THE PLEISTOCENE AVIFAUNA OF THE TALARA TAR SEEPS,
NORTHWESTERN PERU

By

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A DISSERTATION PRESENTED TO THE GRADUATE COUNCIL OF
THE UNIVERSITY OF FLORIDA
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE
DEGREE OF DOCTOR OF PHILOSOPHY

THE UNIVERSITY OF FLORIDA
1973

UNIVERSITY OF FLORIDA

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ACKNOWLEDGMENTS

I would like to thank the members of my supervisory committee, Dr. Pierce Brodkorb, Dr. David Johnston, and Dr. Richard Edwards, for their help and encouragement during the progress of this research and the preparation of this dissertation. I would especially like to thank the chairman of my supervisory committee, Dr. Pierce Brodkorb, for his guidance and critical evaluation of my research and the preparation of this manuscript. His continued interest in my progress has been an invaluable contribution to this study.

I wish to thank the collector of the fossil material, Dr. A. Gordon Edmund of the Royal Ontario Museum, Ontario, Canada, for the opportunity to study the collection. Professor Gustav Orcés of the Instituto Polytécnico, Quito, Ecuador, kindly permitted me to study the fossil material from La Carolina, Ecuador, and extended many courtesies to me while I visited his country. Peruvian officials, particularly Ing. Eduardo Izquierdo C., were most cooperative in allowing me to collect comparative material. Sr. Max Cerro provided a welcome base of operations during field work in northwestern Peru.

The following individuals and institutions generously loaned many specimens for comparative purposes: Dr. Dean Amadon, American Museum of Natural History; Dr. N. Philip Ashmole, Yale Peabody Museum; Dr. Robert M. Mengel, Natural History Museum, University of Kansas; Dr. Robert W. Storer, Museum of Zoology, University of Michigan; Dr. Glen Woolfenden, University of South Florida; and Dr.

Richard Zusi, United States National Museum.

Special acknowledgment is due the Organization for Tropical Studies, Inc., for providing field research funds under OTS Pilot Research Grant N69-23. The Frank M. Chapman Fund, American Museum of Natural History, and Sigma Xi also provided field research funds. Without their support this study would be very incomplete.

Special acknowledgment is also due my wife, Terrie, for her enduring patience and enthusiasm.

To all of these people and many more, I am deeply grateful.

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Abstract of Dissertation Presented to the
Graduate Council of the University of Florida in Partial
Fulfillment of the Requirements for the Degree of Doctor of Philosophy

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June, 1973

Chairman: Dr. Pierce Brodkorb
Major Department: Department of Zoology

The Talara Tar Seeps are a series of fossil-bearing deposits located in northwestern Peru. They have been dated at approximately 14,000 years B.P. and lie directly on a marine terrace thought to be Sangamon in age.

The avifauna is known from 6200 elements representing a minimum of 742 individuals of 13 orders, 24 families, 66 genera, and 88 species. Five new genera and 20 new species are described. The following families are represented, with the number of identified species for each (numbers of new species in parenthesis): Tinamidae, 1; Podicipedidae, 2; Phalacrocoracidae, 2; Ardeidae, 5 (1); Ciconiidae, 2; Plataleidae, 5 (2); Anatidae, 9 (4); Vulturidae, 6 (3); Accipitridae, 7 (2); Falconidae, 6 (1); Cracidae, 1; Rallidae, 1; Charadriidae, 7 (2); Scolopacidae, 13 (2); Phalaropodidae, 3 (1); Burhinidae, 1; Jacanidae, 1; Thinocoridae, 3 (1); Laridae, 2; Columbidae, 4; Psittacidae, 1; Tytonidae, 1; Strigidae, 3; Caprimulgidae, 2 (1).

Diagnostic osteological characters are given in all cases where necessary to justify species identification.

The coast of northern Peru where the Talara Tar Seeps are located is desert today. Very rare unpredictable rains occur during the summer, and a continuous cloud cover with no precipitation prevails during the winter. The paleoavifauna indicates that during the Wisconsin glaciation northwestern Peru was a savanna woodland or a savanna with extensive riparian forests. During the summer months regular heavy monsoon rains occurred, followed by a winter dry season with continuous cloud cover similar to the present winter season.

The explanation of the Pleistocene summer rains is found in the higher zonal index resulting from increased polar activity during the periods of glaciation. During this time the intertropical front was located at or south of the equator. This allowed northern hemisphere winds to cross the equator and become northwesterly winds that covered the normally cold coastal waters with warm equatorial water, establishing the necessary conditions for rainfall on land.

The two oldest marine terraces in the region, the Mancora and Talara Tablazos, with molluscan faunas indicating a cool water environment, are similar in age and were formed during the Sangamon interglacial. At this time the intertropical front was located well north of the equator. The similarity of the molluscan fauna of the Lobitos Tablazo to that of the modern beach indicates a rather recent age, probably late or post-Wisconsin.

Most of the Equatorial Arid Fauna of Chapman is thought to have originated during the glacial periods when the intertropical front was probably located near the equator. Climatic conditions then existed that restricted rainfall along the western coast of Colombia. The

drier coastal areas provided an avenue for the passage of arid and semi-arid species from Central America south to the coast of Ecuador and Peru.

Numerous distinctive subspecies of the Equatorial Arid Fauna have evolved in southwestern Ecuador and northwestern Peru since the Wisconsin. Divergence between populations of species of the Equatorial Arid Fauna occurring in the coastal areas and those found in the Marañon Valley of Peru is thought to have taken place during glacial periods. Increased vegetation on the western slopes of the Andes Mountains during the glacial periods would have effectively isolated the two drier habitats.

Many of the extinct species probably evolved after the beginning of the Wisconsin glaciation and became extinct at the end, thus having a lifespan of approximately 50,000 years.

The Carolinian faunas of southwestern Ecuador are thought to be either very early Wisconsin or Late Wisconsin based on their similarities with the Talaran faunas and postulated climatic events.

The similarly aged Rancho La Brea avifauna includes 98 non-passerine species, compared with the 88 non-passerine species found in the Talara fauna. Sixteen species occur in both localities. Twenty-three per cent of the non-passerine species of the Talara avifauna are extinct, in contrast with 17 per cent of the non-passerine species from Rancho La Brea.

INTRODUCTION

During January and February 1958, Dr. A. Gordon Edmund and Mr. R. R. Hornell of the Royal Ontario Museum, Toronto, Canada, recovered an extensive sample of plant, invertebrate, and vertebrate remains from numerous surface tar seeps in the La Brea-Pariñas oil field, near Talara, Peru (Pl. I). These deposits are known as the Talara Tar Seeps to avoid confusion with the similar deposits at Rancho La Brea, California. This report is the first on the avian remains of the deposit and is concerned with the non-passerine portion of the avifauna. Additional work needs to be completed before the passerine species are satisfactorily identified.

The Talara Tar Seeps are located just west of the Pan American Highway, kilometer 1125, approximately 6 miles west of the Amotape Mountains and 20 miles due east of the Pacific coast at Punta Pariñas, the westernmost point of South America. The site is marked on maps as La Brea, but only a cemetery remains of the town. The tar seeps were first worked by the Indians, who used the material in their road construction program, and later the Spaniards made extensive use of the pitch, developing it into a considerable economic resource. The first oil well in South America was drilled at the site in 1862.

Most of the fossil bones are well preserved, and in numerous cases broken specimens could be pieced back together, even though the pieces may have been separated at the time of collection. The species represented by the most elements is Anas bahamensis, of which

there are 2864 bones from a minimum of 243 individuals. Several species are represented by only one element. Individual specimens range in size from complete humeri of condors to those of swallows. Numerous skulls of various species are also present.

Plate I

View of the Talara Tar Seeps, northwestern Peru, looking north.

MATERIALS AND METHODS

The fossil specimens were studied under loan from the Royal Ontario Museum, Ontario, Canada. At the termination of this study the specimens will be cataloged and housed in that institution.

Except in a few instances only skeletons prepared by maceration were used for the osteological diagnosis. Skeletons that have been cleaned only by bugging are not free of all tendinal material and are unsatisfactory for exact osteological description.

Osteological terminology was taken primarily from Howard (1929). Additional anatomical works used were those of Fisher (1946), Fisher and Goodman (1955), and Owre (1967).

All measurements were taken with vernier dial calipers accurate to 0.05 mm. The following abbreviations are used in the table and text: M, mean; N, number of specimens measured; OR, observed range.

GEOLOGY

The geology of northwestern Peru has been discussed by Bosworth (1922), Iddings and Olsson (1928), Travis (1953), and Lemon and Churcher (1961). Additional information is presented by Sheppard (1937). The following is a brief summary of the geology of the Talara region based on these works.

The major oil-producing area of Peru is known as the La Brea-Pariñas oil field, which straddles the 4th parallel. The oil field occupies the westernmost part of the South American continent, and lies between the Pacific Ocean on the west and the Amotape Mountains, a small outlier of the Andes Mountains, to the east. The Amotape Mountains and basement rocks of the coastal area consist of Pennsylvanian quartzites, graywackes, argillites, and shales. Directly upon these lie a series of Cretaceous rocks in excess of 9000 feet in thickness. The Cretaceous sediments consist of a lower series of limestone rocks and an upper series of shales, sandstones, and conglomerates.

The main oil-producing rocks are Eocene in age, and consist of approximately 15,000 feet of marine clastic sediments. Shales, sands, and a few conglomerates are present in these sediments that originated during the orogenic uplift of the Andes Mountains directly to the east. These sediments are highly faulted and of complex structure as a result of subsequent orogenic movement.

Early, or perhaps Middle, Pleistocene to Recent marine deposits

overlie the Eocene rocks and consist of well stratified marls, limestones, calcareous sands, coquinas, and pebble beds. These deposits occupy three terraces, named the Mancora Tablazo (highest and oldest), the Talara Tablazo (middle terrace and not much younger than the Mancora Tablazo), and the Lobitos Tablazo (lowest and youngest). The terraces represent periods of marine encroachment followed by orogenic uplift, which was greater in the north than in the south, giving the terraces a southward tilt. The deposits are thickest in the north and thin southward, ranging only up to 50 or 80 feet in thickness. The Talara Tar Seeps rest on the Mancora Tablazo. Recent deposits consist of large alluvial breccia fans from the Amotape Mountains, valley terraces, sand dunes, and Recent marine deposits.

The bone-bearing deposits occur as lenses or horizontal beds, a few to several feet in thickness and of varying lengths (Pl. II, Fig. A). The lenses closely resemble sand or gravel deposits that form in normal stream deposition, or they may represent pools of tar that filled with sands or gravels. Probably both types of deposits are represented, for although the area is now desert, dry stream beds and extensive gulleying indicate that the area was considerably wetter during the Wisconsin glaciation. Oil and water currently escaping from abandoned oil wells attract both vertebrate and invertebrate animals and act as active traps (Pl. II, Fig. B). Windblown sand usually forms a crust over most of the recent seeps. Persistent large pools of pitch occur only in areas where man has excavated the natural asphalt for road material or museum collections.

Plate II

Two views of the Talara Tar Seeps

- Fig. A. Close-up view of the deposit, showing lensing type of deposition and abundance of fossil material.
- Fig. B. View of Phalacrocorax olivaceus recently entombed in surface layer of tar.

Fig. A

Fig. B

SYSTEMATIC LIST

The following systematic list details the non-passerine species known from the Talara Tar Seeps, as summarized in Table 1. Nomenclature used is primarily that of Brodkorb (1963, 1964, 1967, 1971). Except where otherwise noted species distributions are taken from Meyer de Schauensee (1966).

In some instances specimens are thought to represent immature individuals. This conclusion is based on the pitted appearance of the surface of the bone and incomplete ossification in the articular areas.

Order Tinamiformes (Huxley)

Family Tinamidae Gray

Genus Crypturellus Brabourne & Chubb

Crypturellus cf. transfasciatus (Sclater & Salvin)

Pale-browed Tinamou

Material. Proximal end of 1 right humerus.

Remarks. At the present time C. transfasciatus occurs from the equator in western Ecuador south to northwestern Peru in Tumbes and Piura. It is the only species of tinamou found in the dry deciduous forests that surround the semi-arid and arid regions of southwestern Ecuador and coastal Peru. The fossil specimen corresponds in size with C. transfasciatus, but as no skeletal material was available for comparison the specimen is only tentatively identified.

Table 1. List of non-passerine species known from the Talara Tar Seeps, with number of elements and least number of individuals of each indicated.

	Number of Elements	Least Number of Individuals
Tinamiformes		
Tinamidae		
<u>Crypturellus cf. transfasciatus</u>	1	1
Podicipediformes		
Podicipedidae		
<u>Podiceps dominicus</u>	4	2
<u>Podilymbus podiceps</u>	4	2
Pelecaniformes		
Phalacrocoracidae		
<u>Phalacrocorax olivaceus</u>	133	15
<u>P. bougainvillii</u>	1	1
Ardeiformes		
Ardeidae		
<u>Ardea cocoi</u>	6	2
<u>Casmerodius albus</u>	11	4
<u>Egretta thula</u>	7	2
<u>E. caerulea</u>	1	1
<u>Syrigma n. sp.</u>	1	1
<u>Nycticorax nycticorax</u>	53	10
Ciconiidae		
<u>Jabiru mycteria</u>	47	5
<u>Mycteria americana</u>	1	1
Plataleidae		
<u>Theristicus n. sp.</u>	1	1
<u>Eudocimus n. sp.</u>	9	2
<u>E. albus</u>	10	3
<u>Ajaia ajaja</u>	1	1
Anseriformes		
Anatidae		
<u>Dendrocygna autumnalis</u>	299	33
<u>Tadorninae, n. gen. n. sp.</u>	112	10
<u>Chloephaga melanoptera</u>	91	7
<u>Cairina moschata</u>	33	4
<u>Anas n. sp. 1</u>	13	2
<u>Anas n. sp. 2</u>	29	5
<u>Anas n. sp. 3</u>	5	1
<u>A. bahamensis</u>	2864	243
<u>Nomonyx dominicus</u>	1	1

Table 1. Continued.

	Number of Elements	Least Number of Individuals
Accipitriformes		
Vulturidae		
Vulturidae, n. gen. n. sp.	28	4
<u>Gymnogyps n. sp.</u>	30	4
<u>Vultur gryphus</u>	17	3
<u>Sarcoramphus? n. sp.</u>	3	1
<u>Coragyps cf. atratus</u>	72	6
<u>Cathartes aura</u>	26	3
Accipitridae		
Buteoninae?, n. gen. n. sp.	8	2
<u>Geranoaëtus n. sp.</u>	52	7
<u>G. melanoleucus</u>	31	4
<u>Buteo polyosoma</u>	30	4
<u>Buteo sp. 1</u>	4	2
<u>Buteo sp. 2</u>	10	4
<u>Parabuteo unicinctus</u>	30	4
Falconidae		
<u>Falco peregrinus</u>	32	3
<u>F. femoralis</u>	7	2
<u>F. sparverius</u>	47	6
<u>Falco sp.</u>	6	1
<u>Polyborus plancus</u>	293	27
<u>Milvago n. sp.</u>	160	17
Galliformes		
Cracidae		
<u>Penelope cf. purpurascens</u>	4	1
Ralliformes		
Rallidae		
<u>Porzana carolina</u>	3	1
Charadriiformes		
Charadriidae		
Vanellinae, n. gen. n. sp.	1	1
<u>Belonopterus n. sp.</u>	3	2
<u>Pluvialis dominica</u>	32	6
<u>Squatarola squatarola</u>	3	1
<u>Charadrius vociferous</u>	7	2
<u>C. collaris</u>	3	1
<u>C. semipalmatus</u>	1	1
Scolopacidae		
<u>Tringa solitaria</u>	21	5
<u>Tringa n. sp.</u>	2	1
<u>Totanus flavipes</u>	69	17
<u>T. melanoleucus</u>	11	2
<u>Actitis macularia</u>	1	1
<u>Catoptrophorus semipalmatus</u>	16	4

Table 1. Continued.

	Number of Elements	Least Number of Individuals
<u>Erolia minutilla</u>	28	12
<u>E. melanotos</u>	220	57
<u>Ereunetes mauri</u>	16	3
<u>Micropalama himantopus</u>	1	1
<u>Arenaria interpres</u>	2	1
<u>Numenius cf. borealis</u>	1	1
<u>Scolopacidae, n. gen. n. sp.</u>	3	1
Phalaropodidae		
<u>Lobipes lobatus</u>	2	2
<u>Steganopus tricolor</u>	65	11
<u>Steganopus n. sp.</u>	1	1
Jacanidae		
<u>Jacana spinosa</u>	1	1
Burhinidae		
<u>Burhinus superciliaris</u>	29	4
Thinocoridae		
<u>Thinocorus n. sp.</u>	1	1
<u>T. rumicivorus</u>	1	1
<u>cf. Attagis sp.</u>	1	1
Laridae		
<u>Larus atricilla</u>	31	8
<u>L. pipixcan</u>	95	17
Columbiformes		
Columbidae		
<u>Zenaida auriculata</u>	102	13
<u>Z. asiatica</u>	7	2
<u>Columbina talpacoti</u>	3	2
<u>C. cruziana</u>	578	68
Psittaciformes		
Psittacidae		
<u>Forpus coelestis</u>	1	1
Strigiformes		
Tytonidae		
<u>Tyto alba</u>	83	8
Strigidae		
<u>Bubo virginianus</u>	101	11
<u>Speotyto cunicularia</u>	6	1
<u>Asio flammeus</u>	12	2
Caprimulgiformes		
Caprimulgidae		
<u>Chordeiles acutipennis</u>	6	1
<u>Caprimulgus n. sp.</u>	2	1
Total	6200	742

Order Podicipediformes (Furbringer)

Family Podicipedidae (Bonaparte)

Genus Podiceps Latham

Podiceps dominicus (Linnaeus)

Least Grebe

Material. One complete right coracoid, 1 nearly complete left femur, proximal end of 1 left femur, proximal end of 1 left tarsometatarsus. The 4 specimens represent a minimum of 2 individuals.

