males in breeding plumage. These were either intermixed with duller individuals or keeping together as a group of their own. In both late dry-season visits to Palo Verde, just as in the early dry season years ago at Catalina, this was the only *Sporophila* I found.

Sporophila americana (Variable Seedeater). At Palo Verde, this widespread species is represented by the race *aurita*, which is restricted to the Pacific slope from southern Guanacaste to central Panama. I met with it only in the wet season. In 1969 adult males were singing from exposed perches (as were those of the more abundant *S. torqueola*) and uttering flight songs at the same time that young birds were moving about in groups below them. In 1975 the only bird I saw was a wary female in bushy growth beside a lane in disturbed woodland.

Volatinia jacarina (Blue-black Grassquit). In 1969–1971, grassquits in small numbers were to be met regularly at Palo Verde. For the most part they were frequenting low cover outside woodland, but an occasional individual could be found partway along a shaded trail in open woodland. In my wet-season visit in 1975, the species was common in open, disturbed parts of the woods. Many males were “singing,” some of them performing their somersault, others not. One was even displaying 30 to 35 feet up in the crown of a completely bare tree.

Arremonops rufivirgatus (Olive Sparrow). This was a common resident at Palo Verde, where it occurred in woodland of almost any description, preferably the shrubby, disturbed portions. Birds were singing during my wet-season and dry-season visits. The species is common through much of the country's northwestern quadrant yet is unknown on the Pacific slope north of Costa Rica until it reappears in southern Mexico.

Aimophila ruficauda (Russet-tailed Sparrow). A uniformly abundant inhabitant of broken growth in nonforest situations, the species seldom breached the woodland border. A notable mannerism was a high lifting of the tail as though the bird were about to tip over when coming to a stop on a perch.

Hypothetical List

A number of additional native species, almost all of them land birds, have been reported within a radius of 30 kilometers of Palo Verde. Some will probably be found there eventually. A few may even be present in habitat pockets I could not reach and of which I was not aware. For example, certain species of the humid life zones reside and others have occurred only or primarily in the edaphic evergreen type of associations known from the well-worked Taboga area (Plates 5–7). Some of these and others would reach Palo Verde as rare wanderers or strays at best. The list is hypothetical in the sense that it contains a range of possibilities rather than species which have been uncertainly detected or whose actual presence at Palo Verde there has been reason to suspect.

Crypturellus soui (Little, or Pileated, Tinamou)
Elanoides forficatus (Swallow-tailed Kite)
Ictinia plumbea (Plumbeous Kite)
Accipiter bicolor (Bicolored Hawk)
Spizastur melanoleucus (Black-and-white Hawk-Eagle)
Heliornis fulica (Sungrebe or American Finfoot)
Aratinga finschi (Finsch's Parakeet)
Amazona autumnalis (Red-lored Amazon-Parrot)
Lophostrix cristata (Crested Owl)

Ciccaba virgata (Mottled Owl)
Ciccaba nigrolineata (Black-and-white Owl)
Nyctibius griseus (Common Potoo)
Caprimulgus cayennensis (White-tailed Nightjar)
Chaetura vauxi (Vaux's Swift)
Florisuga mellivora (Jacobin Hummingbird)
Heliomaster longirostris (Long-billed Starthroat)
Trogon massena (Massena Trogon)
Trogon rufus (Graceful Trogon)
Malacoptila panamensis (White-whiskered Puffbird)
Ramphastos sulfuratus (Keel-billed Toucan)
Xiphorhynchus guttatus (Buff-throated Woodhewer)
Thamnophilus bridgesi (Bridges' Antshrike)
Cercomacra tyrannina (Tyrannine Antbird)
Gymnocichla nudiceps (Bare-crowned Antbird)
Myrmeciza exsul (Sclater's Antbird)
Hylophylax naevioides (Spotted Antbird)
Pachyramphus albogriseus (Black-and-White Becard)
Muscivora tyrannus (Fork-tailed Flycatcher)
Myiobius atricaudus (Black-tailed Myiobius)
Pipromorpha oleaginea (Oleaginous Pipromorpha)
Psilorhinus morio (Brown Jay)
Thryothorus rutilus (Rufous-breasted Wren)
Troglodytes musculus (Tropical House-Wren)
Basileuterus fulvicauda (Buff-rumped Warbler)
Zarhynchus wagleri (Wagler's Oropendola)
Gymnostinops montezuma (Montezuma Oropendola)
Habia fuscicauda (Dusky-tailed Ant-Tanager)
Saltator maximus (Buff-throated Saltator)
Cyanocompsa cyanoides (Blue-black Grosbeak)
Arremon aurantirostris (Orange-billed Finch)