Characters. Easily identified by their small size, the fossil specimens display characters well within the range of variation found in Recent specimens.

Remarks. The present range of P. dominicus includes northwestern Peru.

Genus Podilymbus Lesson

Podilymbus podiceps (Linnaeus)

Pied-billed Grebe

Material. Proximal end of 1 right humerus, 1 nearly complete right femur, proximal end of 1 right femur, 1 complete left tarsometatarsus. The 4 specimens represent a minimum of 2 individuals.

Characters. The fossil specimens vary within acceptable limits from Recent specimens examined.

Remarks. The present range of P. podiceps includes northwestern Peru, and I would expect to find this grebe on almost any body of fresh-water in coastal Peru, although not in large numbers.

Order Pelecaniformes Sharpe

Suborder Sulae Sharpe

Family Phalacrocoracidae (Bonaparte)

Genus Phalacrocorax BrissonPhalacrocorax olivaceus (Humboldt)

Olivaceous Cormorant

Material. Two maxillae, distal halves of 2 right and 2 left mandibles, 5 right and 2 left scapulae, 5 complete right and 11 complete left coracoids, humeral ends of 1 right and 3 left coracoids, sternal ends of 2 right and 4 left coracoids, 2 complete left humeri, proximal ends of 2 right and 4 left humeri, distal ends of 7 right and 6 left humeri, proximal ends of 3 right and 2 left ulnae, distal ends of 5 right and 2 left ulnae, proximal ends of 5 right and 2 left radii, distal ends of 4 right and 1 left radius, 3 complete right and 1 complete left carpometacarpus, proximal ends of 1 right and 1 left carpometacarpus, 4 complete right and 4 complete left femora, proximal end of 1 left femur, distal ends of 1 right and 1 left femur, 2 complete right and 1 complete left tibiotarsus, proximal ends of 1 right and 2 left tibiotarsi, distal ends of 1 right and 3 left tibiotarsi, 8 complete right and 8 complete left tarsometatarsi, proximal ends of 1 right and 2 left tarsometatarsi, distal ends of 3 left tarsometatarsi. The 133 specimens represent a minimum of 15 individuals.

Characters. With the exception of certain cranial elements, elements of P. olivaceus are generally smaller than elements of P. gaimardi, although size ranges of the two species overlap. They are much smaller, especially more slender, than elements of P. bougainvillii.

P. olivaceus differs from P. bougainvillii and P. gaimardi by having premaxillary and mandible with (1) size large (small in P. bougainvillii and P. gaimardi).

Scapula with (1) glenoid facet distinctly triangular (more rounded in P. bougainvillii and P. gaimardi); (2) acromion wide and moderately long (wide and long in P. bougainvillii, narrow and moderately long in P. gaimardi); (3) protrusion on lateral surface of shaft distal to glenoid facet round and prominent (elongated and only slightly raised, if any, in P. bougainvillii and P. gaimardi).

Coracoid with (1) shaft very slender (very robust in P. bougainvillii, slender in P. gaimardi); (2) bicipital attachment narrow and deeply concave (wide and moderately to slightly concave in P. bougainvillii and P. gaimardi); (3) procoracoid short and rounded (moderate to long, stouter, and more angular in P. bougainvillii and P. gaimardi); (4) attachment of Lig. humero-coracoideum antierius superius deep (superficial in P. bougainvillii and P. gaimardi); (5) humeral end narrow (wide in P. bougainvillii and P. gaimardi).

Humerus with (1) pneumatic fossa moderately excavated (deeply excavated in P. bougainvillii and P. gaimardi); (2) deltoid crest small, smoothly rimmed (larger and locally angular in P. bougainvillii and P. gaimardi); (3) attachment of M. extensor metacarpi radialis inset in shallow depression (attachment located on raised platform in P. bougainvillii; attachment inset in depression in P. gaimardi, but bordered distally by large ectepicondylar prominence); (4) attachment of anterior articular ligament with moderate slope (lesser slope in P. bougainvillii, greater slope in P. gaimardi).

Ulna with (1) internal cotyla narrow (wider in P. bougainvillii and P. gaimardi); (2) external cotyla wide and moderately long (long and narrow in P. bougainvillii, short and narrow in P. gaimardi); (3) external condyle of moderate width and length (narrow and long in P. bougainvillii, moderately wide and short in P. gaimardi); (4)

carpal tuberosity moderately large (larger in P. bougainvillii and P. gaimardi).

Radius with (1) insertion of M. biceps moderately deep (very deep in P. bougainvillii and P. gaimardi); (2) projection extending from lateral end of carpal facet sharp and pointed (only slightly developed in P. bougainvillii and P. gaimardi).

Carpometacarpus with (1) external rim of carpal trochlea small (much wider in P. bougainvillii, slightly wider in P. gaimardi); (2) process of metacarpal I narrow (broad in P. bougainvillii and P. gaimardi); (3) pollical facet wide (narrower in P. bougainvillii and P. gaimardi).

Femur with (1) iliac facet small (larger in P. bougainvillii and P. gaimardi, even though the femur is shorter in P. gaimardi); (2) internal condyle slightly angular distally (more rounded, and rotated posteriorly, in P. bougainvillii and P. gaimardi); (4) shaft slender (much heavier in P. bougainvillii and P. gaimardi).

Tibiotarsus with (1) outer cnemial crest wide and short (wide and long in P. bougainvillii, narrow and short in P. gaimardi); (2) shaft slightly to moderately concave distal to internal articular surface (deeply concave in P. bougainvillii, slightly to moderately concave in P. gaimardi); (3) internal condyle short and moderately wide (long and wide in P. bougainvillii, long and narrow in P. gaimardi); (4) size very small.

Tarsometatarsus with (1) internal cotyla short, narrow, and moderately concave (longer, wider, and more concave in P. bougainvillii and P. gaimardi); (2) inner extensor groove wide (narrow in P. bougainvillii and P. gaimardi); (3) external trochlea narrow (wide in P. bougainvillii and P. gaimardi); (4) distal foramen moderately

sized (smaller in P. bougainvillii, much larger in P. gaimardi).

Remarks. P. olivaceus is generally distributed throughout South America, and is common in coastal lagoons, marshes, lakes, and rivers.

Phalacrocorax bougainvillii (Lesson)

Guanay Cormorant

Material. Distal end of 1 right humerus.

Remarks. P. bougainvillii is a marine species that breeds on offshore islands and comes ashore only rarely, and then usually only during times of distress (Murphy, 1936). The population of this species numbers in the millions, and it undergoes wide fluctuations. At times when the population crashes the beaches are literally covered with corpses. This happens whenever the warm current known as El Nino appears. The single specimen in the collection can be regarded as a rare straggler.

Order Ardeiformes (Wagler)

Suborder Ardeae Wagler

Family Ardeidae Vigors

Genus Ardea Linnaeus

Ardea cocoi Linnaeus

White-necked Heron

Material. One right scapula, proximal ends of 1 right and 1 left carpometacarpus, distal ends of 2 left carpometacarpi, distal end of 1 right tarsometatarsus. The 6 specimens represent a minimum of 2 individuals.

Characters. As A. cocoi is the largest living South American heron its elements are readily recognized on size.

Remarks. Generally distributed over all of South America, A. cocoi is found in coastal marshes and lagoons in Peru, although only in small numbers.

Genus Casmerodius Gloger

Casmerodius albus (Linnaeus)

Common Egret

Material. Two complete right and 2 complete left coracoids, humeral ends of 2 right coracoids, 1 right scapula, 1 complete left carpometacarpus, proximal end of 1 left carpometacarpus, distal end of 1 right tibiotarsus, distal end of 1 right tarsometatarsus. The 11 elements represent a minimum of 4 individuals.

Characters. Intermediate in size between Ardea and Tigrisoma, Casmerodius is easily distinguished on size.

Remarks. Generally distributed over all of South America, C. albus is found commonly in coastal marshes and lagoons of Peru.

Genus Egretta T. Forster

Egretta thula (Molina)

Snowy Egret

Material. Two right scapulae, 2 complete right coracoids, proximal end of 1 left humerus, 1 complete right femur, proximal end of 1 right femur. The 7 specimens represent a minimum of 2 individuals.

Additionally, the following specimens are identified to genus only: 1 complete right and 2 complete left carpometacarpi, distal ends of 3 left tibiotarsi, proximal end of 1 right tarsometatarsus, distal ends of 3 right and 5 left tarsometatarsi.

Characters. The three species of Egretta, E. thula, E.

(Hydranassa) tricolor, and E. (Florida) caerulea, are extremely difficult to separate osteologically. Characters used to identify the fossil specimens of E. thula are given below, but intraspecific variation is so great that even these characters may prove to be invalid if sufficient series are examined.

Scapula with (1) thickness between acromion and coracoidal articulation moderate, but variable (similar in E. caerulea, slightly thicker in E. tricolor); (2) length of acromion base moderate (less in E. caerulea, greater in E. tricolor).

Coracoid with (1) curvature of coracohumeral surface slight to moderate as traced by central groove (similar in E. caerulea, very slight in E. tricolor); (2) angle between internal edge of furcular facet and triosseal canal slightly more than 90 (much larger in E. caerulea, and the area is well rounded; slightly larger in E. tricolor).

Humerus with (1) distal end of attachment of M. proscapulo-humeralis surrounded by attachment of M. triceps, external head (not surrounded in E. caerulea, roughly similar in E. tricolor); (2) external attachment of M. supracoracoideus short and deep (short and shallow in E. caerulea, long and shallow in E. tricolor).

Carpometacarpus with (1) intermuscular line between pollical facet and pisiform process lying near pollical facet (similar in E. caerulea, positioned posteriorly in E. tricolor). No characters were found that reliably separated the carpometacarpi of E. thula from those of E. caerulea. The three fossil specimens could thus be separated from E. tricolor, but assignment to either E. thula or E. caerulea was not possible.

Femur with (1) iliac facet narrow antero-posteriorly (narrow to moderate width in E. caerulea, broader in E. tricolor); (2) external

condyle flat dorsally (similar in E. caerulea, extending farther dorsally in E. tricolor); (3) distal end broad (narrow in E. caerulea, broad in E. tricolor).

Tibiotarsus with (1) rotular crest low (low in E. caerulea, higher in E. tricolor); (2) external condyle slightly undercut dorso-proximally (not undercut in E. caerulea; slightly, or not, undercut in E. tricolor); As no characters were found that could reliably be used to separate the tibiotarsi of E. thula and E. tricolor, the specimens are simply referred to the genus.

Tarsometatarsus. No reliable characters were found that could be considered valid for separating tarsometatarsi of the three species of Egretta. For this reason the specimens are simply referred to the genus.

Remarks. Generally distributed over almost all of South America, E. thula is common in coastal lagoons and marshes of Peru.

Egretta caerulea (Linnaeus)

Little Blue Heron

Material. One complete left coracoid.

Remarks. Generally distributed over almost all of South America, E. caerulea is found in coastal lagoons and marshes of Peru, but not in such large numbers as E. thula.

Genus Syrigma Ridgway

Syrigma n. sp.

Holotype. Complete left coracoid. (Pl. III, Fig. C)

Diagnosis. Agrees with Syrigma and differs from all other genera of South American herons by having (1) head broad and slightly peaked in medial view (subangular to subrounded); (2) brachial tuberosity

prominent and angular; (3) triosseal canal very deep adjacent to glenoid facet; (4) attachments of M. coracobrachialis anterior and Lig. humero-coracoideum anterius superius deep, elongated, and notched; with center of latter lying parallel, and roughly in line with, anterior edge of shaft; (5) protrusion internal to glenoid facet large, bordering ventral side of triosseal canal; (6) external side of shaft with slight ridge running ventrally from middle of head.

Differs from Syrigma sibilatrix (Temminck) by having (1) coracohumeral surface short (displaces dorsal-most point of head posteriorly); (2) furcular facet larger; (3) brachial tuberosity larger; (4) proximal end with medial side flatter (locally more convex and concave in S. sibilatrix); (5) protrusion internal to glenoid facet smaller; (6) head thicker between attachment of Lig. humero-coracoideum anterius superius and anterior furcular facet; (7) glenoid facet rotated posteriorly, lengthening distance from external edge of glenoid facet and anterior edge of shaft; (8) external sternal facet much higher. Measurements of the holotype, with those of one male specimen of S. sibilatrix in parenthesis, are as follows: length, 42.3 (41.6); head to scapular facet, 13.3 (13.5); proximal depth, 9.5 (9.2); least depth of shaft, 4.2 (4.3).

Remarks. The genus Syrigma is represented by one living species in South America, S. sibilatrix, and it occurs only east of the Andes. The presence of a second, extinct species west of the Andes suggests that perhaps the climate west of the Peruvian Andes was more equitable during the late Pleistocene than it is today.

Syrigma n. sp. is the first paleospecies of the genus to be described.

Genus Nycticorax T. ForsterNycticorax nycticorax (Linnaeus)

Black-crowned Night Heron

Material. Middle third of 1 left mandible, 1 right and 3 left quadrates, 4 right and 3 left scapulae, 1 complete right coracoid, humeral ends of 9 right and 4 left coracoids, proximal end of 1 left humerus, proximal end of 1 right ulna, distal ends of 2 right and 3 left ulnae, distal end of 1 left radius, proximal end of 1 left carpometacarpus, 1 complete right femur, proximal end of 1 right and 1 left femur, distal ends of 3 right and 5 left tibiotarsi, 1 complete right and 1 complete left tarsometatarsus, proximal end of 1 right tarsometatarsus, distal ends of 1 right and 3 left tarsometatarsi. The 53 specimens represent a minimum of 10 individuals.

Characters. All elements of Nycticorax examined are separable from those of Egretta by size, those of Nycticorax being either much longer, shorter, wider, or stouter than corresponding elements of Egretta. Nycticorax differs from Nyctanassa Stejneger and Tigrisoma Swainson by having scapula with (1) coracoidal articulation large (large and subrounded in Tigrisoma, smaller in Nyctanassa); (2) glenoid facet oval (broad oval in Tigrisoma, narrow oval in Nyctanassa); (3) acromion deflected moderately externally (less in Tigrisoma, more in Nyctanassa).

Coracoid with (1) triosseal canal moderately inset (slightly inset, if any, in Tigrisoma and Nyctanassa); (2) glenoid facet large (much smaller in Tigrisoma, of similar size in Nyctanassa); (3) dorsal surface of head notched by deep concavity in medial view (rounded in Tigrisoma, notched and more angular in Nyctanassa); (4) anterior end of head rotated moderately externally (rotated less

in Tigrisoma, much more in Nyctanassa).

Humerus with (1) attachment of M. proscapulo humeralis elongated and moderately inset (oval and inset only slightly in Tigrisoma and Nyctanassa); (2) pneumatic fossa very shallow (moderately deep in Tigrisoma and Nyctanassa); (3) dorsal edge of attachment of external head of triceps curving away from capital shaft ridge distal to attachment of M. latissimus dorsi posterioris (extends farther proximally on capital shaft ridge in Tigrisoma and Nyctanassa).

Ulna with (1) olecranon narrow (broad in Tigrisoma, similar in Nyctanassa); (2) external cotyla large, with small ridge leading distally (smaller, without ridge in Tigrisoma and Nyctanassa); (3) external condyles long (short in Tigrisoma, moderate in Nyctanassa); (4) carpal tuberosity moderately long (long in Tigrisoma, short in Nyctanassa).

Radius with (1) palmar surface of distal end moderately excavated (slightly excavated in Tigrisoma, greatly excavated in Nyctanassa); (2) tendinal groove broad and deep (narrower and not as deep in Tigrisoma and Nyctanassa); (3) carpal facet broad (narrow in Tigrisoma and Nyctanassa).

Carpometacarpus with (1) internal ligamental attachment of pisiform process and ligamental attachment of ulnare confluent (separated in Tigrisoma and Nyctanassa); (2) corner on distal end of internal rim of carpal trochlea small (large in Tigrisoma, absent in Nyctanassa); (3) carpal trochlea moderately wide (wider in Tigrisoma, similar in Nyctanassa); (4) process of metacarpal I slender (stouter in Tigrisoma and Nyctanassa).

Femur with (1) proximal lateral face curving medially (curvature slightly less in Tigrisoma, much less in Nyctanassa); (2) concavity

distal to iliac facet posteriorly deep (moderate concavity in Tigrisoma, slight concavity in Nyctanassa); (3) posterior intermuscular line curving medially to base of internal condyle (lies more in center of shaft and does not curve in Tigrisoma, does not curve as far internally in Nyctanassa); (4) gap between external condyle and origin of M. gastrocnemius, pars externa, wide (ridge present between the two in Tigrisoma, slight gap in Nyctanassa).

Tibiotarsus with (1) internal articular surface large (similar in Tigrisoma, smaller in Nyctanassa); (2) inner cnemial crest short and thick (long and of moderate width, tapering distally, in Tigrisoma and Nyctanassa); (3) ridge leading to postero-most corner of internal articular surface absent (present in Tigrisoma, absent in Nyctanassa); (4) internal condyle undercut dorsally (not undercut in Tigrisoma and Nyctanassa); (5) internal condyle flaring extensively internally (much less in Tigrisoma and Nyctanassa).

Tarsometatarsus with (1) shaft large (more slender in Tigrisoma, much more slender in Nyctanassa); (2) cotylae and trochleae wide (narrow in Tigrisoma and Nyctanassa); (3) internal edge to shaft angular (rounded in Tigrisoma and Nyctanassa).

Remarks. N. nycticorax is generally distributed throughout South America, including coastal rivers, swamps, and lagoons of Peru.

On the basis of osteological comparisons listed above I believe Nycticorax is generically distinct from Nyctanassa.

Suborder Plataleae Newton

Family Plataleidae Bonaparte

Subfamily Threskiornithinae (Richmond)

Genus Theristicus Wagler

Theristicus n. sp.

Holotype. Complete left coracoid. (Pl. III, Fig. B)

Diagnosis. Agrees with Theristicus and differs from all other genera of South American ibises (with possible exception of Harpiprion Wagler and Cercibis Wagler which were not available for comparison), by having (1) head long and subangular in medial view; (2) attachment of M. coracobrachialis anterior moderately deep, long, with a narrow posterior section and a much wider anterior section; (3) attachment of Lig. humero-coracoideum anterius superius shallow and confluent with anterior section of attachment of M. coracobrachialis anterior; (4) coracohumeral surface broad, of almost uniform width; (5) head very wide, with external and internal sides roughly parallel; (6) brachial tuberosity large, well rounded; (7) glenoid facet large, with widest area immediately dorsal to scapular facet; (8) shaft with anterior edge immediately dorsal to sternal facet flattened and rotated slightly internally; (9) anterior external sternal facet with large protrusion posteriorly.

Differs from Theristicus caudatus (Boddaert) by having (1) coracohumeral surface much shorter, giving a more rounded head with lower profile in medial view; (2) attachments of M. coracobrachialis anterior and Lig. humero-coracoideum anterius superius shallower; (3) procoracoid deeply concave internally; (4) shaft with anterior edge immediately dorsal to sternal facet more flattened and rotated less internally; (5) external sternal facet and external distal angle much shorter; (6) concavity between external sternal facet and flattened anterior edge of shaft shallow. Measurements of the holotype, with those of three male specimens of T. caudatus in parenthesis are as follows: length, 50.5 (52.0-54.3; mean, 52.8); head to scapular facet, 19.9 (20.8-21.1; mean, 20.9); proximal depth, 12.9 (13.7-14.1; mean,

13.8); least depth of shaft, 8.5 (9.0-9.1; mean, 9.1).

Referred Material. Fragmentary proximal end of 1 right humerus.

Characters. Agrees with Theristicus and differs from all other examined genera of South American ibises by having (1) pneumatic fossa shallow; (2) internal tuberosity short; (3) median crest very prominent.

Differs from Theristicus caudatus by having (1) internal tuberosity shorter; (2) attachment of M. coracobrachialis posterior rotated toward axis of shaft; (3) median crest more prominent; (4) attachment of Lig. humero-coracoideum anterius inferius positioned more anconally. The specimen is too broken to yield accurate measurements.

Remarks. Theristicus is represented by one living species in South America, T. caudatus, that occurs over almost the entire continent, including cultivated areas of coastal Peru (Koeppke, 1970). No significant differences were seen between specimens of T. c. caudatus and T. c. branickii examined. Although no specimens of T. c. melanopsis were available, I doubt that it would vary significantly from T. c. caudatus or T. c. branickii.

Theristicus n. sp. is the first described paleospecies of the genus.

Genus Eudocimus Wagler

Eudocimus n. sp.

Holotype. Complete left tarsometatarsus. (Pl. III, Fig. A)

Paratype. Distal end of 1 left tarsometatarsus.

Diagnosis. Agrees with Eudocimus and differs from all other genera of South American ibises (with possible exception of Harpiprion and Cercibis which were unavailable for comparison) by having (1) shaft long, moderately stout; (2) cotylae, trochleae, and hypotarsus moderately compressed.

Differs from Eudocimus albus Wagler by having (1) shaft with channeling of anterior face very shallow, deepest on external side, with proximal ligamental attachment raised to level of sides of shaft (shaft with anterior face deeply channeled, deepest on internal side, with proximal ligamental attachment lying below level of sides of shaft in E. albus); (2) intercotylar prominence larger, rounder, and rotated dorsally; (3) proximal end wider and distal end narrower (when compared with specimen of E. albus of same, or greater, length); (4) cotylae slightly longer and wider; (5) groove between intercotylar prominence and external cotylae distinct; (6) hypotarsal ridges extend farther distally and forming "V"; (7) external side of hypotarsus and shaft anterior to internal side of hypotarsus more excavated; (8) attachment of external ligament strong, positioned posteriorly; (9) convexity at anterior end of internal trochlea slightly developed; (10) depth of middle trochlea less; (11) external trochlea with external face large, extending less posteriorly.

For measurements see Table 2. Measurements of the holotype are as follows: length, 100.8; proximal width, 13.7; distal width, 12.7; least width of shaft, 5.3; width of middle trochlea, 4.9.

Referred material. One right scapula, distal end of 1 left humerus, proximal end of 2 radii, 1 complete left femur, proximal end of 1 right femur, 1 complete right tibiotarsus (immature), distal end of 1 right tibiotarsus. The 10 specimens, including holotype and paratype, represent a minimum of 2 individuals.

Characters. Scapula with (1) distal end of glenoid facet slightly elevated above surface of shaft, and rotated ventrally only slightly (more elevated and rotated ventrally in E. albus).

Humerus with (1) attachment of anterior articular ligament

broad, extending less distally; (2) attachment of *M. pronator brevis* located farther distally; (3) internal condyle projecting less distally, more palmarly; (4) intercondylar groove shallower.

Radius with (1) capital tuberosity larger; (2) ligamental papillae smaller; (3) bicipital attachment a very deep pit; (4) ulnar facet larger.

Femur with (1) anterior intermuscular line straight, lying near external side of shaft (curved and positioned medially in *E. albus*); (2) iliac facet shorter; (3) concavity distal to posterior edge of iliac facet shallower; (4) trochanter projecting less anteriorly; (5) internal flexure of shaft proximal to internal condyle greater; (6) ridge leading to posterior corner of internal condyle much smaller, with more curving edge; (7) external condyle smaller, less rounded.

Remarks. *E. ruber* differs more from *E. albus* and *Eudocimus* n. sp. than the latter two do from each other, thus a detailed comparison with *E. ruber* is not considered necessary.

Eudocimus n. sp. is the first paleospecies of the genus described from the New World. Its presence in the same deposit as *E. albus*, which does not quite reach so far south as the fossil site today, poses the interesting question of whether the two species were sympatric or merely had seasonally overlapping ranges. Neither of the two species occur in very large numbers in the collection.

Eudocimus albus (Linnaeus)

White Ibis

Material. One complete left coracoid, humeral ends of 2 left coracoids, distal end of 1 right ulna, 1 complete right carpometacarpus, distal ends of 2 left tibiotarsi, proximal end of 1 right

Table 2. Measurements of the scapula, humerus, radius, femur, tibiotarsus, and tarsometatarsus of *Eudocimus* n. sp. and Recent *E. albus*, and of the scapula, tibiotarsus, and tarsometatarsus of *E. albus* from the Talara Tar Seeps (in mm).

		<u><i>Eudocimus</i></u> n. sp.		<u><i>Eudocimus albus</i></u>	
		Talara Tar Seeps		Recent	
Scapula Proximal Height	OR	11.9	11.0	9.3-11.8	
	M	-	-	10.9	
	N	1	1	5	
Proximal Width	OR	3.5	3.7	3.1-4.1	
	M	-	-	3.7	
	N	1	1	5	
Humerus Distal Width	OR	17.2		14.6-17.8	
	M	-		16.3	
	N	1		5	
Depth of External Condyle	OR	8.9		7.9-9.9	
	M	-		8.9	
	N	1		5	
Radius Proximal Width	OR	5.6-5.9		4.3-5.4	
	M	5.8		4.9	
	N	2		5	

Table 2. Continued.

		<u>Eudocimus n. sp.</u>		<u>Eudocimus albus</u>	
		Talara Tar Seeps		Recent	
Femur Length	OR	59.0		56.1-67.1	
	M	-		62.9	
	N	1		5	
Proximal Width	OR	11.9-12.2		10.8-13.5	
	M	12.1		13.2	
	N	2		5	
Distal Width	OR	12.6		11.1-13.8	
	M	-		12.4	
	N	1		5	
Least Width of Shaft	OR	5.3		5.0-6.5	
	M	-		5.8	
	N	1		5	
Tibiotarsus Length	OR	141.0		102.3-141.8	
	M	-		127.3	
	N	1		5	
Distal Width	OR	10.6-11.0		8.5-10.6	
	M	10.8		9.8	
	N	2		5	

Table 2. Continued.

		<u>Eudocimus</u> n. sp.		<u>Eudocimus albus</u>	
				Talara Tar Seeps	Recent
Least Width of Shaft	OR	5.2-5.4			4.4-5.4
	M	5.3			5.0
	N	2			5
Depth of Internal Condyle	OR	11.3-11.7		10.0-11.8	9.2-12.1
	M	11.5		10.9	10.8
	N	2		2	5
Tarsometatarsus					
Length	OR	100.8			73.0-103.8
	M	-			92.7
	N	1			5
Proximal Width	OR	13.7		12.4	10.2-12.8
	M	-		-	11.8
	N	1		1	5
Distal Width	OR	12.7		11.2	10.4-13.3
	M	-		-	12.1
	N	1		1	5
Least Width of Shaft	OR	5.3			4.6-5.4
	M	-			4.9
	N	1			5
Width of Middle Trochlea	OR	4.6-4.9		4.2	4.0-5.0
	M	4.8		-	4.6
	N	2		1	5

tarsometatarsus, distal end of 1 right tarsometatarsus. The 9 specimens represent a minimum of 3 individuals.

Remarks. E. albus occurs today in the northernmost part of coastal Peru, western Ecuador, Colombia, and Venezuela.

Subfamily Plataleinae Bonaparte

Genus Ajaia Reichenbach

Ajaia ajaja (Linnaeus)

Roseate Spoonbill

Material. Proximal end of 1 right carpometacarpus.

Characters. Carpometacarpus with (1) metacarpal I long and slender; (2) posterior carpal fossa elongated and very deep; (3) pollical facet moderately wide; (4) size large.

Remarks. A. ajaja is widespread in South America, and has been recorded from northwestern Peru.

Suborder Ciconiae Bonaparte

Family Ciconiidae (Gray)

Subfamily Ciconiinae Gray

Genus Jabiru Hellmayr

Jabiru mycteria (Lichtenstein)

Jabiru

Material. One cranium, 1 sternal fragment, proximal ends of 2 left scapulae, symphyseal area of 1 furculum, portions of 3 right and 4 left coracoids, distal ends of 1 right and 1 left humerus, proximal ends of 2 left ulnae, distal ends of 2 right and 2 left ulnae, distal ends of 2 right and 1 left radius, proximal end of 1 left carpometacarpus, distal ends of 2 right carpometacarpi, 5 right and 1 left carpal digits, proximal end of 1 left tibiotarsus, distal ends of 3

right and 4 left tibiotarsi, proximal ends of 1 right and 2 left tarsometatarsi, distal ends of 3 right and 1 left tarsometatarsi. The 47 elements represent a minimum of 5 individuals.

Remarks. J. mycteria has been recorded on the coast of southern Peru, but only as isolated individuals, and these are regarded as trans-Andean vagrants. The specimens represented here may also represent trans-Andean vagrants, or they may represent individuals that moved southward from the moister coastal regions of southern Ecuador. Although there are no Recent records of Jabiru in Ecuador, I see no reason why it may not have been there in the past, or why it may not be there now.

Subfamily Mycteriinae American Ornithologists' Union

Genus Mycteria Linnaeus

Mycteria americana Linnaeus

Wood Stork

Material. Proximal end of 1 carpometacarpus.

Remarks. Although M. americana has been recorded from north-western Peru, it has not been recorded from the remainder of coastal Peru. The scarcity of M. americana may indicate that there were no large wet areas near the fossil site. The single specimen must represent a very rare vagrant.

Order Anseriformes Wagler

Suborder Anseres Wagler

Family Anatidae Vigors

Subfamily Dendrocygninae Reichenbach

Genus Dendrocygna Swainson

Dendrocygna autumnalis (Linnaeus)

Black-bellied Tree Duck

Material. Portions of 2 crania, 1 frontal, 4 right and 7 left quadrates, 1 right and 2 left articulars, 1 right and 5 left mandibular fragments, 15 right and 14 left scapulae, 13 complete right and 21 complete left coracoids, humeral ends of 5 right and 4 left coracoids, sternal ends of 2 left coracoids, 2 complete right and 2 complete left humeri, proximal ends of 14 right and 12 left humeri, distal ends of 17 right and 12 left humeri, 2 complete right and 1 complete left ulna, proximal ends of 6 right and 6 left ulnae, distal ends of 8 right and 7 left ulnae, 1 complete left radius, proximal ends of 5 right and 4 left radii, distal ends of 9 right and 8 left radii, 12 complete right and 10 complete left carpometacarpal, proximal ends of 7 right and 7 left carpometacarpal, 7 complete right and 4 complete left femora, proximal ends of 4 right and 5 left femora, distal ends of 1 right and 1 left femora, distal ends of 14 right and 4 left tibiotarsi, 1 complete right tarsometatarsus, proximal end of 1 right and 1 left tarsometatarsus, distal ends of 4 right and 5 left tarsometatarsi. The 299 specimens represent a minimum of 33 individuals.

Characters. The larger size of D. autumnalis serves to distinguish its elements from those of D. viduata (Linnaeus). Although D. bicolor (Vieillot) is usually smaller than D. autumnalis, the two species overlap in size. Characters of D. autumnalis used to separate it from D. bicolor are listed below. For the scapula, radius and ulna, elements not utilized by Woolfenden (1961), generic characters are also given.

Scapula of Dendrocygna with (1) glenoid facet long and narrow,

lacking an antero-ventral projection. Scapula of D. autumnalis with (1) acromion longer; (2) glenoid facet longer and more elevated.

Coracoid with (1) angle between furcular facet and edge of triosseal canal much smaller; (2) brachial tuberosity less rounded; (3) head more rounded in medial view; (4) attachment of Lig. humero-coracoideum antierius superius larger.

Humerus with (1) proximal and distal ends much wider; (2) deltoid crest longer and more flaring; (3) internal tuberosity much larger; (4) ectepicondylar prominence more rounded; (5) attachment of anterior articular ligament higher; (6) entepicondyle much larger.

Ulna of Dendrocygna with (1) external cotyla large; (2) bicipital attachment large and prominent; (3) carpal tuberosity very large. Ulna of D. autumnalis with (1) olecranon much thicker; (2) internal cotyla larger; (3) distal end of external cotyla more rounded; (4) external condyle longer; (5) carpal tuberosity larger.

Radius of Dendrocygna with (1) shaft immediately posterior to head very narrow; (2) ulnar facet narrow and U-shaped; (3) capital tuberosity large; (4) carpal facet narrow, with distinct anconal projection centrally located. Radius of D. autumnalis with (1) capital tuberosity smaller, but more prominent shaft flaring more abruptly to meet a wider distal end.

Carpometacarpus with (1) process of metacarpal I larger; (2) lobe at end of external rim of carpal trochlea more prominent; (3) area of fusion between metacarpal II and metacarpal III longer; (4) internal rim of carpal trochlea larger.

Femur with (1) head rotated dorsally, and concavity between iliac facet and head greater; (2) iliac facet larger and more irregularly shaped; (3) trochanter larger and more prominent; (4)

distal end wider; (5) ligamental attachment at base of fibular condyle more prominent; (6) condyles larger; (7) rotular groove deeper.

Tibiotarsus with (1) shaft reasonably straight and stout (in D. viduata and D. bicolor there is a greater internal concavity and distal third of shaft has larger posteriorly directed convexity); (2) inner cnemial crest larger; (3) condyles not reflected anteriorly.