Literature Cited

- Blake, Emmet R.
1977. *Manual of Neotropical Birds*. Volume 1. Chicago and London: The University of Chicago Press.
- Bourgeois, W. W., D. W. Cole, H. Riekerk, and S. P. Gessel
1972. Geology and Soils of Comparative Ecosystem Study Areas, Costa Rica. *College of Forest Resources, University of Washington, Tropical Forestry Series*, number 11.
- Bussing, William A.
1976. Geographic Distribution of the San Juan Ichthyofauna of Central America with Remarks on Its Origin and Ecology. In Thomas B. Thorson, editor, *Investigations of the Ichthyofauna of Nicaraguan Lakes*, chapter 10. Lincoln, Nebraska: School of Life Sciences, University of Nebraska.
- Carriker, M. A., Jr.
1910. An Annotated List of the Birds of Costa Rica, Including Cocos Island. *Annals of the Carnegie Museum*, 6:314-915.
- Chapin, James P.
1932. The Birds of the Belgian Congo, Part 1. *Bulletin of the American Museum of Natural History*, volume 65.
- Coen P., Elliott
1953. La Meteorología de Costa Rica. In *Atlas Estadístico de Costa Rica*, pages 34-37, San José, Costa Rica: Ministerio de Economía y Hacienda, Dirección General de Estadística y Censos.
- Dickerman, Robert W.
1971. Further Notes on Costa Rican Birds. *Condor*, 73: 252-253.
- Dickey, Donald R., and Adriaan J. van Rossem
1938. The Birds of El Salvador. *Field Museum of Natural History, Zoological Series*, volume 123.
- Edwards, Ernest P.
1972. *A Field Guide to the Birds of Mexico*. Sweet Briar, Virginia: Ernest P. Edwards.
- Ferrero, Luis
1977. *Costa Rica Precolombina*. Second edition, San José, Costa Rica: Editorial Costa Rica.
- Foster, Mercedes S.
1975. The Overlap of Molting and Breeding in Some Tropical Birds. *Condor*, 77:304-314.
- Frankie, Gordon W., Herbert G. Baker, and Paul A. Opler
1974. Comparative Phenological Studies of Trees in Tropical Wet and Dry Forests in the Lowlands of Costa Rica. *Journal of Ecology*, 62:881-919.
- Friedmann, Herbert, and Foster D. Smith, Jr.
1950. A Contribution to the Ornithology of Northeastern Venezuela. *Proceedings of the United States National Museum*, 100:411-538.
1955. A Further Contribution to the Ornithology of Northeastern Venezuela. *Proceedings of the United States National Museum*, 104:463-524.
- Goodwin, Derck
1967. *Pigeons and Doves of the World*. London: Trustees of the British Museum (Natural History).
- Griscom, Ludlow
1940. Origin and Relationships of the Faunal Areas of Central America. *Proceedings of the 8th American Scientific Congress*, 3:425-430.
- Hall, E. Raymond, and Keith R. Kelson
1959. *The Mammals of North America*. 2 volumes. New York: Ronald Press Co.
- Holdridge, Leslie R.
1953. La Vegetación de Costa Rica. In *Atlas Estadístico de Costa Rica*, pages 32-33. San José, Costa Rica: Ministerio de Economía y Hacienda, Dirección General de Estadística y Censos.
- 1959a. *Mapa Ecológico de El Salvador (1:1,000,000)*. Turrialba, Costa Rica: Interamerican Institute of Agricultural Sciences.
- 1959b. *Mapa Ecológico de Guatemala, A.C. (1:1,000,000)*. Turrialba, Costa Rica: Interamerican Institute of Agricultural Sciences.
- 1962a. *Mapa Ecológico de Honduras (1:1,000,000)*. Washington, D.C.: Organization of American States.
- 1962b. *Mapa Ecológico de Nicaragua, A.C. (1:1,000,000)*. Managua, Nicaragua: United States Agency for International Development.
1972. Ecological Differences Between the Tropical and Subtropical Regions. In *Memorias de Symposia del I Congreso Latinoamericano y V Mexicano de Botánica, 3-9 Dic 1972*, pages 431-436. Mexico City: Sociedad Botánica de Mexico. S. C.
- Holdridge, Leslie R., William C. Grenke, William H. Hatheway, Ta Liang, and Joseph A. Tosi, Jr.
1971. *Forest Environments in Tropical Life Zones: A Pilot Study*. Oxford: Pergamon Press.
- Istituto Geografico de Agostina
1968. *Mapa de la República de Costa Rica*. Novara, Italy: Istituto Geografico de Agostina S. p. A.
- James, Preston E.
1959. *Latin America*. Third Edition. New York: The Odyssey Press.
- Johnsgard, Paul A.
1965. *Handbook of Waterfowl Behavior*. Ithaca, New York: Cornell University Press.
- Kahl, M. Philip
1971. Social Behavior and Taxonomic Relationships of the Storks. In *The Living Bird, Tenth Annual of*