Tarsometatarsus with (1) intercotylar prominence less prominent; (2) cotylae large; (3) external edge of hypotarsus longer, positioned proximally; (4) external trochlea slightly narrower, but middle and internal trochleae wider; (5) internal trochlea projecting less distally.

Remarks. D. autumnalis is recorded in western Ecuador south to the southernmost coastal province (Chapman, 1926), and occasionally on the coast of Peru (Koeppke, 1970). However, it was not recorded by Marchant (1958) on the Santa Elena Peninsula of Ecuador. The presence of this species may indicate an abundance of vegetation surrounding the fossil site because of the species preference for quiet waters surrounded by forests (Delacour, 1954).

Subfamily Tadorninae Reichenbach

"Humerus with (1) fairly prominent capital shaft ridge directed toward external tuberosity; (2) area of origin of external head of triceps relatively narrow; (3) deltoid crest relatively large and flaring, and in lateral view more rounded, or if an abrupt bend occurs, it lies more posteriad; (4) deltoid crest extending farther distad; (5) head rotated so that external tuberosity is higher."
(Woolfenden, 1961, p. 108)

Tadorninae, n. gen.

Holotype. Tadorninae, n. gen. n. sp.

Diagnosis. Humerus resembles that of Lophonetta Riley and differs from Chloephaga Eyton and Neochen Salvadori by having (1) head more rounded in anconal view; (2) external tuberosity reduced and elongated; (3) external head of triceps only slightly, if any, undercutting head; (4) deltoid crest shorter and less flaring; (5) capital groove rotated internally, reducing size of internal tuberosity and increasing size of head; (6) attachment of anterior articular ligament less elevated; (7) shaft flaring less to meet ectepicondyle; (8) internal condyle elongated, less bulbous.

Humerus differs from that of Lophonetta by having (1) attachment of M. supracoracoideus on external tuberosity proportionately more elongated; (2) capital groove narrower and straighter; (3) deltoid crest shorter and less flaring, with sharp angle at its midpoint; (4) bicipital crest shorter and more rounded; (5) pneumatic fossa completely rimmed by heavy bone, such that distal edge is elevated above floor of bicipital crest; (6) pneumatic fossa with highest point located under tip of internal tuberosity (under median crest in Lophonetta); (7) shaft with greater palmar flexure in distal quarter, such that line drawn along anterior edge of shaft would almost bisect distal-most point of ectepicondyle (bisects anterior edge of ectepicondyle in Lophonetta); (8) ectepicondylar prominence smaller, with narrow ridge along proximal portion; (9) ectepicondyle less rounded and more V-shaped, extending farther distally; (10) attachment of anterior articular ligament wider than it is long (longer than wide in Lophonetta), less elevated, and located farther distally; (11) entepicondyle more prominent and rounded, not as large, with larger

entepicondylar prominence and external curvature to anconal side; (12) condyles more rounded, giving deeper and narrower intercondylar groove; (13) external condyle shorter, retaining internal flexure found in Lophonetta, but lacking distinct ridge leading internally from tip of condyle; (14) shaft widening more gradually toward distal end.

Tadorninae, n. gen. n. sp.

Holotype. Complete right humerus. (Pl. III, Fig. D)

Paratypes. One complete right and 3 complete left humeri, proximal ends of 6 right and 5 left humeri, distal ends of 2 right and 7 left humeri.

Diagnosis. As for genus. For measurements see Table 3. Measurements of the holotype are as follows: length, 68.6; proximal width, 14.7; distal width, 11.0; least width of shaft, 5.2.

Referred material. Three right and 4 left scapulae, 8 complete right and 7 complete left coracoids, humeral ends of 2 right and 1 left coracoid, 4 complete right and 3 complete left ulnae, proximal ends of 5 right and 3 left ulnae, distal ends of 5 right and 3 left ulnae, 2 complete left radii, proximal ends of 3 left radii, distal end of 1 right radius, 3 complete right and 2 complete left carpometacarpi, proximal ends of 2 right and 6 left carpometacarpi, 2 complete right and 2 complete left femora, proximal end of 1 right femur, 1 complete left tibiotarsus, distal ends of 4 right tibiotarsi, 4 complete right and 5 complete left tarsometatarsi, proximal end of 1 left tarsometatarsus. The 112 specimens, including holotype and paratypes, represent a minimum of 10 individuals.

Characters. All elements of Tadorninae, n. gen. n. sp. agree

with the humerus in resembling Lophonetta more than Chloephaga or Neochen. Tadorninae, n. gen. n. sp. differs from Lophonetta specularioides by having scapula with (1) coracoidal articulation proportionately more prominent, confluent with glenoid facet; (2) intermuscular line between attachments of *M. rhomboidius superficialis* and *M. subscapularis* better developed; (3) glenoid facet rotated such that it faces more anteriorly and distal end is displaced dorsally.

Coracoid with (1) head projecting less anteriorly; (2) head with width much greater; (3) glenoid facet flaring less laterally; (4) scapular facet larger.

Ulna with (1) attachment of anterior articular ligament more oval and less elongated; (2) external cotyla shorter but wider; (3) external condyle longer but less prominent; (4) carpal tuberosity more prominent.

Radius with (1) capital tuberosity more prominent, and shaft more constricted immediately distal to it; (2) carpal facet less curved; (3) shaft with internal flexure at distal end.

Carpometacarpus with (1) attachment of *M. flexor carpi ulnaris brevis* deeper; (2) external scapho-lunar ligamental attachment small, lying proximal to ridge extending from external cuneiform ligamental attachment to proximal fornix, and lying very close to external cuneiform ligamental attachment (the large size and posterior position of this attachment in other genera of the subfamily *Tadorninae* is listed as a subfamilial character by Woolfenden (1961)); (3) lobe at end of external rim of carpal trochlea, beginning at notch in rim, very long and prominent; (4) internal rim of carpal trochlea more prominent, giving more rounded proximal end in internal view; (5) internal ligamental fossa deeper; (6) area of fusion of metacarpal I

and metacarpal II much shorter both proximally and distally.

Femur with (1) neck more constricted; (2) area between anterior corner of trochanter and head more concave but similarly curved, not angular; (3) ridge on posterior surface of shaft leading to external condyle more prominent; (4) fibular condyle similar in shape, but less produced proximally; (5) external condyle well rounded where joined by fibular condyle (pointed in L. specularioides); (6) pit for M. tibialis anticus positioned more distally; (7) ridge on shaft leading distally to internal condyle, as traced by intermuscular line, less developed; (8) lip of internal condyle larger.

Tibiotarsus with (1) rotular crest forming straight line (curved in L. specularioides); (2) outer cnemial crest thickened on distal side; (3) intermuscular line curving internally proximally to approach attachment of M. flexor digitorum longus (curves less internally in L. specularioides); (4) external ligamental attachment elliptical (similar in L. specularioides), but positioned more proximally.

Tarsometatarsus with (1) anterior lip of internal cotyla more undercut; (2) intercotylar prominence with greater anterior, but smaller dorsal component; (3) posterior border of internal cotyla with more distinct lip; (4) trochleae very spread (similar in L. specularioides), but internal and external trochleae turned slightly more medially; (5) external rim of external trochlea less elongated; (6) internal side of middle trochlea lacking prominent internally directed ridge.

Remarks. Tadorninae, n. gen. n. sp. is the smallest representative of the subfamily known to date, and it is considerably smaller than related living South American species. Agreement of humeral

Table 3. Measurements of the scapula, coracoid, humerus, radius, ulna, carpometacarpus, femur, tibiotarsus, and tarsometatarsus of Tadorninae, n. gen. n. sp. and Lophonetta specularioides (in mm).

		Tadorninae n. gen. n. sp.	<u>Lophonetta specularioides</u>
Scapula			
Proximal Height	OR	8.2-9.0	11.9-12.9
	M	8.6	12.5
	N	7	3
Proximal Width	OR	2.5-2.8	3.6-3.8
	M	2.6	3.7
	N	7	3
Coracoid			
Length	OR	34.3-36.4	45.4-51.0
	M	35.4	49.1
	N	14	3
Head to Scapular Facet	OR	11.8-13.0	16.7-19.2
	M	12.3	18.2
	N	18	3
Proximal Depth	OR	6.2-7.6	9.5-10.1
	M	6.9	9.8
	N	18	3
Least Depth of Shaft	OR	3.5-4.0	5.1-5.7
	M	3.8	5.5
	N	15	3
Length of Sternal Facet	OR	13.4-14.9	17.7-20.3
	M	14.2	19.4
	N	4	3
Humerus			
Length	OR	61.9-68.6	95.3-101.8
	M	65.0	99.5
	N	4	3
Proximal Width	OR	13.9-14.7	19.0-22.4
	M	14.5	21.1
	N	16	3
Distal Width	OR	9.9-11.0	14.5-15.7
	M	10.5	15.3
	N	14	3

Table 3. Continued.

		Tadorninae n. gen. n. sp.	<u>Lophonetta</u> <u>specularioides</u>
Least	OR	4.6-5.2	6.1-6.5
Width of	M	4.9	6.3
Shaft	N	11	3
Radius			
Length	OR	51.5-52.9	82.6-86.8
	M	52.2	85.1
	N	2	3
Proximal	OR	3.5-3.9	4.9-5.2
Width	M	3.6	5.0
	N	5	3
Distal	OR	4.8-5.2	6.1-7.3
Width	M	5.0	6.9
	N	3	3
Ulna			
Length	OR	54.7-58.0	89.3-94.7
	M	56.3	92.1
	N	4	3
Proximal	OR	7.1-7.7	10.0-11.8
Width	M	7.4	10.9
	N	11	3
Distal	OR	6.3-7.6	9.5-10.8
Depth	M	7.0	10.2
	N	14	3
Least	OR	3.4-4.0	4.8-5.6
Width of	M	3.7	5.1
Shaft	N	7	3
Carpometacarpus			
Length	OR	38.4-41.2	57.1-60.7
	M	40.3	59.1
	N	5	3
Height	OR	9.2-9.9	12.9-15.0
Through	M	9.5	14.2
Metacarpal I	N	12	3

Table 3. Continued.

		Tadorninae n. gen. n. sp.	<u>Lophonetta</u> <u>specularioides</u>
Proximal	OR	4.1-4.6	5.9-6.7
Width	M	4.4	6.4
	N	12	3
Least	OR	3.3-4.6	3.9-4.8
Width of	M	3.6	4.5
Shaft	N	5	3
Length of	OR	4.9-5.3	8.9-9.1
Distal	M	5.2	9.0
Fornix	N	5	3
Femur			
Length	OR	36.9-37.3	52.6-59.1
	M	37.1	56.1
	N	3	3
Proximal	OR	7.5-8.0	9.9-11.2
Width	M	7.7	10.5
	N	5	3
Distal	OR	8.0	11.7-12.9
Width	M	8.0	12.5
	N	3	3
Least	OR	3.2-3.3	4.8-5.8
Width of	M	3.2	5.3
Shaft	N	5	3
Tibiotarsus			
Length	OR	58.5	85.7-95.4
	M	-	92.1
	N	1	3
Proximal	OR	6.6	9.6-10.4
Width	M	-	10.0
	N	1	3
Distal	OR	6.5-6.9	9.4-10.4
Width	M	6.6	10.0
	N	5	3

Table 3. Continued.

		Tadorninae n. gen. n. sp.	<u>Lophonetta</u> <u>specularioides</u>
Least	OR	2.8	4.3-4.7
Width of	M	-	4.4
Shaft	N	1	3
Depth of	OR	7.2-7.3	10.5-11.0
Internal	M	7.3	10.8
Condyle	N	5	3
Tarsometatarsus			
Length	OR	33.6-38.5	51.0-56.9
	M	35.3	54.3
	N	7	3
Proximal	OR	6.8-7.4	10.3-10.9
Width	M	7.1	10.7
	N	9	3
Distal	OR	7.2-7.8	10.4-11.0
Width	M	7.5	10.8
	N	7	3
Least	OR	3.5-3.8	4.0-4.5
Width of	M	3.6	4.3
Shaft	N	10	3
Width of	OR	2.8-3.3	4.6-5.0
Middle	M	3.1	4.8
Trochlea	N	9	3

characters with those of the subfamily as listed by Woolfenden (1961) indicate that it is placed in the correct subfamily, despite its small size and variance with a few other subfamilial characters in other elements.

Genus Chloephaga Eyton

Chloëphaga melanoptera (Eyton)

Andean Goose

Material. One right quadrate, 1 right and 2 left scapulae, 4 complete right and 2 complete left coracoids, humeral ends of 1 right and 3 left coracoids, 1 complete left humerus, proximal ends of 1 right and 4 left humeri, distal ends of 1 right and 5 left humeri, 1 complete right ulna, proximal end of 1 right ulna, distal ends of 5 right and 4 left ulnae, proximal end of 1 right and 1 left radius, distal ends of 2 right and 1 left radius, 4 complete right and 1 complete left carpometacarpus, proximal ends of 4 right and 2 left carpometacarpi, 1 complete pelvis, 2 complete right and 1 complete left femur, proximal ends of 2 right and 4 left femora, distal ends of 4 right and 4 left femora, proximal end of 2 left tibiotarsi, distal ends of 3 right and 6 left tibiotarsi, 1 complete left tarsometatarsus, proximal ends of 2 right and 2 left tarsometatarsi, distal ends of 2 right and 1 left tarsometatarsus. The 91 specimens represent a minimum of 7 individuals.

Characters. The large size of Chloëphaga readily separates it from other genera of the subfamily Tadorninae found in South America, and indeed, in size of individuals it is the largest genus of the family in South America. As the fossil specimens did not differ from the C. melanoptera available for comparison, and C. melanoptera is the only

species of the genus occurring in Peru today, the material is referred to that species.

Remarks. C. melanoptera is primarily resident in the high Andes, living up to the snow line. It does, however, migrate to lower altitudes during the non-breeding season. It has not been recorded in the Andes closer than 100 miles south of the fossil site (Koepcke, 1970). Because this species feeds almost exclusively on grass and is seldom seen on water (Delacour, 1954), the presence of an abundant ground cover of vegetation near the fossil site would seem to be more likely to attract this species than a body of water surrounded by sparse vegetation.

A number of the specimens appear to represent immature individuals.

Subfamily Anatinae (Vigor)

"Humerus with (1) capital shaft ridge obsolete; (2) pneumatic fossa opening, containing bony struts; (3) ectepicondyle typically equal or subequal in height to entepicondyle." (Woolfenden, 1961, p. 109)

Genus Cairina Fleming

Cairina moschata (Linnaeus)

Muscovy Duck

Material. One right articular, 4 left scapulae, 2 complete right coracoids, humeral end of 1 right coracoid, proximal ends of 2 right humeri, distal ends of 2 right and 1 left humerus, 2 complete right ulnae, proximal end of 1 left ulna, distal ends of 1 right and 3 left ulnae, proximal ends of 1 right and 1 left radius, distal ends of 1 right and 1 left radius, 1 complete left carpometacarpus, proximal ends of 1 right and 1 left carpometacarpus, distal end of

2 right tibiotarsi, 1 complete left tarsometatarsus, proximal end of 1 left tarsometatarsus, distal end of 2 left tarsometatarsi. The 33 specimens represent a minimum of 4 individuals.

Characters. Cairina is easily separated from Sarkidiornis, the most closely related genus present in South America.

Remarks. C. moschata, a forest duck, occurs on the arid coast of Peru only by accident today. It has been recorded only once, near Lima. Marchant (1958) did not report it from the arid Santa Elena Peninsula of Ecuador. Chapman (1926) reported this species near the coast only 20 miles north of the Peru-Ecuador border, and less than 120 miles from the fossil site, but in a completely different type of habitat.

The sedentary habits of this species would seem to indicate that either its range extended much farther south than today, increasing the number of stragglers, or that it was in residence. If Cairina was in residence its preference for water surrounded by forests would indicate a considerable amount of vegetation in the area.

Genus Anas Linnaeus

Anas n. sp. 1

Holotype. Complete left humerus (internal tuberosity and bicipital crest broken). (Pl. III, Fig. E)

Diagnosis. Agrees with Anas and differs from other genera of subfamily Anatinae by having those characters of the genus as described by Woolfenden (1961).