- the Cornell Laboratory of Ornithology*, pages 151-170.
- Lanyon, Wesley E.
1978. Revision of the *Myiarchus* Flycatchers of South America. *Bulletin of the American Museum of Natural History*, 161:427-628.
- Mangelsdorf, Paul C., Richard S. MacNeish, and Gordon R. Willey
1964. Origins of Agriculture in Middle America. In Robert C. West, editor, *Handbook of Middle American Indians*, volume 1, chapter 13. Austin: University of Texas Press.
- Marchant, Stephen
1958. The Birds of the Santa Elena Peninsula. *Ibis*, 100: 349-387.
- Meyer de Schauensee, Rodolphe
1970. *A Guide to the Birds of South America*. Wynnewood, Pennsylvania: Livingston Publishing Company, for the Academy of Natural Sciences of Philadelphia.
- Miller, Robert R.
1966. Geographical Distribution of Central American Freshwater Fishes. *Copeia*, 1966(4):773-802.
- Monroe, Burt L., Jr.
1968. A Distributional Survey of the Birds of Honduras. *American Ornithologists' Union, Ornithological Monographs*, number 7.
- Nutting, Charles C.
1883. On a Collection of Birds from the Hacienda "La Palma," Gulf of Nicoya, Costa Rica, with Critical Notes by Robert Ridgway. *Proceedings of the United States National Museum*, 1882, 5:382-409.
- Organization for Tropical Studies
1972. Field Stations of the Organization for Tropical Studies. South Miami, Florida: Organization for Tropical Studies.
- Orians, Gordon H., and Dennis R. Paulson
1969. Notes on Costa Rican Birds. *Condor*, 71:426-431.
- Palmer, Ralph S., editor
1976. *Handbook of North American Birds*. Volume 2. New Haven and London: Yale University Press.
- Quiros A., Tulia
1954. *Geografía de Costa Rica*. San José, Costa Rica: Instituto Geográfico de Costa Rica.
- Ridgway, Robert
1911. The Birds of North and Middle America, Part 5. *United States National Museum Bulletin*, number 50.
- Ryan, R. Mark
1963. The Biotic Provinces of Central America as Indicated by Mammalian Distribution. *Acta Zoologica Mexicana*, 6(2-3):1-54.
- Savage, Jay M.
1966. The Origin and History of the Central American Herpetofauna. *Copeia*, 1966(4):719-766.
- Sawyer, John O., and Alton A. Lindsey
1971. Vegetation of the Life Zones in Costa Rica. *Indiana Academy of Sciences Monograph*, number 2.
- Servicio Meteorológico
1965. *Anuario Climatológico*. San José, Costa Rica: Ministerio de Agricultura y Ganadería.
- Skutch, Alexander F.
1949. Life History of the Ruddy Quail-Dove. *Condor*, 51:3-19.
1954. Life History of the Tropical Kingbird. *Proceedings of the Linnaean Society of New York for 1951-53*, 63-65:21-38.
1960. Life Histories of Central American Birds, II. *Pacific Coast Avifauna*, number 34.
- Slud, Paul
1957. Cattle Egret in Costa Rica. *Condor*, 59:400.
1964. The Birds of Costa Rica: Distribution and Ecology. *Bulletin of the American Museum of Natural History*, volume 128.
1965. Report on the Ornithological Portion of the W/NRE Ecological Investigation in Costa Rica. In *Research on a Bio-ecological Classification for Military Environments Found in Tropic Latitudes*, chapter 7. Chestertown, Maryland: Wilson, Nuttall, Raimond Engineers, Incorporated.
1976. Geographic and Climatic Relationships of Avifaunas with Special Reference to Comparative Distribution in the Neotropics. *Smithsonian Contributions to Zoology*, number 212.
- Stiles, F. Gary, and Susan M. Smith
1977. New Information on Costa Rican Waterbirds. *Condor*, 79:91-97.
- Stone, Doris
1966. Synthesis of Lower Central American Ethnohistory. In G. F. Ekholm and G. R. Willey, editors, *Handbook of Middle American Indians*, volume 4, chapter 10. Austin: University of Texas Press.
- Stuart, Laurence C.
1964. Fauna of Middle America. In Robert C. West, editor, *Handbook of Middle American Indians*, volume 1, chapter 9. Austin: University of Texas Press.
1966. The Environment of the Central American Cold-blooded Vertebrate Fauna. *Copeia*, 1966(4):684-699.
- Suter, Christoph
1969. Von der Vogelwelt der Hacienda La Pacifica. *CIBA-Blättern*, 223 (Sep-Oct 1969):33-41.
- Tosi, Joseph A., Jr.
1969. *Mapa Ecológico de la República de Costa Rica*. San José, Costa Rica: Centro Científico Tropical.
- Underwood, Cecil F.
1896. A List of Birds Collected or Observed on the Lower, Southern, and South-western Slopes of the Volcano of Miravalles and on the Lower Lands Extending to Bagaces in Costa Rica, with a Few Observations on Their Habits. *Ibis*, 1896:431-451.
- Wagner, Phillip L.
1958. Nicoya: A Cultural Geography. *University of California Publications in Geography*, 12:195-250.
1964. Natural Vegetation of Middle America. In Robert C. West, editor, *Handbook of Middle American Indians*, volume 1, chapter 7. Austin: University of Texas Press.

West, Robert C.

1964. Surface Configuration and Associated Geology of Middle America. In Robert C. West, editor, *Handbook of Middle American Indians*, volume 1, chapter 2. Austin: University of Texas Press.

Wetmore, Alexander

1944. A Collection of Birds from Northern Guanacaste, Costa Rica. *Proceedings of the United States National Museum*, 95:25-80.
1965. The Birds of the Republic of Panamá, Part 1. *Smithsonian Miscellaneous Collections*, volume 150.
1968. The Birds of the Republic of Panamá, Part 2. *Smithsonian Miscellaneous Collections*, volume 150.
1972. The Birds of the Republic of Panamá, Part 3. *Smithsonian Miscellaneous Collections*, volume 150.

Wolf, Larry L.

1966. Notes on Costa Rican Birds. *Condor*, 68:400-401.
1970. The Impact of Seasonal Flowering on the Biology of Some Tropical Hummingbirds. *Condor*, 72:1-14.

Zeledón, José C.

1885. Catalogue of the Birds of Costa Rica, Indicating Those Species of Which the United States National Museum Possesses Specimens from That Country. *Proceedings of the United States National Museum*, 8:104-118.
1887. Catálogo de las aves de Costa Rica, con indicación de las especies, localidades y número de ejemplares contenidos en la colección del Museo Nacional. *Anales del Museo Nacional de Costa Rica*, 1:103-133.

Plates



PLATE I.—Cattle lands rising toward Guanacaste Cordillera; note spreading guanacaste tree (*Enterolobium cyclocarpum*) on right.



PLATE 2.—Guanacaste cattle lands: *a*, partially cleared, plains type of country;
b, view along Inter-American Highway.



PLATE 3.—Hacienda Ciruelas; example of degraded ranch lands in dry season: *a*, pastures near the "central," continental divide seen in distance; *b*, dried-out pasture and scrubby low woods.



PLATE 4.—Scrubby pastures late in dry season; note flowering leafless branches attractive to hummingbirds.



PLATE 5.—Mixed stand on high water-table, flat, alluvial plain, occasionally flooded in wet season; similar to Site 6 (see "Physiognomy").



PLATE 6.—Dry-season approach to edaphically moist Site 7 (see "Physiognomy").



PLATE 7.—Edaphically moist "cathedral" forest at Site 7 (see "Physiognomy") in dry season: note evergreen appearance and leaf fall covering the ground.

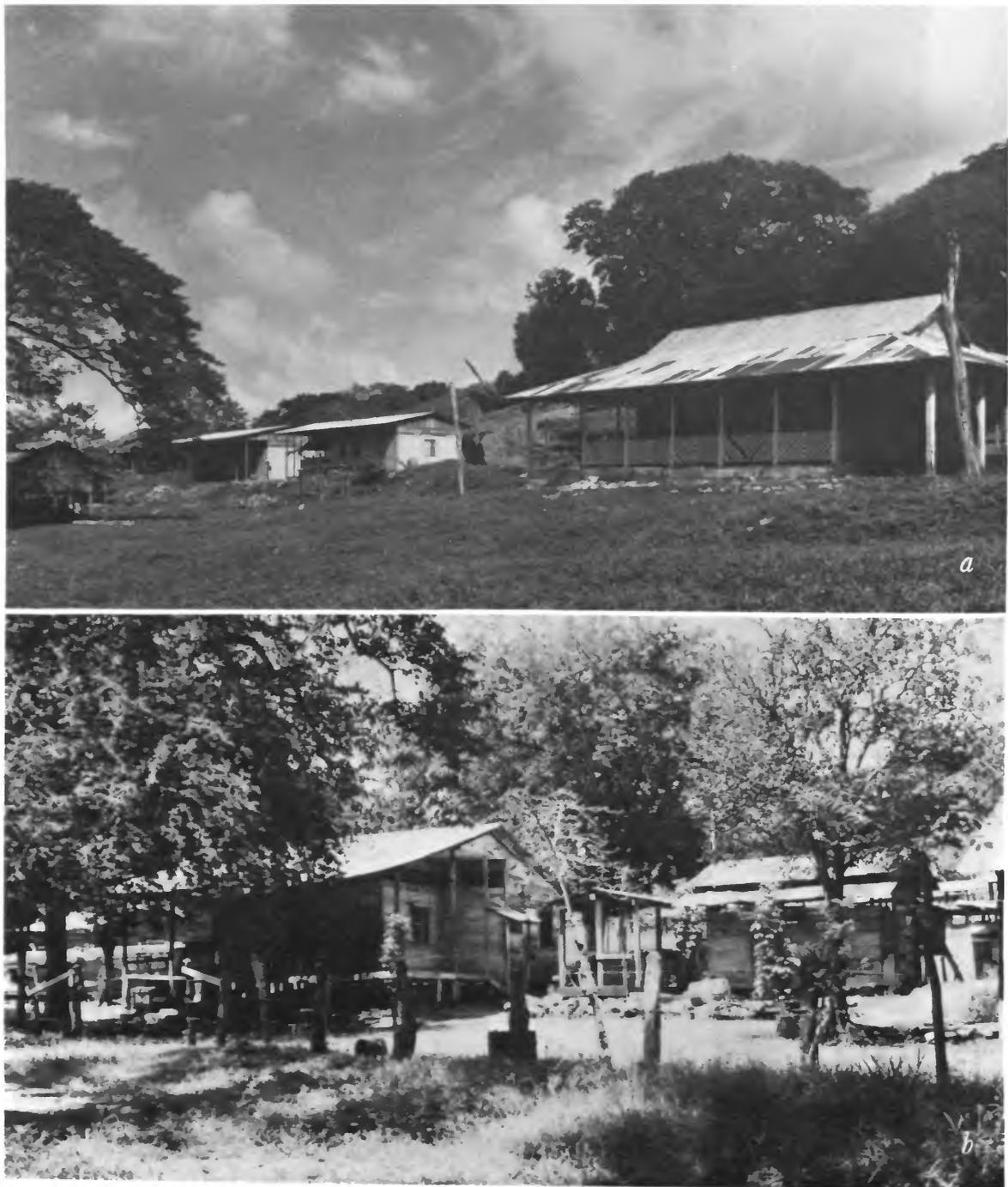


PLATE 8.—Palo Verde: *a*, original hacienda (right) and recent structures (left); *b*, site of "beehives" (see Figure 4), now abandoned.



PLATE 9.—Palo Verde: *a*, OTS building under construction, 1970; *b*, airstrip with marshes on right, Cerros de Catalina in distance.



PLATE 10.—Palo Verde, Cerro Guayacán.



PLATE 11.—Palo Verde, eastern extremity of Cerro Guayacán: *a*, dry season; *b*, wet season.



PLATE 12.—Palo Verde, wet-season marshes viewed from hacienda: *a*, mid-September 1969; note Cattle Egrets (*Bubulcus*) on crowns of trees and attending cattle; *b*, end of September 1969.



PLATE 13.—Palo Verde, inundated valley floor in October 1969.



PLATE 14.—Palo Verde, valley floor in latter part of dry season.



PLATE 15.—Palo Verde marshes: *a*, wet season, reeds beyond fence harbor gallinules and bitterns;
b, dry season, burning pastures in distance, lizard on limestone boulder in right foreground.



PLATE 16.—Palo Verde, road and cattle avenue between hacienda and OTS building: *a*, roofed gate (portón); *b*, guanacaste tree (*Enterolobium cyclocarpum*) beside reedy marsh.



PLATE 17.—Palo Verde, wet-season woodland at base of Cerro Guayacán: *a*, exterior view; *b*, interior view.



PLATE 18.—Near-climatic association (see "Physiognomy," Site 1) near waterfall at Hacienda Ciruelas (Figure 4); note similarity to woodland at Palo Verde (Plates 19, 20).



PLATE 19.—Palo Verde, view in woodland.