Differs from living species of Anas by having (1) head of humerus small, profile rounded in palmar view, and projecting more anconally than distally (similar in Anas (Callonetta) leucophrys Vieillot; head

large, subrounded, and projecting more distally than anconally in Anas (Amazonetta) brasiliensis Gmelin, A. crecca Linnaeus, and A. cyanoptera (Vieillot)); (2) head without inflection (similar in A. leucophrys, A. crecca, and A. cyanoptera; head inflected in A. brasiliensis); (3) internal tuberosity broken, but appearing prominent (similar in A. brasiliensis, A. crecca, and A. cyanoptera; reduced in A. leucophrys); (4) attachment of M. coracobrachialis posterior forming short, broad shelf, not extending down median crest (moderate to long, broad, usually not forming shelf, and usually extending down median crest in A. leucophrys, A. brasiliensis, A. crecca, and A. cyanoptera); (5) median crest prominent (similar in A. leucophrys and A. brasiliensis; slender to moderately prominent in A. crecca and A. cyanoptera); (6) pneumatic fossa elongated, not entering into internal tuberosity (moderately elongated, not entering into internal tuberosity in A. brasiliensis; slightly elongated and entering into internal tuberosity in A. leucophrys, A. crecca, and A. cyanoptera); (7) deltoid crest not flaring, with depression at distal end (similar in A. crecca; flaring, without depression in A. leucophrys and A. brasiliensis; not flaring, without depression, and reduced in size in A. cyanoptera); (8) attachment of M. pectoralis superficialis rotated palmarly (similar in A. brasiliensis; not rotated in A. leucophrys, A. crecca, and A. cyanoptera); (9) shaft with moderate internal curvature immediately distal to bicapital crest, giving moderately sigmoid shaft (similar in A. leucophrys; sharp internal curvature in A. brasiliensis, giving strongly sigmoid shaft; slight internal curvature in A. crecca and A. cyanoptera, giving weakly sigmoid shaft); (10) impression of M. brachialis anticus relatively deep, oriented at small angle to axis of shaft (deep in

A. brasiliensis; shallow in A. leucophrys, A. crecca, and A. cyanoptera; oriented at large angle to axis of shaft in all); (11) attachment of anterior articular ligament longer than wide (width roughly equal to length in A. leucophrys, A. brasiliensis, A. crecca, and A. cyanoptera); (12) entepicondyle rotated so internal side faces antero-distally (rotated strongly anteriorly in A. leucophrys and A. brasiliensis; rotated slightly to moderately anteriorly in A. cyanoptera; not rotated in A. crecca); (13) entepicondyle rounded distally, not produced (subrounded distally and very produced in A. leucophrys; subangular distally and moderately produced in A. brasiliensis; angular to subangular distally and moderately produced in A. crecca and A. cyanoptera); (14) internal tip of external condyle broken (undercut in A. leucophrys, A. brasiliensis, A. crecca, and A. cyanoptera); (15) olecranol fossa long (similar in A. leucophrys and A. cyanoptera; short in A. brasiliensis and A. crecca).

For measurements see Table 4. Measurements of the holotype are as follows: length, 56.4; proximal width, 13; distal width, 9.2; least width of shaft, 4.3.

Referred material. One right scapula, 2 complete right coracoids, 1 complete right and 1 complete left ulna, distal end of 1 right ulna, proximal end of 1 left radius, distal end of 1 right radius, proximal end of 1 right carpometacarpus, distal end of 1 right and 1 left tibiotarsus, 1 complete left tarsometatarsus. The 13 elements, including holotype, represent a minimum of 2 individuals.

Characters. Scapula with (1) acromion of moderate length, narrow, with strong anterior curvature (wide, of similar length and curvature in A. leucophrys; short and wide, with very slight anterior curvature in A. crecca; long and wide, with moderate anterior curvature

in A. cyanoptera); (2) glenoid facet of moderate length and narrow, lacking strong projection to antero-ventral corner (similar, but long, in A. leucophrys; long and wide, with prominent antero-ventral corner in A. brasiliensis, A. crecca, and A. cyanoptera); (3) attachment of Lig. furculo-scapulare dorsale oval, located dorsal to midline of shaft (similar in A. leucophrys, A. brasiliensis, and A. crecca; elongated and situated ventral to midline of shaft in A. cyanoptera).

Coracoid with (1) coracohumeral surface long, relatively wide, not widening markedly anteriorly, with moderate curvature, and positioned internally to edge of triosseal canal (short, narrow, not widening markedly anteriorly, of moderate curvature, positioned slightly internally in A. leucophrys; long, wide, widening markedly anteriorly, of slight curvature, and positioned internally in A. brasiliensis; long, narrow, moderate to marked widening anteriorly, of slight to moderate curvature, not positioned internally in A. crecca and A. cyanoptera); (2) attachment of Lig. humero-coracoideum anterus superius slightly elevated (similar in A. leucophrys and A. brasiliensis; not elevated in A. crecca and A. cyanoptera); (3) scapular facet small and elongated (similar in A. leucophrys and A. brasiliensis; large oval in A. crecca and A. cyanoptera).

Ulna with (1) distal lip of external cotyla broad, extending moderately distally (similar in A. brasiliensis; internal side of external cotyla extends distally much farther than external side in A. leucophrys, A. crecca, and A. cyanoptera); (2) ridge leading to shaft from carpal tuberosity large (similar in A. crecca; slight to moderate ridge in A. leucophrys, A. brasiliensis, and A. cyanoptera).

Radius with no distinguishing characters other than size.

Carpometacarpus with (1) process of metacarpal I low and of

moderate length (low, with distal edge sloping sharply proximally in A. leucophrys; high and short in A. brasiliensis; of moderate height and length in A. crecca and A. cyanoptera); (2) proximal edge of metacarpal I sloping sharply proximally (similar in A. leucophrys and A. cyanoptera; moderate slope in A. crecca; slight slope in A. brasiliensis); (3) internal face of metacarpal I slightly excavated (similar in A. crecca; moderately to deeply excavated in A. leucophrys, A. brasiliensis, and A. cyanoptera); (4) proximal area of fusion of metacarpal II and metacarpal III very long (long in A. leucophrys and A. brasiliensis; short in A. crecca and A. cyanoptera); (5) external rim of carpal trochlea rounded proximally (subangular to angular in A. leucophrys, A. brasiliensis, A. crecca, and A. cyanoptera); (6) area covered by external cuneiform ligament markedly convex (similar in A. leucophrys; slightly convex in A. brasiliensis; flat in A. crecca and A. cyanoptera); (7) posterior carpal fossa of essentially uniform width (similar in A. leucophrys and A. brasiliensis; wide distally, narrowing gradually proximally in A. crecca; wide proximally and distally with central constriction in A. cyanoptera).

Tibiotarsus with (1) external face of distal end flat (similar in A. leucophrys, A. brasiliensis, and A. crecca; flat or slightly concave in A. cyanoptera); (2) internal condyle flaring medially (not flaring in A. leucophrys, A. brasiliensis, A. crecca and A. cyanoptera).

Tarsometatarsus with (1) intercotylar prominence broad (similar in A. leucophrys, A. brasiliensis, A. crecca, and A. cyanoptera); (2) shaft narrowing sharply immediately distal to internal cotyla (similar in A. leucophrys, A. brasiliensis, and A. crecca; narrows gradually in A. cyanoptera); (3) hypotarsus short (similar in

A. leucophrys and A. crecca; long in A. brasiliensis and A. cyanoptera); (4) anterior face of shaft straight in lateral view (similar in A. cyanoptera; slight concavity in A. brasiliensis and A. crecca; moderate concavity in A. leucophrys); (5) internal trochlea projecting distally without turning externally (similar in A. leucophrys, A. brasiliensis, and A. cyanoptera; turned slightly externally in A. crecca).

Remarks. Anas n. sp. 1 and the following two new species of Anas are compared with A. leucophrys, A. brasiliensis, A. crecca, and A. cyanoptera because the fossil species are all small and the four living species represent the smallest forms of the genus. Although A. crecca does not reach South America it was used rather than A. discors, which does reach South America, because the two species are extremely difficult to separate osteologically, and of the two the former has smaller individuals.

The numbers under each element correspond in the comparisons of all three of the new species.

Anas n. sp. 2

Holotype. Complete left humerus. (Pl. IV, Fig. D)

Paratypes. One complete right and 1 complete left humerus, proximal ends of 1 right and 1 left humerus, distal ends of 2 right and 1 left humerus.

Diagnosis. Agrees with Anas and differs from other genera of the subfamily Anatinae by having those characters of the genus as described by Woolfenden (1961).

Differs from other species of Anas by having (1) head large, profile subrounded in palmar view, and projecting more anconally than distally; (2) head not inflected; (3) internal tuberosity reduced;

(4) attachment of *M. coracobrachialis* posterior moderate to long, broad, forming slight shelf, extending down median crest; (5) median crest prominent; (6) pneumatic fossa round, entering moderately into internal tuberosity; (7) deltoid crest long, very flaring, without depression at distal end; (8) attachment of *M. pectoralis superficialis* not rotated palmarly; (9) shaft with sharp internal curvature immediately distal to bicipital crest, giving strongly sigmoid shaft; (10) impression of *M. brachialis anticus* extremely shallow, oriented at large angle to axis of shaft; (11) attachment of anterior articular ligament high and very small; (12) entepicondyle rotated moderately anteriorly; (13) entepicondyle rounded distally, not produced; (14) internal lip of external condyle not undercut, but with slight ridge leading internally; (15) olecranon fossa short.

For measurements see Table 4. Measurements of the holotype are as follows: length, 65.2; proximal width, 14.1; distal width, 9.7; least width of shaft, 4.5.

Referred material. One left scapula, 2 complete right and 4 complete left coracoids, 1 complete right ulna, proximal ends of 2 left radii, 1 complete left carpometacarpus, proximal ends of 1 right and 1 left carpometacarpus, proximal end and shaft of 1 right femur, distal ends of 5 right and 1 left tibiotarsus, 1 complete left tarso-metatarsus. The 29 specimens, including holotype and paratypes, represent a minimum of 5 individuals.

Characters. Scapula with (1) acromion long and wide, with moderate anterior curvature; (2) glenoid facet long and wide, with antero-ventral corner not projecting; (3) attachment of Lig. furculoscapulare dorsale round, located on midline of shaft.

Coracoid with (1) coracohumeral surface wide and of moderate

length, with moderate to marked widening anteriorly, moderate to marked curvature, and positioned slightly internally; (2) attachment of Lig. humero-coracoideum antierius superius elevated; (3) scapular facet large oval.

Ulna with (1) internal side of external cotyla extending much farther distally than external side; (2) ridge leading from carpal tuberosity to shaft very small.

Radius with no distinguishing characters other than size.

Carpometacarpus with (1) process of metacarpal I long and low; (2) proximal edge of metacarpal I sloping slightly proximally; (3) proximal area of fusion of metacarpal II and metacarpal III long, and distal area of fusion short (distal area short in A. leucophrys; long in A. brasiliensis and A. crecca; very long in A. cyanoptera); (4) internal face of metacarpal I slightly excavated; (5) external rim of carpal trochlea subangular proximally; (6) area covered by external cuneiform ligament markedly convex; (7) posterior carpal fossa wide distally, narrowing abruptly proximally.

Femur with (1) head large, projecting medially (small to moderate sized head projecting medially in A. leucophrys, A. crecca, and A. cyanoptera; very large head projecting equally dorsally and medially in A. brasiliensis); (2) attachment of M. ilio-trochantericus medius very long (long in A. leucophrys; of moderate length in A. brasiliensis and A. crecca; short in A. cyanoptera); (3) iliac facet curving sharply medially posteriorly (moderate curvature in A. leucophrys and A. brasiliensis; slight if any curvature in A. crecca and A. cyanoptera).

Tibiotarsus with (1) external face of distal end markedly concave; (2) internal condyle not flaring medially.

Tarsometatarsus with (1) intercotylar prominence broad; (2) shaft narrowing sharply immediately posterior to internal cotyla; (3) hypotarsus long; (4) anterior face of shaft straight in lateral view; (5) internal trochlea moderately turned externally.

Anas n. sp. 3

Holotype. Complete left humerus. (Pl. IV, Fig. E)

Paratypes. Proximal end of 1 right humerus, distal end of 1 right humerus.

Diagnosis. Agrees with Anas and differs from other genera of the subfamily Anatinae by having those characters of the genus as described by Woolfenden (1961).

Differs from other species of Anas by having (1) head large, profile rounded in palmar view, and projecting more distally than anconally; (2) head not inflected; (3) internal tuberosity reduced; (4) attachment of M. coracobrachialis posterior short broad shelf, not extending down median crest; (5) median crest moderately prominent; (6) pneumatic fossa slightly elongated, entering only slightly into internal tuberosity; (7) deltoid crest long, moderately flaring, without depression at distal end; (8) attachment of M. pectoralis superficialis not rotated palmarly; (9) shaft with moderate internal curvature immediately distal to bicipital crest, giving moderately sigmoid shaft; (10) impression of M. brachialis anticus shallow, oriented at large angle to axis of shaft; (11) attachment of anterior articular ligament as wide as it is long; (12) entepicondyle rotated moderately anteriorly; (13) entepicondyle rounded distally, not produced, very small; (14) internal tip of external condyle not undercut, but with slight ridge present leading internally; (15) olecranon fossa short.

For measurements see Table 4. Measurements of the holotype are as follows: length, 57.7; proximal width, 12.3; distal width, 9.1; least width of shaft, 4.4.

Referred material. One complete left coracoid, distal end of 1 left tibiotarsus, 1 complete right tarsometatarsus. The 5 specimens, excluding holotype but including paratypes, represent a minimum of 1 individual.

Characters. Coracoid with (1) coracohumeral surface short, narrow, widening moderately anteriorly, of moderate curvature, and not positioned internally; (2) attachment of Lig. humero-coracoideum antierius superius elevated; (3) scapular facet large oval.

Tibiotarsus with (1) external face of distal end flat; (2) internal condyle flaring medially.

Tarsometatarsus with (1) intercotylar prominence slender; (2) shaft narrowing sharply immediately posterior to internal cotyla; (3) hypotarsus short; (4) anterior face of shaft markedly convex in lateral view; (5) internal trochlea strongly turned externally.

Remarks. The holotype of Anas n. sp. 3 is from La Carolina, Ecuador, not the Talara Tar Seeps. The Ecuadorian specimen was chosen for the holotype because of its completeness and the lack of a complete specimen in the Talara material. The paratypes and all referred material are from the Talara Tar Seeps.

Anas bahamensis Linnaeus

Bahama Pintail

Material. Portions of 14 crania, 5 frontals, 9 right and 11 left quadrates, 3 right and 3 left articulars, 5 right and 7 left

Table 4. Measurements of the scapula, coracoid, humerus, radius, ulna, carpometacarpus, femur, tibiotarsus, and tarsometatarsus of Anas n. sp. 1 (excluding femur), Anas n. sp. 2, Anas n. sp. 3 (coracoid, humerus, tibiotarsus, and tarsometatarsus only), A. leucophrys, A. brasiliensis, A. cyanoptera, and A. crecca carolinensis (in mm).

		<u>Anas</u> n. sp. 1	<u>Anas</u> n. sp. 2	<u>Anas</u> n. sp. 3
Scapula				
Proximal	OR	7.4	8.4	
Height	M	-	-	
	N	1	1	
Proximal	OR	2.4	2.5	
Width	M	-	-	
	N	1	1	
Coracoid				
Length	OR	31.7	32.9-33.7	30.7
	M	-	33.4	-
	N	1	3	1
Head to	OR	10.9	10.7-11.6	10.3
Scapular	M	-	11.2	-
Facet	N	1	4	1
Proximal	OR	6.4	5.9-6.5	5.7
Depth	M	-	6.3	-
	N	1	4	1
Least	OR	3.2-3.7	3.4-3.9	3.3
Depth of	M	3.5	3.6	-
Shaft	N	2	6	1
Length of	OR		12.2-13.5	
Sternal	M		12.9	
Facet	N		2	
Humerus				
Length	OR	56.4	61.1-65.2	57.7
	M	-	63.1	-
	N	1	2	1
Proximal	OR	12.7	13.2-14.1	12.3-13.1
Width	M	-	13.5	12.7
	N	1	4	2

Table 4. Extended.

<u>Anas</u> <u>leucophrys</u>	<u>Anas</u> <u>brasiliensis</u>	<u>Anas</u> <u>cyanoptera</u>	<u>Anas</u> <u>crecca</u>
7.1	9.5	7.5-9.6	7.3-8.1
-	-	8.3	7.7
1	1	5	8
2.0	3.0	2.4-2.7	2.5-3.0
-	-	2.5	2.7
1	1	5	8
32.8	41.1	32.6-39.8	31.5-34.1
-	-	35.1	32.6
1	1	5	8
11.2	13.8	10.8-13.5	10.8-11.5
-	-	11.8	11.1
1	1	5	8
6.6	8.3	6.2-7.5	6.1-7.0
-	-	6.7	6.3
1	1	5	8
4.3	4.7	3.3-4.1	3.2-4.0
-	-	3.7	3.6
1	1	5	8
12.4	16.4	12.7-16.0	12.8-14.4
-	-	13.7	13.6
1	1	5	8
59.8	74.8	61.0-71.5	55.9-59.5
-	-	64.6	57.9
1	1	5	8
13.5	17.0	12.7-15.7	12.5-13.2
-	-	13.6	12.8
1	1	5	8

Table 4. Continued.

		<u>Anas</u> n. sp. 1	<u>Anas</u> n. sp. 2	<u>Anas</u> n. sp. 3
Distal Width	OR	9.2	9.6-10.1	9.1-9.4
	M	-	9.8	9.2
	N	1	5	2
Least Width of Shaft	OR	4.3	4.3-4.8	4.4
	M	-	4.6	-
	N	1	5	1
Radius Length				
	OR			
	M			
	N			
Proximal Width	OR	3.2	3.6-3.7	
	M	-	3.7	
	N	1	2	
Distal Width	OR	4.5		
	M	-		
	N	1		
Ulna Length				
	OR	53.0-53.6	56.0	
	M	53.3	-	
	N	2	1	
Proximal Width	OR	6.8	7.6	
	M	-	-	
	N	1	1	
Distal Depth	OR	6.5-6.7	7.6	
	M	6.6	-	
	N	3	1	
Least Width of Shaft	OR	3.2-3.5	3.8	
	M	3.4	-	
	N	2	1	
Carpometacarpus Length				
	OR		39.1	
	M		-	
	N		1	

Table 4. Extended.