PLATE 20.—Palo Verde, view in woodland.

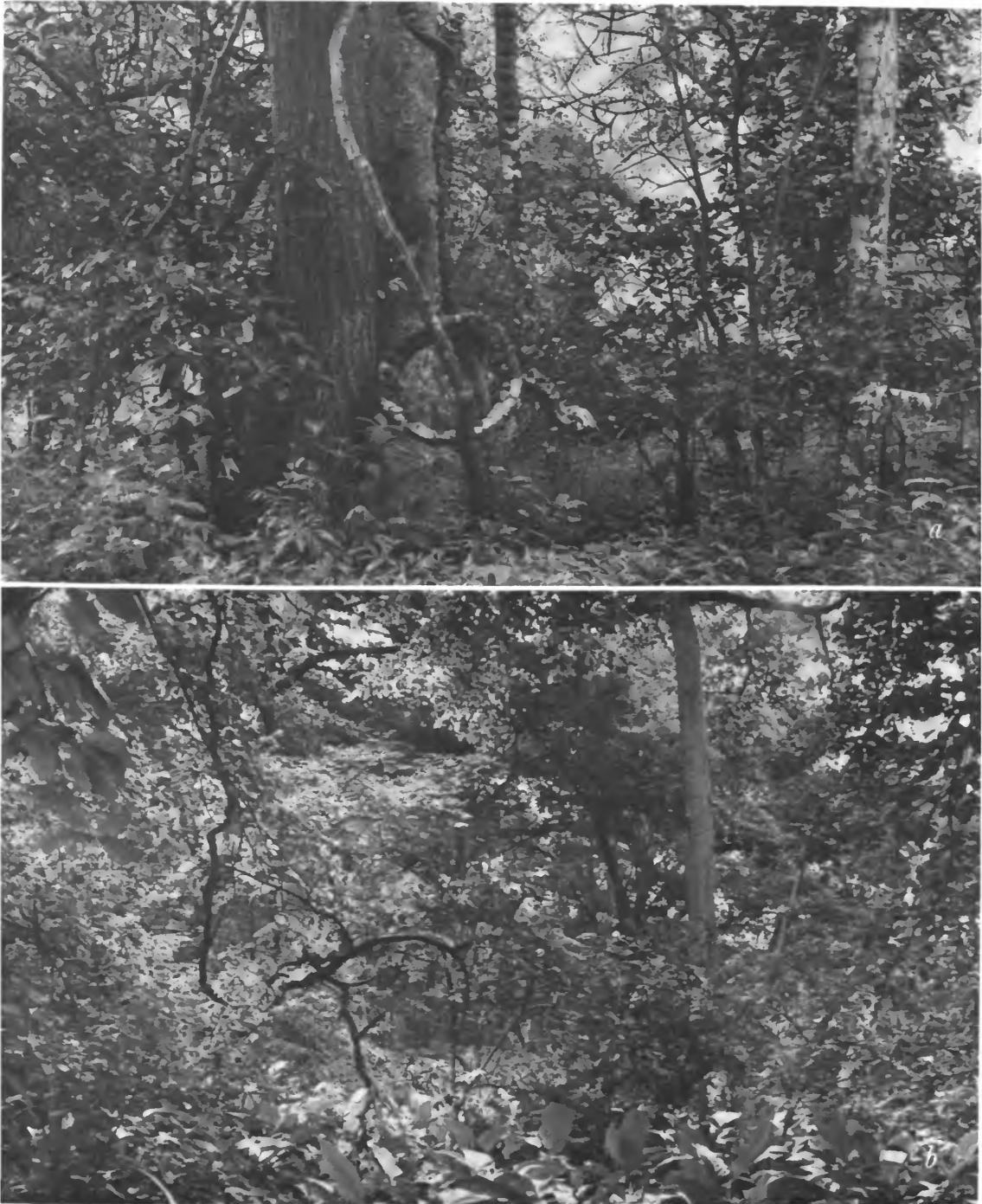


PLATE 21.—Palo Verde, wet-season woodland; note lack of clinging vines, mossy growth, and epiphytes: *a*, lianas; *b*, herbaceous ground cover at damp spot.



PLATE 22.—Palo Verde, views in woodland.



PLATE 23.—Palo Verde, views in woodland: *a*, overgrown opening with emergent fig tree; *b*, erosion in study tract (see page 10).



PLATE 24.—Palo Verde, view in woodland.



PLATE 25.—Palo Verde, low woods, boggy in wet season (see page 10).



PLATE 26.—Palo Verde: *a* and *b*, low woods, boggy and partially flooded in wet season.

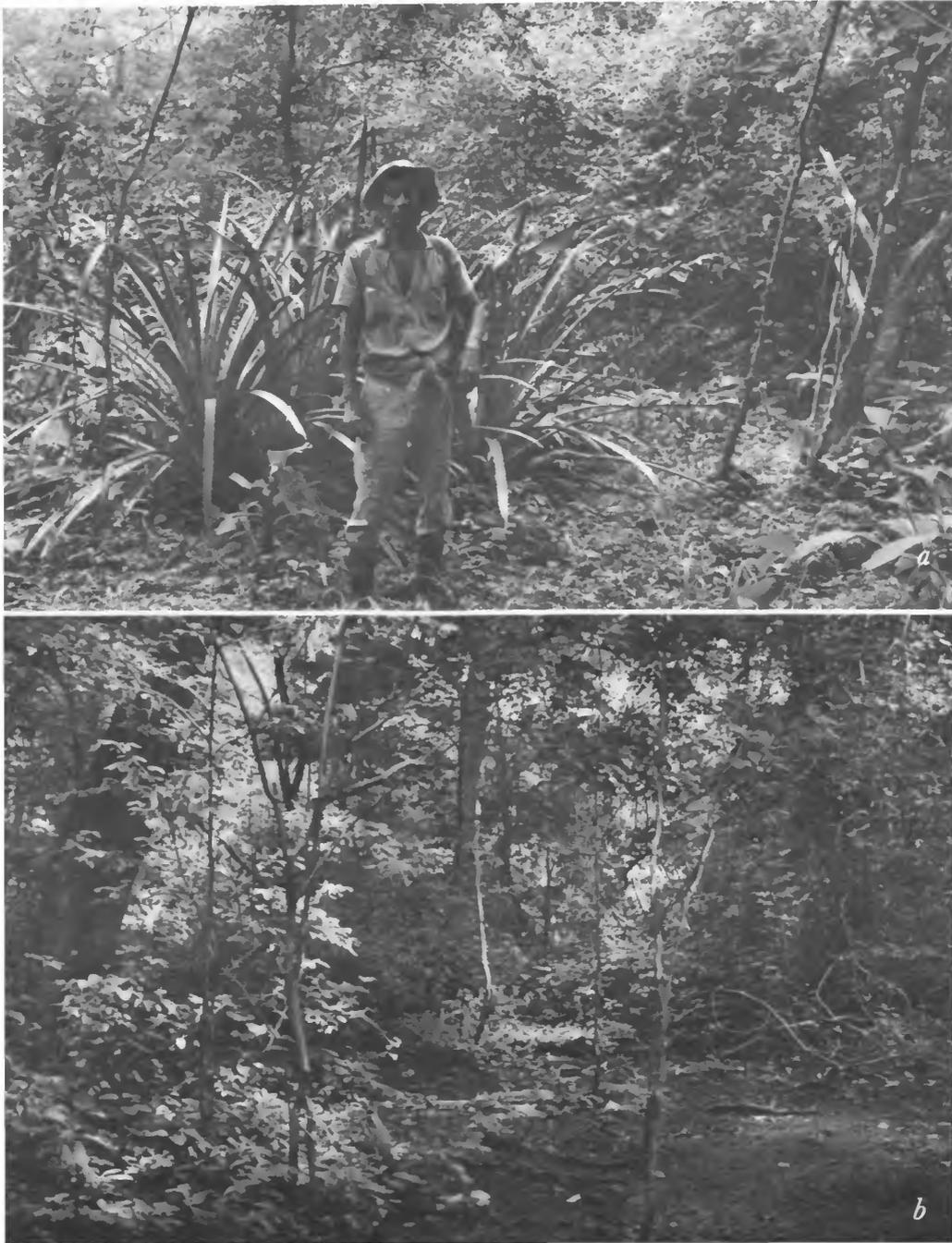


PLATE 27.—Palo Verde, low woods, boggy in wet season; birds of prey (*Micrastur semitorquatus*, *Leptodon cayanensis*, *Geranospiza careulescens*) frequent the larger trees: *a*, bromeliads on somewhat higher ground; *b*, miry cattle-disturbed opening.



PLATE 28.—Palo Verde, narrow muddy road through partially shaded opening in wet season.



PLATE 29.—Palo Verde, tall grass opening in wet season.



PLATE 30.—Palo Verde, rocky knoll with columnar cacti beside cattle drive; note bull's horn acacias in foreground.



PLATE 31.—Palo Verde, low mixed stand at seasonally flooded, then parched Bajuras Cortés (Figure 4); note prevalence of bull's horn acacias.



PLATE 32.—Palo Verde, dry scrubby woodland and parched pastures: *a*, open cattle range
b, spiny palm thicket (*Bactris*).



PLATE 33.—Palo Verde, seasonally flooded, then parched *Parkinsonia* (palo verde) habitat.