<u>Anas</u> <u>leucophrys</u>	<u>Anas</u> <u>brasiliensis</u>	<u>Anas</u> <u>cyanoptera</u>	<u>Anas</u> <u>crecca</u>
9.7	12.6	9.1-11.7	8.3-9.7
-	-	9.9	9.3
1	1	5	8
4.7	5.8	4.4-5.1	4.2-4.7
-	-	4.6	4.4
1	1	5	8
50.7	61.5	46.8-56.7	44.2-46.6
-	-	50.5	45.8
1	1	5	8
3.3	4.3	3.1-4.0	3.1-3.3
-	-	3.4	3.2
1	1	5	8
4.6	5.7	3.9-5.3	4.2-4.5
-	-	4.6	4.3
1	1	5	8
54.7	66.3	50.6-61.1	48.3-51.1
-	-	54.4	50.2
1	1	5	8
6.8	8.9	6.6-8.5	6.2-6.9
-	-	7.1	6.6
1	1	5	8
6.9	8.6	6.7-8.2	6.6-7.0
-	-	7.1	6.8
1	1	5	8
3.4	4.4	3.3-3.9	3.3-3.6
-	-	3.5	3.4
1	1	5	8
37.6	46.0	36.0-43.9	34.5-37.1
-	-	38.9	36.2
1	1	5	8

Table 4. Continued.

		<u>Anas</u> n. sp. 1	<u>Anas</u> n. sp. 2	<u>Anas</u> n. sp. 3
Proximal	OR	4.0	4.3	
Width	M	-	4.3	
	N	1	3	
Height	OR	8.6	8.9	
Through	M	-	8.9	
Metacarpal I	N	L	2	
Least	OR	3.2	3.0-3.3	
Width of	M	-	3.1	
Shaft	N	1	2	
Length of	OR		4.7	
Distal	M		-	
Fornix	N		1	
Femur				
Length	OR			
	M			
	N			
Proximal	OR		7.0	
Width	M		-	
	N		1	
Distal	OR			
Width	M			
	N			
Least	OR		3.8	
Width of	M		-	
Shaft	N		1	
Tibiotarsus				
Length	OR			
	M			
	N			
Proximal	OR			
Width	M			
	N			
Distal	OR	6.1-6.5	6.3-6.5	6.0
Width	M	6.3	6.5	-
	N	2	6	1

Table 4. Extended.

<u>Anas</u> <u>leucophrys</u>	<u>Anas</u> <u>brasiliensis</u>	<u>Anas</u> <u>cyanoptera</u>	<u>Anas</u> <u>crecca</u>
3.9	4.9	3.9-4.7	3.8-4.1
-	-	4.1	3.9
1	1	5	8
8.3	11.0	8.7-10.2	8.4-9.0
-	-	9.2	8.7
1	1	5	8
3.2	3.8	2.8-3.7	2.8-3.3
-	-	3.3	3.1
1	1	5	8
4.9	7.2	4.9-6.8	4.5-5.3
-	-	6.1	5.1
1	1	5	8
33.6	43.4	31.5-38.3	31.9-33.6
-	-	34.8	32.9
1	1	5	8
7.1	9.3	6.1-7.5	6.1-6.8
-	-	6.7	6.6
1	1	5	8
7.4	9.1	6.5-8.4	6.7-7.3
-	-	7.2	6.8
1	1	5	8
2.9	3.4	2.8-3.2	2.6-3.0
-	-	2.9	2.8
1	1	5	8
55.1	67.7	53.1-64.5	52.7-56.5
-	-	57.7	54.4
1	1	5	8
6.1	7.4	5.2-6.9	5.5-6.0
-	-	6.1	5.7
1	1	5	8
5.8	7.5	5.4-6.7	5.3-5.8
-	-	5.9	5.5
1	1	5	8

Table 4. Continued.

		<u>Anas</u> n. sp. 1	<u>Anas</u> n. sp. 2	<u>Anas</u> n. sp. 3
Least	OR	2.7	2.9-3.2	
Width of	M	-	3.0	
Shaft	N	1	3	
Depth of	OR		6.7-7.3	6.4
Internal	M		7.0	-
Condyle	N		4	1
Tarsometatarsus				
Length	OR	30.8	35.6	29.5
	M	-	-	-
	N	1	1	1
Proximal	OR	6.6	7.3	6.6
Width	M	-	-	-
	N	1	1	1
Distal	OR	6.3	7.2	6.2
Width	M	-	-	-
	N	1	1	1
Least	OR	3.0	3.5	2.9
Width of	M	-	-	-
Shaft	N	1	1	1
Width of	OR	2.9	3.2	2.8
Middle	M	-	-	-
Trochlea	N	1	1	1

Table 4. Extended.

<u>Anas</u> <u>leucophrys</u>	<u>Anas</u> <u>brasiliensis</u>	<u>Anas</u> <u>cyanoptera</u>	<u>Anas</u> <u>crecca</u>
2.7	3.5	2.5-2.9	2.4-2.8
-	-	2.7	2.6
1	1	5	8
6.6	8.9	6.3-7.8	6.0-6.6
-	-	6.8	6.3
1	1	5	8
29.9	38.4	31.3-35.5	28.1-31.8
-	-	32.8	29.6
1	1	5	8
6.5	7.8	6.1-7.0	5.7-6.2
-	-	6.3	5.9
1	1	5	8
6.5	7.7	5.5-6.7	5.7-6.0
-	-	6.2	5.8
1	1	5	8
3.0	3.9	2.7-3.3	2.5-3.0
-	-	3.1	2.8
1	1	5	8
2.9	3.7	2.6-3.3	2.5-2.9
-	-	2.7	2.7
1	1	5	8

mandibular fragments, 122 right and 106 left scapulae, 172 complete right and 128 complete left coracoids, humeral ends of 71 right and 87 left coracoids, 35 complete right and 34 complete left humeri, proximal ends of 86 right and 104 left humeri, distal ends of 103 right and 110 left humeri, 71 complete right and 64 complete left ulnae, proximal ends of 69 right and 61 left ulnae, distal ends of 87 right and 78 left ulnae, 14 complete right and 19 complete left radii, proximal ends of 83 right and 61 left radii, distal ends of 52 right and 41 left radii, 135 complete right and 103 complete left carpometacarpi, proximal ends of 73 right and 73 left carpometacarpi, 29 complete right and 21 complete left femora, proximal ends of 22 right and 25 left femora, distal ends of 11 right and 7 left femora, 5 complete right and 4 complete left tibiotarsi, proximal ends of 26 right and 15 left tibiotarsi, distal ends of 102 right and 91 left tibiotarsi, 60 complete right and 65 complete left tarsometatarsi, proximal ends of 17 right and 19 left tarsometatarsi, distal ends of 24 right and 21 left tarsometatarsi. The 2,864 specimens represent a minimum of 243 individuals.

Characters. Only two species (A. bahamensis and A. discors Linnaeus) of the subfamily Anatinae have been previously recorded from northwestern Peru, although I have seen A. cyanoptera (subspecies not determined) near Ciudad de Piura, Departamento de Piura (4 October 1971). A. bahamensis is easily separated on size from these two species, including the largest subspecies of A. cyanoptera, A. c. orinomus.

Anas flavirostris Vieillot, A. georgica Gmelin, A. puna Tshudi, and A. platalea Vieillot also occur in Peru today, but not in the northwestern section. A. bahamensis is readily separable from A. puna

and A. platalea by numerous osteological characters, and from smaller A. flavirostris by size. Elements of A. bahamensis are usually smaller than those of A. georgica, the most closely related species, but the two species overlap in size. A. bahamensis differs from A. georgica by having scapula with (1) concavity dorsal to proximal end of glenoid facet deep; (2) acromion longer.

Coracoid with (1) coracohumeral surface narrower and shorter; (2) head more rounded in medial view; (3) procoracoid projecting farther dorsally.

Humerus with (1) capital groove narrower; (2) internal tuberosity projecting less anconally; (3) attachment of Lig. humero-coracoideum antierius inferius smaller and positioned anconally on internal tuberosity; (4) concavity immediately external to attachment of M. proscapulohumeralis much narrower; (5) ectepicondylar prominence larger; (6) entepicondyle smaller; (7) external condyle narrower.

Ulna with (1) olecranon longer; (2) external cotyla smaller, with distal projection smaller; (3) internal cotyla more concave.

Radius with (1) capital tuberosity smaller; (2) ligamental prominence narrower, more distinct, and situated more laterally.

Carpometacarpus with (1) process of metacarpal I slightly longer and more rectangular, lacking a sharp anterior curvature; (2) posterior carpal fossa larger; (3) internal scapholunar ligamental attachment on proximal end of metacarpal III usually positioned proximally; (4) proximal area of fusion of metacarpal II and metacarpal III shorter.

Femur with (1) head smaller; (2) iliac facet narrower; (3) internal condyle not as deep; (4) external condyle not as deep, more rounded, and extending farther proximally.

Tibiotarsus with (1) concavity between internal articular surface and rotular crest shallower; (2) area between proximal internal ligamental attachment and flexor attachment slightly convex (very convex in A. georgica); (3) condyles less deep.

Tarsometatarsus with (1) cotylae smaller; (2) external ligamental attachment positioned proximally; (3) trochleae less compressed; (4) middle trochlea extending less proximally.

Remarks. A. bahamensis is widespread throughout tropical and subtropical South America, and is capable of rapidly colonizing impermanent bodies of water in large numbers, even in very arid areas (Marchant, 1958). It is very characteristic of coastal lagoons and where found is present in large numbers.

The large number of specimens of this species represents almost a third of the collection of fossil birds from this site.

I believe material referred to Archeoquerquedula lambrechtii by Spillman (1942) is in actuality Anas bahamensis. Although I have not seen his material, I do have considerable material from the same site as that cited by Spillman and it agrees with Anas bahamensis. Spillman did not describe any of the elements referred to Archeoquerquedula lambrechtii, but he did figure a skull. From his figure it is possible to determine that the length of the orbit is greater than the distance from the posterior edge of the orbit to the parietal. Of the species of Anas found in South America this condition is found only in Anas bahamensis. In all other species the distance from the posterior edge of the orbit to the parietal is greater than the length of the orbit.

Subfamily Oxyurinae Phillips

Genus Nomonyx RidgwayNomonyx dominicus (Linnaeus)

Masked Duck

Material. One complete left humerus.

Remarks. N. dominicus has been recorded as far south in western Peru as Lambeyeque, and Marchant (1958) reported it as scarce on the arid Santa Elena Peninsula of Ecuador. It is sedentary in habits, but strays great distances. It would appear from the single specimen that N. dominicus was not a regular resident at or near the fossil site.

Discussion of Family Anatidae

The nine species of waterfowl found in the Talara Tar Seeps avifauna represent almost 10 per cent of the non-passerine portion of the avifauna and give a good indication of what the habitat was like at the time of their fossilization. Although some of the species are well known colonizers of temporary ponds (A. bahamensis) or widely wandering species (Nomonyx dominicus), others indicate the presence of abundant grasses (Chloëphaga melonoptera) or forests (Dendrocygna autumnalis and Cairina moschata).

The most interesting species are of course the four that are extinct, and perhaps special notes should be made that all of them are of very small size. The relatively large number of elements representing each of the four species is large enough to remove any doubt that they are indeed separate species, especially considering the possibility of confusion in the three new small species of Anas.

The fact that the four extinct species are all small suggests

that although there was adequate water present there may have been annual periods of stress resulting from dry periods. If there were such annual periods of stress smaller sized individuals would allow for a greater density of each species than larger individuals. Of course there is the possibility that the four species were derived from similarly sized ancestral species.

That the four species became extinct suggests that they were endemic to at least northwestern Peru, and southwestern Ecuador in the case of Anas n. sp. 3, and that there must have been a sufficient period of stability for them to evolve as endemics. This would require a long period of adequate water supply, which recently disappeared, making the habitat uninhabitable. The speciation of the four species may have occurred much as it is currently occurring in Anas cyanoptera, where one finds three allopatric subspecies of quite different size ranges in northern South America.

The three new species of Anas tend to fill in some of the larger gaps in osteological characters between Anas and Anas (Callonetta) leucophrys and Anas (Amazonetta) brasiliensis noted by Woolfenden (1961). For this reason I have considered the latter two species and the three new species of the subfamily Anatinae as members of a larger, more inclusive genus Anas rather than proposing new genera for the new intermediate forms.

Order Accipitriformes (Vieillot)

Suborder Sarcoramphi (Ridgway)

Family Vulturidae (Illiger)

Vulturidae, n. gen.

Holotype. Vulturidae, n. gen. n. sp.

Diagnosis. Tarsometatarsus agrees with that of Vultur Linnaeus and Gymnogyps Lesson by having (1) intercotylar prominence large; (2) anterior metatarsal groove very deep with large attachment of M. tibialis anticus located immediately distal to proximal foramina; (3) hypotarsus flattened, roughly triangular in shape, with central ridge leading distally; (4) shaft robust, rectangular, widening proximally and distally to meet articular surfaces; (5) external and internal trochleae much smaller than middle trochlea and turned slightly toward midline of shaft; (6) size large.

Tarsometatarsus differs from that of Vultur and Gymnogyps by having (1) intercotylar prominence very high and narrow (low and broad in Vultur, high and of moderate width in Gymnogyps); (2) internal cotyla very deep, narrow, with very high, almost straight internal edge (deep, wide, internal edge moderately curved in Vultur; deep, of moderate width, with internal edge rounded in Gymnogyps); (3) external cotyla round, with articular surface extending onto external anterior metatarsal ridge (very elongated with articular surface restricted in Vultur, oval with articular surface restricted in Gymnogyps); (4) hypotarsus narrow, deeply grooved, moderately notched externally, with central ridge leading distally narrow (broad, very deeply grooved, deeply notched externally, with central ridge broad in Vultur; of moderate width, moderately grooved, moderately notched externally, with central ridge broad in Gymnogyps); (5) anterior metatarsal groove of moderate width and appears slightly pneumatic proximal to attachment of M. tibialis anticus (wide and highly pneumatic in Vultur, narrow and moderately pneumatic in Gymnogyps); (6) attachment of M. tibialis anticus very large with length equal to or exceeding length of anterior metatarsal groove

proximal to it (of moderate size, wider than long, much shorter than proximal portion of anterior metatarsal groove in Vultur; of moderate size, length greater than width, much shorter than proximal portion of anterior metatarsal groove in Gymnogyps); (7) attachment of M. extensor hallucis longus located approximately halfway between base of anterior metatarsal groove and top of internal metatarsal ridge (located near top of internal metatarsal ridge in Vultur and Gymnogyps); (8) external anterior metatarsal ridge broad and rounded and internal anterior metatarsal ridge of moderate width but with sharp proximal edge (broad, rounded external and narrow, moderately rounded internal anterior metatarsal ridge in Vultur; both internal and external anterior metatarsal ridge broad and rounded in Gymnogyps); (9) shaft moderately depressed external to hypotarsus (slightly, if any, depressed in Vultur, moderately to deeply depressed in Gymnogyps); (10) shaft transversely concave posteriorly at midpoint of shaft (flat to rounded in Vultur; flat to slightly concave in Gymnogyps); (11) shaft widens slightly to moderately to meet internal cotyla, widens abruptly to meet external cotyla (widens abruptly to meet both external and internal cotylae in Vultur, widens moderately to abruptly to meet internal cotyla and abruptly to meet external cotyla in Gymnogyps); (12) shaft widens much more to meet internal trochlea than it does to meet external trochlea, placing middle trochlea off center (widens equally to both internal and external trochleae, placing middle trochlea near midline of shaft in Vultur; similar in Gymnogyps); (13) internal trochlear surface small (large in Vultur; moderate to large in Gymnogyps); (14) internal trochlea extending distally to almost reach distal-most point of middle trochlea (does not project as far distally in Vultur and Gymnogyps); (15) internal

trochlea with rounded posterior edge (posterior edge arrow-shaped, directed posteriorly in Vultur; arrow-shaped, directed postero-proximally in Gymnogyps); (16) middle trochlea short (moderate to long in Vultur and Gymnogyps); (17) external trochlear surface large, not delimited sharply antero-proximally (moderate, sharply delimited antero-proximally in Vultur; moderate to large, moderately delimited antero-proximally in Gymnogyps); (18) external trochlea with distinct postero-proximal corner to posterior edge (rounded in Vultur; rounded to prominent proximal projection in Gymnogyps); (19) external trochlear notch moderately wide (very wide in Vultur; moderately wide in Gymnogyps).

Vulturidae, n. gen. n. sp.

Holotype. Complete right tarsometatarsus. (Pl. IV, Figs. A & B)

Paratypes. Complete right tarsometatarsus and distal end of 1 right tarsometatarsus.

Diagnosis. As for genus. For measurements see Table 5.

Measurements of the holotype are as follows: length, 121.8; proximal width, 25.4; distal width, 29.0; least width of shaft, 13.8; width of middle trochlea, 10.9.

Referred material. Portions of 2 sterna, 1 complete left coracoid, 2 left coracoids lacking head, humeral end of 1 right coracoid, sternal end of 1 left coracoid, shaft and distal end of 1 left humerus, proximal end of 1 right humerus, distal end of 1 right humerus, proximal end of 1 left ulna, distal end of 1 left ulna, proximal ends of 1 right and 1 left radius, distal ends of 1 right and 2 left radii, proximal end of 1 right carpometacarpus, distal end of 1 left tibiotarsus, proximal ends of 4 right femora, distal ends of 2 right femora. The 28 specimens, including holotype and

paratypes, represent a minimum of 4 individuals. In addition the following elements are tentatively referred to the species, but cannot be assigned with certainty: 2 left articulars, 1 left quadrate, portion of 1 cranium.

Characters. Sternum with (1) ventral lip of coracoidal sulcus markedly concave along ventral edge, matching short external anterior sternal facet of coracoid (not concave in Vultur and Gymnogyps); (2) carinal apex situated very far distally (situated short distance distally in Vultur, moderate distance in Gymnogyps); (3) carina large (of moderate size in Vultur and Gymnogyps); (4) ventral manubrial spine very broad (broad in Vultur, narrow in Gymnogyps).

Coracoid with (1) coracoidal fenestra lacking (present in Vultur and Gymnogyps); (2) shaft leading distally from external corner of glenoid facet forming large ridge (slight to moderate in Vultur, very slight in Gymnogyps); (3) shaft very concave between procoracoid and anterior sternal facet (not as concave in Vultur and Gymnogyps); (4) external portion of anterior sternal facet short, distinctly set off from base of shaft distally (long, not distinctly set off in Vultur and Gymnogyps); (5) procoracoid directed internally along plane of glenoid facet (directed more anteriorly in Vultur and Gymnogyps).

Humerus with (1) head narrow (wide in Vultur, narrow in Gymnogyps): (2) capital shaft ridge dropping off sharply on both sides (shaft more rounded in Vultur and Gymnogyps); (3) attachment of M. proscapulo-humeralis brevis elevated (not elevated in Vultur, elevated or not elevated in Gymnogyps); (4) pectoral attachment very prominent (less prominent in Vultur, more similar in Gymnogyps); (5) deltoid crest flaring distally (not flaring as much in Vultur and Gymnogyps); (6) shaft ventral to M. pectoralis superficialis not depressed

(depressed in Vultur, not depressed in Gymnogyps); (7) external condyle wide and short (narrow and long in Vultur and Gymnogyps); (8) internal condyle short (very long in Vultur, moderately long in Gymnogyps); (9) ectepicondylar prominence long, moderately produced proximally (of moderate length, not produced distally, greatly produced and angular proximally in Vultur; short, greatly produced and rounded in Gymnogyps); (10) internal condyle moderately rotated anteriorly, giving moderately flexed distal end (greatly rotated in Vultur, moderately rotated in Gymnogyps); (11) impression of M. brachialis anticus moderately deep (very deep in Vultur and Gymnogyps).

Ulna with (1) olecranon of moderate size (very large in Vultur, small to moderate in Gymnogyps); (2) attachment of anterior articular ligament small, not extending far distally (large, extending very far distally in Vultur; large, extending far distally in Gymnogyps); (3) area between external and internal condyles flat in external view (internal condyle projects slightly farther distally in Vultur and Gymnogyps); (4) carpal tuberosity large, joins shaft abruptly (large in Vultur, small in Gymnogyps, merges more gently with shaft in both).

Radius with (1) bicipital attachment large (small in Vultur and Gymnogyps); (2) bicipital tubercle large (large in Vultur, very small in Gymnogyps); (3) capital tuberosity bordered internally by deep notch, pierced by large nutrient foramina (shallow in Vultur, moderate in Gymnogyps, nutrient foramina small to moderate in both); (4) external corner of distal end rounded (flattened so angle is formed at external end of carpal facet in Vultur, more rounded in Gymnogyps); (5) tendinal groove bordered externally by high ridge (very slight in Vultur, moderate ridge in Gymnogyps); (6) distal end

with external edge curving sharply palmarly (almost straight in Vultur and Gymnogyps).

Carpometacarpus with (1) process of metacarpal I low, curving sharply proximally (high, with moderate proximal curvature in Vultur; moderately high, with slight proximal curvature in Gymnogyps); (2) external ligamental attachment a small deep pit bordered posteriorly by raised area (of moderate size, lying in a pit, with no raised area posteriorly in Vultur and Gymnogyps).

Femur with (1) trochanter of moderate size, subrounded (large, well rounded in Vultur; of moderate size, subrounded in Gymnogyps); (2) attachment of M. obturator externis deep (larger, not as deep, positioned similarly in Vultur; similar size, not as deep, located more posteriorly in Gymnogyps); (3) attachments of M. ilio-trochantericus medius and M. iliacus confluent and with surface ribbed (separate and not ribbed in Vultur and Gymnogyps); (4) concavity immediately distal to iliac facet posteriorly deep, bordered externally by large protuberance (shallow, very small protuberance in Vultur; very deep, moderate sized protuberance in Gymnogyps); (5) distal end of internal condyle subrounded in medial view (more rounded in Vultur; less rounded in Gymnogyps); (6) rotular groove moderately undercut distally (deeply undercut in Vultur, moderately undercut in Gymnogyps).

Tibiotarsus with (1) internal condyle short antero-posteriorly (long in Vultur and Gymnogyps); (2) distal internal ligamental attachment very deep (deep in Vultur, moderately deep in Gymnogyps).

Remarks. The tarsometatarsus is traditionally made the holotype of fossil species when available, particularly in the case of falconiform species, and the sum of many tarsometatarsal characters

of Vulturidae, n. gen. n. sp. establishes it as a distinctive genus and species, although from the above diagnosis it is apparent that it resembles Gymnogyps more than Vultur. Additional very apparent large differences found in other elements strengthens this belief, i.e., the shape of the sternum and the manner of articulation with the coracoid, the absence of a coracoidal fenestra, and the confluent ribbed attachments of M. ilio-trochantericus medius and M. iliacus of the femur.

Genus Gymnogyps Lesson

Gymnogyps n. sp.

Holotype. Complete right tarsometatarsus. (Pl. V, Figs. A & B)

Paratypes. One complete left tarsometatarsus, proximal ends of 2 right and 3 left tarsometatarsi, distal ends of 1 right and 3 left tarsometatarsi.

Diagnosis. Agrees with Gymnogyps and differs from Vultur and Vulturidae, n. gen. by having those characters of Gymnogyps listed in description of Vulturidae, n. gen. n. sp.

Differs from Gymnogyps californianus (Shaw) and G. amplus L. Miller (Collection of Pierce Brodkorb no. PB498, Reddick, Florida) by having (1) intercotylar prominence with prominent concavity on external side (slight to deep groove present in G. californianus and G. amplus); (2) internal cotyla with moderately curved posterior rim (moderately to sharply curved in G. californianus and G. amplus); (3) hypotarsus extending internally to at least middle of internal cotyla (does not extend as far internally in G. californianus and G. amplus); (4) posterior projection of external cotyla large (small to large in G. californianus and G. amplus); (5) ridge leading distally

from hypotarsus very prominent, extending distally for more than third of length of bone, with deep depression of shaft on both sides (moderately prominent, extending distally for less than third length of shaft, with depression internally greater than that externally in G. californianus and G. amplus); (6) anterior metatarsal groove with marked concavity distal to attachment of M. tibialis anticus (no noticable concavity to marked concavity in G. californianus and G. amplus); (7) anterior metatarsal ridges well rounded and approximately equal in size (external anterior metatarsal ridge larger and more rounded than internal anterior metatarsal ridge in G. californianus and G. amplus); (8) internal anterior metatarsal ridge continues distally and forms a marked corner to shaft that ends at base of internal rim of middle trochlea (is not traceable as a distinct corner in G. californianus and G. amplus); (9) internal trochlea long, large, rotated posteriorly, with longest part of postero-internal edge directed postero-proximally (short, small to large, not rotated as much posteriorly, with sharp to rounded postero-internal edge directed more posteriorly than proximally in G. californianus and G. amplus); (10) middle trochlea very long, lying parallel to main axis of shaft, rims straight, and ending posteriorly in gradual taper (short, distal end turned slightly inward from main axis of shaft, rims flaring and terminating more abruptly posteriorly in G. californianus and G. amplus); (11) external trochlea short, not extending as far distally as internal trochlea, rotated slightly posteriorly, trochlear surface very long anteriorly, with posterior edge well rounded and directed posteriorly (long, extending as far distally as internal trochlea, rotated slightly, if any, posteriorly, trochlear surface short, with posterior edge directed posteriorly or proximally in G. californianus and

G. amplus.

For measurements see Table 5. Measurements of the holotype are as follows: length, 122.0; proximal width, 26.9; distal width, 30.2; least width of shaft, 13.5; width of middle trochlea, 11.1.

Referred material. Portion of 1 sternum, 1 left scapula, 1 complete right coracoid, 1 right coracoid lacking head, 1 complete right and 1 complete left humerus, shaft and distal end of 1 right humerus, proximal end of 1 left humerus, distal ends of 1 right and 2 left humeri, proximal ends of 1 right and 1 left ulna, distal ends of 1 right and 2 left ulnae, distal end of 1 right radius, distal ends of 2 left tibiotarsi. The 30 specimens, including holotype and paratypes, represent a minimum of 4 individuals.

Characters. Sternum with (1) ventral manubrial spine narrow (wider in G. californianus); (2) ventral lip of coracoidal sulcus curved along ventral edge (less curvature in G. californianus, straight in Vultur).

Scapula with (1) internal surface very concave anteriorly (less in G. californianus, similar in Vultur); (2) distal end of dorsal acromion edge greatly elevated above shaft (similar, but not quite as sharply set off in G. californianus; moderately elevated, merging gradually with shaft in Vultur).

Coracoid with (1) anterior sternal facet with small dorsal slope (moderate in G. californianus, great in Vultur); (2) scapular facet moderately elevated above shaft (slightly elevated in G. californianus, greatly elevated in Vultur); (3) head narrow (similar in G. californianus, wide in Vultur).

Humerus with (1) head narrow (slightly wider in G. californianus); (2) attachment of M. proscapulohumeralis brevis elevated (not elevated

in G. californianus); (3) capital groove divides base of median crest and capital shaft ridge (does not extend as far distally in G. californianus); (4) internal tuberosity moderately prominent (very prominent in G. californianus); (5) deltoid crest small, with anconal side very concave (larger, with anconal side less concave in G. californianus); (6) shaft moderately robust (very robust in G. californianus); (7) internal condyle small (large in G. californianus); (8) external condyle moderately produced distally (very produced in G. californianus); (9) ectepicondylar prominence short, distinctly set off from shaft distally (long, not distinctly set off from shaft in G. californianus); (10) entepicondyle moderately produced (more produced in G. californianus); (11) impression of M. brachialis anticus deep (very deep in G. californianus).

Ulna with (1) olecranon of moderate size (short, narrow, but deep in G. californianus); (2) attachment of anterior articular ligament long, elevated, and terminating abruptly (long, not elevated, terminating gradually in G. californianus); (3) internal condyle projecting slightly distal to external condyle (projects moderately distal to external condyle in G. californianus); (4) carpal tuberosity long (shorter in G. californianus).

Radius with (1) ulnar depression moderately deep (shallow in G. californianus); (2) shaft widening very abruptly internally for carpal facet (widens more gradually in G. californianus).

Tibiotarsus with (1) distal internal ligamental attachment moderately deep (moderately deep in G. californianus, deep in Vultur); (2) internal condyle not flaring internally at antero-proximal end (similar in G. californianus, flares internally in Vultur).

Remarks. The appearance in the fossil record of a South American

Table 5. Measurements of the scapula, coracoid, humerus, radius, ulna, carpometacarpus, femur, tibiotarsus, and tarsometatarsus of Gymnogyps californianus, Recent Vultur gryphus, V. gryphus from the Talara Tar Seeps (excluding scapula, humerus, and carpometacarpus), Gymnogyps n. sp. (excluding carpometacarpus and femur), and Vulturidae, n. gen. n. sp. (excluding scapula) (in mm).

		<u>Gymnogyps</u> n. sp.	<u>Gymnogyps</u> <u>californianus</u>
Scapula			
Proximal	OR	27.5	27.2
Height	M	-	-
	N	1	1
Proximal	OR	8.5	8.1
Width	M	-	-
	N	1	1
Coracoid			
Length	OR	96.2	102.6
	M	-	-
	N	1	1
Head to	OR	43.2	46.9
Scapular	M	-	-
Facet	N	1	1
Proximal	OR	25.5	28.1
Depth	M	-	-
	N	1	1
Least	OR	14.8-18.1	16.4
Depth of	M	16.4	-
Shaft	N	2	1
Length of	OR		38.6
Sternal	M		-
Facet	N		1
Humerus			
Length	OR	256.0-265.0	273.0
	M	260.5	-
	N	2	1
Proximal	OR	52.5-54.3	55.7
Width	M	53.4	-
	N	2	1

Table 5. Extended.

Recent	<u>Vultur gryphus</u> Talara Tar Seeps	Vulturidae n. gen. n. sp.
28.6-30.5 29.5 2		
7.4-9.6 8.5 2		
98.2-98.8 98.5 2	103.1 - 1	89.4 - 1
50.5-51.3 50.9 2	52.0 - 1	44.0-51.9 47.9 2
29.8-30.3 30.1 2	30.0 - 1	25.7-28.2 26.9 2
16.6-18.0 17.3 2	16.9 - 1	13.9-14.9 14.4 3
43.3-44.1 43.7 2	42.5 - 1	
265.0-292.0 278.5 2		
62.6-63.4 63.0 2		55.7 - 1

Table 5. Continued.

		<u>Gymnogyps</u> n. sp.	<u>Gymnogyps</u> <u>californianus</u>
Distal	OR	46.4-49.0	51.1
Width	M	47.6	-
	N	5	1
Least	OR	18.2-19.6	23.0
Width of	M	19.1	-
Shaft	N	3	1
Radius			
Length	OR		304.0
	M		-
	N		1
Proximal	OR		14.1
Width	M		-
	N		1
Distal	OR	21.7	22.8
Width	M	-	-
	N	1	1
Ulna			
Length	OR		319.0
	M		-
	N		1
Proximal	OR	29.3-31.9	33.5
Width	M	30.6	-
	N	2	1
Distal	OR	23.6-25.3	24.7
Depth	M	24.5	-
	N	2	1
Least	OR		13.5
Width of	M		-
Shaft	N		1
Carpometacarpus			
Length	OR		139.0
	M		-
	N		1

Table 5. Extended.

Recent	<u>Vultur gryphus</u> Talara Tar Seeps	Vulturidae n. gen. n. sp
55.1-55.6		48.5
55.4		-
2		1
21.2-21.8		
21.5		
2		
298.0-328.0		
313.0		
2		
15.6-15.7	14.6	13.2-13.4
15.7	-	13.3
2	1	2
24.3-24.4	24.1	22.7-24.3
24.4	-	23.4
2	1	3
313.0-341.0		
327.0		
2		
33.7-36.3	33.5-34.0	30.1
35.0	33.8	-
2	2	1
26.7-28.8		25.3
27.7		-
2		1
14.3-15.4		
14.9		
2		
132.2-140.3		
136.2		
2		

Table 5. Continued.

		<u>Gymnogyps</u> n. sp.	<u>Gymnogyps</u> <u>californianus</u>
Proximal	OR		16.5
Width	M		-
	N		1
Height	OR		35.3
Through	M		-
Metacarpal 1	N		1
Least	OR		13.2
Width of	M		-
Shaft	N		1
Length of	OR		14.4
Distal	M		-
Fornix	N		1
Femur			
Length	OR		137.7
	M		-
	N		1
Proximal	OR		32.3
Width	M		-
	N		1
Distal	OR		35.3
Width	M		-
	N		1
Least	OR		17.3
Width of	M		-
Shaft	N		1
Tibiotarsus			
Length	OR		214.0
	M		-
	N		1
Proximal	OR		28.7
Width	M		-
	N		1
Distal	OR	24.2-25.3	25.1
Width	M	24.8	-
	N	2	1

Table 5. Extended.

Recent	<u>Vultur gryphus</u> Talara Tar Seeps	Vulturidae n. gen. n. sp.
17.2-17.4		15.4
17.3		-
2		1
36.3-38.9		32.6
37.6		-
2		1
13.0-14.6		
13.8		
2		
18.1-20.5		
19.3		
2		
143.6-158.3		
150.9		
2		
37.6-38.5	37.3	31.7-32.8
38.0	-	32.2
2	1	3
37.9-41.1	37.9	34.1-34.7
39.5	-	34.4.
2	1	2
18.0-19.5		
18.7		
2		
216.0-242.0	213.0	
229.0	-	
2	1	
28.6-30.6	30.0-31.1	
29.6	30.6	
2	2	
25.1-27.1	23.9-26.1	24.1
26.1	25.0	-
2	4	1

Table 5. Continued.