Index to Annotated List

- Actitis macularia*, 39
Agelaius phoeniceus, 56
Aimophila ruficauda, 58
Ajaia ajaja, 30
Amazilia boucardi, 44
 rutila, 44
 saucerottei, 44
 tzacatl, 44
Amazona albifrons, 42
 ochrocephala, 42
Anas acuta, 31
 americana, 32
 clypeata, 32
 cyanoptera, 32
 discors, 31
Anhinga anhinga, 25
Anthracothonax prevostii, 44
Ara macao, 42
Aramides cajanea, 37
Aramus guarauna, 37
Aratinga canicularis, 42
Archilochus colubris, 44
Ardea herodias, 26
Arremonops rufivirgatus, 58
Attila spadiceus, 49
Aythya affinis, 32
- Basileuterus rufifrons*, 55
Botaurus pinnatus, 29
Brotogeris jugularis, 42
Bubulcus ibis, 27
Burhinus bistriatus, 39
Busarellus nigricollis, 35
Buteo albicaudatus, 34
 albonotatus, 34
 brachyurus, 35
 jamaicensis, 34
 magnirostris, 35
 nitidus, 35
 platypterus, 34
 swainsoni, 34
Buteogallus anthracinus, 35
 urubitinga, 35
- Cairina moschata*, 31
Calidris mauri, 39
 minutilla, 39
 pusilla, 39
Calocitta formosa, 51
Campephilus guatemalensis, 46
Camptostoma imberbe, 51
 obsoletum, 51
- Campylorhynchus rufinucha*, 52
Capella gallinago, 39
Caprimulgus carolinensis, 43
Caracara plancus, 36
Casmerodius albus, 26
Cathartes aura, 33
 burrovianus, 33
Catharus ustulatus, 52
Charadrius vociferus, 38
 wilsonia, 38
Chiroxiphia linearis, 47
Chlidonias niger, 40
Chloroceryle aenea, 45
 amazona, 45
 americana, 45
Chlorostilbon canivetii, 44
Chondrohierax uncinatus, 34
Chordeiles acutipennis, 43
Circus cyaneus, 36
Claravis pretiosa, 41
Coccyzus americanus, 42
 minor, 42
Cochlearius cochlearius, 29
Colinus leucopogon, 37
Columba flavirostris, 40
Columbina minuta, 41
 passerina, 41
 talpacoti, 41
Contopus cinereus, 49
 sordidulus, 49
 virens, 49
Coragyps atratus, 32
Grax rubra, 37
Crotophaga sulcirostris, 42
Crypturellus cinnamomeus, 25
Cyanerpes cyaneus, 53
Cyclarhis gujanensis, 53
- Dendrocincla homochroa*, 46
Dendrocolaptes certhia, 46
Dendrocoryna autumnalis, 31
 bicolor, 31
 viduata, 31
Dendroica coronata, 54
 fusca, 54
 magnolia, 54
 pensylvanica, 54
 petechia, 54
Dromococcyx phasianellus, 42
Dryocopus lineatus, 45
- Egretta caerulea*, 26
 thula, 26
 tricolor, 26
Elaenia flavogaster, 50
Elanus leucurus, 33
Empidonax flaviventris, 49
 minimus, 49
 traillii, 49
Erebor inquisitor, 47
Eucometis penicillata, 57
Eudocimus albus, 30
Eumomota superciliosa, 45
Euphonia affinis, 56
 hirundinacea, 57
Eutoxeres aquila, 44
- Falco peregrinus*, 37
 sparverius, 37
Fregata magnificens, 26
Fulica americana, 38
- Galbula ruficauda*, 45
Gallinula chloropus, 38
Gallinula martinica, 38
Gelochelidon nilotica, 40
Geothlypis poliocephala, 55
Geotrygon montana, 41
Geranoospiza caerulea, 36
Glaucidium brasilianum, 43
Guiraca caerulea, 57
- Habia rubica*, 57
Harpagus bidentatus, 34
Heliomaster constantii, 44
Herpetotheres cachinnans, 36
Himantopus mexicanus, 39
Hirundo rustica, 51
Hylocharis eliciae, 44
Hylophilus decurtatus, 53
- Icterus galbula*, 55
 pectoralis, 55
 pustulatus, 55
 spurius, 55
Ixobrychus exilis, 28
- Jabiru mycteria*, 29
Jacana spinosa, 38
- Larus atricilla*, 40
 pipixcan, 40
Laterallus ruber, 38
Legatus leucophaius, 47

- Lepidocolaptes souleyetii*, 46
Leptodon cayanensis, 33
Leptotila plumbeiceps, 41
 verreauxi, 41
Limnodromus scolopaceus, 39
Lobipes lobatus, 39
- Megaceryle alcyon*, 45
 torquata, 45
Megarhynchus pitangua, 48
Melanerpes hoffmannii, 46
Micrastur semitorquatus, 36
Mniotilta varia, 54
Molothrus aeneus, 55
Momotus momota, 45
Morococcyx erythropygus, 43
Muscivora forficata, 47
Mycteria americana, 29
Myiarchus crinitus, 48
 nuttingi, 48
 panamensis, 48
 tuberculifer, 49
 tyrannulus, 48
Myiodynastes luteiventris, 47
 maculatus, 48
Myiopagis viridicata, 50
Myiozetetes similis, 48
- Notharchus macrorhynchos*, 45
Nuttallornis borealis, 49
Nyctanassa violacea, 27
Nycticorax nycticorax, 27
Nyctidromus albigollis, 43
- Oncostoma cinereigulare*, 50
Onychorhynchus mexicanus, 50
Oporornis formosus, 55
 philadelphia, 55
Ortalis vetula, 37
Otus cooperi, 43
Oxyura dominica, 32
- Pachyrampus cinnamomeus*, 46
 polychopterus, 46
Pandion haliaetus, 36
Parabuteo unicinctus, 35
Passerina ciris, 58
- cyanea*, 58
Penelope purpurascens, 37
Petrochelidon pyrrhonota, 51
Phaeochroa cuvierii, 44
Phaethornis longuemareus, 43
 superciliosus, 43
Phalacrocorax olivaceus, 25
Pheucticus ludovicianus, 57
Piaya cayana, 42
Piranga ludoviciana, 57
 olivacea, 57
 rubra, 57
Pitangus sulphuratus, 48
Platyparis aglaiae, 47
Platyrrhynchus cancrinus, 50
Plegadis falcinellus, 30
Podiceps dominicus, 25
Podilymbus podiceps, 25
Poliotilta albiloris, 52
 plumbea, 52
Porzana flaviventer, 38
Procnias tricarunculata, 47
Progne chalybea, 51
Protonotaria citrea, 54
Pteroglossus torquatus, 45
Pulsatrix perspicillata, 43
- Quiscalus mexicanus*, 55
- Ramphocaenus melanurus*, 52
Rhinoptynx clamator, 43
Riparia riparia, 51
Rostrhamus sociabilis, 34
Rynchops niger, 40
- Saltator coerulescens*, 57
Sarcoramphus papa, 32
Scardafella inca, 40
Setophaga ruticilla, 55
Scirrus aurocapillus, 54
 motacilla, 54
 novaboracensis, 54
Sittasomus griseicapillus, 46
Spiza americana, 58
Spizaetus ornatus, 36
Sporophila americana, 58
 torqueola, 58
- Stelgidopteryx ruficollis*, 51
Streptoprocne zonaris, 43
Sturnella magna, 56
Sublegatus arenarum, 50
- Tachycineta albilinea*, 51
Tapera naevia, 42
Taraba major, 46
Thamnophilus doliatus, 46
Thraupis episcopus, 57
Thryothorus modestus, 52
 pleurostictus, 52
 rufalbus, 52
Tigrisoma mexicanum, 27
Tityra semifasciata, 47
Todirostrum cinereum, 50
 sylvia, 50
Tolmomyias sulphureus, 50
Tringa flavipes, 38
 melanoleuca, 38
 solitaria, 39
Trogon elegans, 45
 melanocephalus, 44
 violaceus, 45
Turdus grayi, 52
Tyranniscus vilissimus, 51
Tyrannus melancholicus, 47
 tyrannus, 47
Tyto alba, 43
- Vermivora peregrina*, 54
Vireo flavifrons, 53
 flavoviridis, 53
 olivaceus, 53
 pallens, 53
 philadelphicus, 53
Volatinia jacarina, 58
- Wilsonia canadensis*, 55
- Xenops minutus*, 46
Xiphorhynchus flavigaster, 46
- Zenaida asiatica*, 40
 macroura, 40

REQUIREMENTS FOR SMITHSONIAN SERIES PUBLICATION

Manuscripts intended for series publication receive substantive review within their originating Smithsonian museums or offices and are submitted to the Smithsonian Institution Press with approval of the appropriate museum authority on Form SI-36. Requests for special treatment—use of color, foldouts, casebound covers, etc.—require, on the same form, the added approval of designated committees or museum directors.

Review of manuscripts and art by the Press for requirements of series format and style, completeness and clarity of copy, and arrangement of all material, as outlined below, will govern, within the judgment of the Press, acceptance or rejection of the manuscripts and art.

Copy must be typewritten, double-spaced, on one side of standard white bond paper, with 1 $\frac{1}{4}$ " margins, submitted as ribbon copy (not carbon or xerox), in loose sheets (not stapled or bound), and accompanied by original art. Minimum acceptable length is 30 pages.

Front matter (preceding the text) should include: **title page** with only title and author and no other information, **abstract page** with author/title/series/etc., following the established format, **table of contents** with indents reflecting the heads and structure of the paper.

First page of text should carry the title and author at the top of the page and an unnumbered footnote at the bottom consisting of author's name and professional mailing address.

Center heads of whatever level should be typed with initial caps of major words, with extra space above and below the head, but with no other preparation (such as all caps or underline). Run-in paragraph heads should use period/dashes or colons as necessary.

Tabulations within text (lists of data, often in parallel columns) can be typed on the text page where they occur, but they should not contain rules or formal, numbered table heads.

Formal tables (numbered, with table heads, boxheads, stubs, rules) should be submitted as camera copy, but the author must contact the series section of the Press for editorial attention and preparation assistance before final typing of this matter.

Taxonomic keys in natural history papers should use the aligned-couplet form in the zoology and paleobiology series and the multi-level indent form in the botany series. If cross-referencing is required between key and text, do not include page references within the key, but number the keyed-out taxa with their corresponding heads in the text.

Synonymy in the zoology and paleobiology series must use the short form (taxon, author, year:page), with a full reference at the end of the paper under "Literature Cited." For the botany series, the long form (taxon, author, abbreviated journal or book title, volume, page, year, with no reference in the "Literature Cited") is optional.

Footnotes, when few in number, whether annotative or bibliographic, should be typed at the bottom of the text page on which the reference occurs. Extensive notes must appear at the end of the text in a notes section. If bibliographic footnotes are required, use the short form (author/brief title/page) with the full reference in the bibliography.

Text-reference system (author/year/page within the text, with the full reference in a "Literature Cited" at the end of the text) must be used in place of bibliographic footnotes in all scientific series and is strongly recommended in the history and technology series: "(Jones, 1910:122)" or ". . . Jones (1910:122)."

Bibliography, depending upon use, is termed "References," "Selected References," or "Literature Cited." Spell out book, journal, and article titles, using initial caps in all major words. For capitalization of titles in foreign languages, follow the national practice of each language. Underline (for italics) book and journal titles. Use the colon-parentheses system for volume/number/page citations: "10(2):5-9." For alinement and arrangement of elements, follow the format of the series for which the manuscript is intended.

Legends for illustrations must not be attached to the art nor included within the text but must be submitted at the end of the manuscript—with as many legends typed, double-spaced, to a page as convenient.

Illustrations must not be included within the manuscript but must be submitted separately as original art (not copies). All illustrations (photographs, line drawings, maps, etc.) can be intermixed throughout the printed text. They should be termed **Figures** and should be numbered consecutively. If several "figures" are treated as components of a single larger figure, they should be designated by lowercase italic letters (underlined in copy) on the illustration, in the legend, and in text references: "Figure 9 \underline{b} ." If illustrations are intended to be printed separately on coated stock following the text, they should be termed **Plates** and any components should be lettered as in figures: "Plate 9 \underline{b} ." Keys to any symbols within an illustration should appear on the art and not in the legend.

A few points of style: (1) Do not use periods after such abbreviations as "mm, ft, yds, USNM, NNE, AM, BC." (2) Use hyphens in spelled-out fractions: "two-thirds." (3) Spell out numbers "one" through "nine" in expository text, but use numerals in all other cases if possible. (4) Use the metric system of measurement, where possible, instead of the English system. (5) Use the decimal system, where possible, in place of fractions. (6) Use day/month/year sequence for dates: "9 April 1976." (7) For months in tabular listings or data sections, use three-letter abbreviations with no periods: "Jan, Mar, Jun," etc.

Arrange and paginate sequentially EVERY sheet of manuscript—including ALL front matter and ALL legends, etc., at the back of the text—in the following order: (1) title page, (2) abstract, (3) table of contents, (4) foreword and/or preface, (5) text, (6) appendixes, (7) notes, (8) glossary, (9) bibliography, (10) index, (11) legends.