		<u>Gymnogyps</u> n. sp.	<u>Gymnogyps</u> <u>californianus</u>
Least	OR		14.7
Width of	M		-
Shaft	N		1
Depth of	OR	22.8	22.5
Internal	M	-	-
Condyle	N	1	1
Tarsometatarsus			
Length	OR	118.5-122.0	117.8
	M	120.3	-
	N	2	1
Proximal	OR	25.8-29.9	26.7
Width	M	27.0	-
	N	7	1
Distal	OR	29.5-34.0	29.8
Width	M	31.3	-
	N	4	1
Least	OR	13.4-13.5	14.0
Width of	M	13.5	-
Shaft	N	2	1
Width of	OR	10.6-12.1	11.1
Middle	M	11.3	-
Trochlea	N	6	1

Table 5. Extended.

Recent	<u>Vultur gryphus</u> Talara Tar Seeps	Vulturidae n. gen. n. sp.
13.9-15.3	14.1	
14.6	-	
2	1	
24.9-26.2	22.9-24.6	22.5
25.6	23.9	-
2	4	1
118.8-134.7		121.8-124.5
126.7		123.1
2		2
27.5-29.8	30.0	25.4-26.3
28.7	-	25.8
2	1	2
30.7-33.6		29.0-30.0
32.1		29.5
2		2
13.7-14.7		13.8
14.2		13.8
2		2
12.1-12.9		10.6-11.6
12.5		11.0
2		3

species of Gymnogyps poses the question of its relationships with the G. amplus-G. californianus line of North America. The continent of origin of the genus must remain uncertain until specimens of an earlier period are found.

Genus Vultur Linnaeus

Vultur gryphus Linnaeus

Andean Condor

Material. One complete right coracoid, distal end of 1 right humerus, proximal end of 1 right and 1 left ulna, distal end of 1 right ulna, proximal end of 1 left radius, distal end of 1 left radius, proximal end of 1 left femur, distal ends of 3 left femora, 1 complete right tibiotarsus, proximal end of 1 right tibiotarsus, distal ends of 2 right and 1 left tibiotarsus, proximal end of 1 left tarsometatarsus. The 17 specimens represent a minimum of 3 individuals.

Characters. See diagnosis for Vulturidae, n. gen. n. sp. and Gymnogyps n. sp.

Remarks. V. gryphus is found almost throughout the Andes of South America and often on the Pacific coast.

Discussion

In addition to the two species of living condors, seven large extinct vulturid species have been named from the Pliocene and Pleistocene, one each in the two living genera and the other five in extinct genera. The possibility of one or more of these extinct North American species being identical to an extinct form from the Talara Tar Seeps requires a discussion of their characters.

In the subfamily Vulturinae (Illiger) two extinct monotypic

genera are known, Pliogyps Tordoff and Breagyps L. Miller and Howard. Pliogyps fisheri Tordoff is much smaller than any of the Talara specimens, and additional characters listed by Tordoff (1959) indicate that this species is not similar to any of the Talara species.

The distinctions between Breagyps, Vultur, and Gymnogyps have been listed (L. Miller, 1910; L. Miller and Howard, 1938) and these hold for Gymnogyps n. sp. A glance at the illustration of Breagyps clarki (L. Miller, 1910, p. 9) immediately reveals large differences between it and Vulturidae, n. gen. n. sp. The following characters of Breagyps are most significant: (1) intercotylar prominence of similar height, but more rounded and broader; (2) shaft widening equally internally and externally for proximal articular surfaces, giving symmetrical appearance; (3) internal trochlea not extending nearly so far distally as middle trochlea; (4) internal intertrochlear notch wide.

Gymnogyps amplus is considered to be either the direct ancestor but specifically distinct from (Fisher, 1944), or a temporal subspecies (Brodkorb, 1964) of, G. californianus. The few specimens of G. amplus available indicate a closer relationship between it and G. californianus than to Gymnogyps n. sp. (see diagnosis of Gymnogyps n. sp.)

Lönnberg (1903) named Vultur patruus from a tarsometatarsus and femur from the Tarija Valley of Bolivia, listing primarily familial characters for identification of the material. The primary character used for the separation of V. patruus from V. gryphus was the small size of the fossil specimens in relation to one Recent specimen available to Lönnberg. Although V. patruus is probably near the lower limit of the size range of V. gryphus, Table 5 shows that it is not significantly smaller than V. gryphus. In addition, the following

characters of the tarsometatarsus of V. patruus, all taken from Lönnberg's photograph of the specimen, are similar to those of V. gryphus, namely: (1) intercotylar prominence broad; (2) the bone appears symmetrical, with proximal and distal widening of shaft approximately equal; (3) presence of a prominent point of inflection near midpoint of internal side of shaft, distal to which a long curve leads to the edge of the internal condyle, positioning the narrowest point of the shaft distal to point of inflection; (4) middle trochlea short; (5) internal and external intertrochlear notches approximately equal.

That V. patruus does not represent *Vulturidae*, n. gen. n. sp. is easily seen by two characters of the latter, i.e., (1) shaft widening much more externally than internally for proximal articular surfaces, giving an asymmetrical bone; (2) internal trochlea extending almost as far distally as middle trochlea (internal trochlea does not extend nearly so far distally in Vultur).

V. patruus superficially resembles G. californianus and G. amplus more than Gymnogyps n. sp., but the new species is easily distinguished by having (1) intercotylar prominence narrow; (2) shaft widening more gradually for proximal articular surfaces, more abruptly for distal articular surfaces; (3) no distinct point of inflection on internal side; (4) middle trochlea much longer; (5) trochlear surfaces asymmetrical.

Although the associated material was considered Pliocene by Lönnberg, later studies by Boule (1920) and Oppenheim (1943) have placed the age of the Tarija beds as Pleistocene. From the above information it appears that V. patruus is a specimen of V. gryphus and should be placed in synonymy with the latter.

The three species known from the subfamily Teratornithinae (L. Miller) are so distinctive they are readily seen to bear no resemblance to the Talara specimens.

Monotypic genera are perhaps undesirable from certain viewpoints, but the discovery of another species of Gymnogyps indicates again that Recent taxonomy is at best incomplete without full knowledge of the fossil record, which is often slow in coming. The "lumping" of Vultur, Gymnogyps, and Pliogyps into one genus, Vultur, as suggested by Mayr and Short (1970) is an example of eliminating monotypic genera solely for the purpose of reducing the number of taxonomic names and not for valid systematic, or phylogenetic, reasons.

Genus Sarcoramphus Dumeril

Sarcoramphus? n. sp.

Holotype. Distal end of 1 right tibiotarsus. (Pl. IV, Fig. C)

Diagnosis. Agrees with Sarcoramphus and differs from Vultur, Gymnogyps, Coragyps Geoffroy, and Cathartes Illiger by having (1) external condyle of greater depth than length (similar in Cathartes; more rounded in Gymnogyps, Vultur, and Coragyps); (2) tendinal groove passing under supratendinal bridge along straight line (similar in Cathartes; curving internally before reaching supratendinal bridge in Gymnogyps, Vultur, and Coragyps); (3) external condyle broad (similar in Gymnogyps, Vultur, and Coragyps; narrow in Cathartes).

Differs from Sarcoramphus papa (Linnaeus) by having (1) shaft very flattened postero-proximally to internal condyle (less flattened in S. papa); (2) external condyle with rather even slope to medial surface (well rounded in S. papa); (3) size larger, width and depth 40 mm proximal to base of intercondylar groove, 11.8 and 9.6,

respectively (in S. papa, width, 10.2-10.3, mean, 10.2; depth, 7.7-8.1, mean, 7.9; N = 3).

Referred material. Distal end of 1 right ulna, proximal end of 1 left radius. The three specimens, including holotype, represent a minimum of 1 individual.

Characters. Ulna with (1) external condylar surface passing internally into broad, shallow depression in shaft (passes onto shaft, but no depression in S. papa; does not pass onto shaft in Gymnogyps, Vultur, Cathartes, or Coragyps); (2) pneumaticity lacking in palmar surface (similar in S. papa, Gymnogyps, and Vultur; present in Cathartes and Coragyps). Distal width, 21.5 (in S. papa, 14.2-15.9; mean, 14.8; N = 3).

Radius with (1) ligamental attachment of internal side of capital tuberosity divided into two distinct sections (similar in S. papa; not divided into two distinct sections in Gymnogyps, Vultur, Cathartes, or Coragyps); (2) bicipital tubercle extending much farther distally than long attachment for M. biceps (similar in S. papa; does not extend as far distally in Gymnogyps, Vultur, Cathartes, or Coragyps, and attachment of M. biceps much shorter in all but Gymnogyps). Proximal width, 12.6 (in S. papa, 8.5-9.2; mean, 8.9; N = 3).

Remarks. Unfortunately Sarcoramphus? n. sp. is represented by such poor material that its true generic status must remain unknown until further collections of fossil material are made. That the material represents a large species of Sarcoramphus is reasonably certain, or at least it is much more similar to that genus than any other living genus of vulture. That the elements are intermediate in size between S. papa and Vultur indicates that they represent a new

species as there is no living vulturid of that size.

Genus Coragyps Geoffrey

Coragyps cf. atratus (Bechstein)

Black Vulture

Material. Four premaxillaries, 2 left quadrates, 1 right articular, 4 right and 3 left scapulae, 4 complete right and 3 complete left coracoids, humeral ends of 2 right coracoids, sternal end of 1 left coracoid, proximal ends of 3 right and 2 left humeri, distal ends of 4 right and 2 left humeri, 2 complete right and 1 complete left ulna, proximal ends of 2 right and 1 left ulna, distal ends of 1 right and 2 left ulnae, proximal ends of 3 right and 3 left radii, distal ends of 4 right and 2 left radii, proximal ends of 2 left carpometacarpi, 1 complete left femur, proximal end of 1 right femur, proximal ends of 1 right and 2 left tibiotarsi, distal ends of 5 right and 4 left tibiotarsi. The 72 specimens represent a minimum of six individuals.

Characters. Coragyps atratus and Cathartes aura (Linnaeus) are easily separated by many characters.

Although the material listed above closely resembles Coragyps atratus, including C. a. brasiliensis, it differs in numerous small, but consistent ways from that species. Measurements of the fossil material all fall within the range of living C. atratus and are much smaller than corresponding measurements for C. occidentalis (Howard, 1968).

Remarks. Despite strong resemblances to C. atratus the fossil material is definitely distinctive, and may represent a new species, or at least a temporal subspecies. This being the case, earlier assumptions about C. occidentalis being the direct ancestor to C.

C. atratus must be re-examined. A detailed analysis of C. atratus C. cf. atratus, and C. occidentalis will be forthcoming at a later date.

Genus Cathartes Illiger

Cathartes aura (Linnaeus)

Turkey Vulture

Material. One premaxillary, 2 left quadrates, 3 left scapulae, 2 complete right and 1 complete left coracoid, humeral end of 1 left coracoid, proximal end of 1 right humerus, distal ends of 2 left humeri, proximal ends of 2 left radii, distal end of 1 right radius, distal end of 1 left carpometacarpus, distal ends of 2 right and 3 left tibiotarsi, 1 complete right and 1 complete left tarsometatarsi, proximal ends of 1 right and 1 left tarsometatarsus. The 26 specimens represent a minimum of three individuals.

Remarks. C. aura is generally distributed throughout South America.

Suborder Accipitres Vieillot

Family Accipitridae (Vieillot)

Subfamily Buteoninae (Vigor)

Buteoninae?, n. gen.

Holotype. Buteoninae?, n. gen. n. sp.

Diagnosis. Tarsometatar agrees with Geranoaëtus melanoleucus (Vieillot) and Harpyhaliaëtus solitaria (Tschudi) in general form and proportions, and is similar in width but significantly longer than the latter.

Tarsometatarsus characterized by having (1) inner calcaneal ridge of hypotarsus projecting posteriorly at 90° to vertical axis

of shaft (projects posteriorly at approximately 80° to vertical axis of shaft in Heterospizias Sharpe and Buteogallus Lesson; approximately 60° - 70° in Buteo Lacépède, Geranoaëtus Kaup, Harpyhaliaëtus Lafresnaye, Spizaëtus Vieillot, and Aquila Brisson); (2) intercotylar area distinctive ridge (low elevated area in Buteo, Geranoaëtus, Harpyhaliaëtus, Spizaëtus, and Aquila; moderate ridge in Heterospizias and Buteogallus); (3) edge of shaft external to outer calcaneal ridge of hypotarsus distinct long ridge flaring externally (long ridge but not as large in Buteogallus; short, protruding externally only slightly in Buteo, Geranoaëtus, Harpyhaliaëtus, Heterospizias, Spizaëtus, and Aquila); (4) anterior metatarsal groove very deep (shallow in Geranoaëtus, Harpyhaliaëtus, Heterospizias, and Buteogallus; moderately deep internally in Buteo; deep in Spizaëtus and Aquila); (5) internal anterior metatarsal ridge well developed, extending distally for more than third of shaft (moderately developed in Buteo; slightly developed in Geranoaëtus and Buteogallus; poorly developed in Harpyhaliaëtus, Heterospizias, Spizaëtus, and Aquila); (6) attachment of tibialis anticus separated from external anterior metatarsal ridge by groove (groove slightly developed in Buteo and Buteogallus; not distinctive in Geranoaëtus, Harpyhaliaëtus, Heterospizias, Spizaëtus, or Aquila); (7) middle trochlea long anteriorly turned, only slightly externally (long anteriorly, turned significantly externally in Geranoaëtus and Aquila; long anteriorly, turned moderately externally in Heterospizias, Buteogallus, and Spizaëtus; short, turned significantly externally in Buteo and Harpyhaliaëtus); (8) internal trochlea rotated posteriorly such that posterior edge is at same level as posterior edge of middle trochlea (similar in Buteo, Geranoaëtus, Heterospizias, Buteogallus, Spizaëtus, and Aquila; not rotated posteriorly in Harpyhaliaëtus).

Buteoninae?, n. gen. n. sp.

Holotype. Proximal end of left tarsometatarsus. (Pl. V, Fig. E)

Paratypes. Proximal end of 1 right tarsometatarsus, distal ends of 2 right tarsometatarsi.

Diagnosis. As for genus. For measurements see Table 6. The only measurement available from the holotype is the proximal width, 20.8.

Referred material. One complete left coracoid, 1 complete left carpometacarpus, proximal ends of 2 left tibiotarsi. The 8 specimens, including holotype and paratypes, represent a minimum of 2 individuals.

Characters. Coracoid with (1) coracohumeral surface twice as broad anteriorly as distal to bicipital tuberosity, sloping moderately externally (approximately same size throughout, sloping steeply externally in G. melanoleucus, Buteo, Heterospizias, and Buteogallus; slightly broader anteriorly, sloping moderately steeply externally in Geranoaëtus n. sp., Harpyhaliaëtus, Spizaëtus, and Aquila); (2) attachment of M. coracobrachialis anterior and Lig. humero-coracoideum anterior superiorly elevated (neither elevated in G. melanoleucus; former not elevated and latter elevated only along posterior margin in Buteo, Heterospizias, Buteogallus, Harpyhaliaëtus, and Aquila; former not elevated but latter elevated in Geranoaëtus n. sp. and Spizaëtus); (3) angle formed between internal side of shaft and anterior edge of glenoid facet approximately 155° (approximately 160° in Geranoaëtus and Buteo; approximately 165° in Heterospizias, Buteogallus, Harpyhaliaëtus, Spizaëtus, and Aquila); (4) shaft very thick in distal view ventral to pneumatic foramen (slender in Geranoaëtus, Buteo, Heterospizias, Buteogallus, Harpyhaliaëtus, and Spizaëtus; moderately thick in Aquila).

Carpometacarpus with (1) process of metacarpal I low, not

turned proximally, and of approximately equal length for all of height (high, directed proximally, much longer through base than terminus in Geranoaëtus, Harpyhaliaëtus, and Aquila; high to low, directed proximally, of equal length throughout in Buteo; high, directed slightly proximally, and of equal length throughout in Heterospizias and Buteogallus; low, directed proximally, and of equal length throughout in Spizaëtus); (2) length of proximal fusion of metacarpal II and metacarpal III long (similar in Harpyhaliaëtus, Heterospizias, and Buteogallus; of moderate length in Buteo, Geranoaëtus, Spizaëtus, and Aquila); (3) external edge of metacarpal III extending as slight ridge to base of external rim of carpal trochlea (similar in Harpyhaliaëtus; extends external to midline of metacarpal II in Heterospizias and Buteogallus; extends to approximately midline of metacarpal II in Buteo, Spizaëtus, and Aquila; lies directly in line with internal rim of carpal trochlea in Geranoaëtus); (4) surface of carpal trochlea much wider anteriorly than posteriorly (similar in Buteo, Geranoaëtus, Heterospizias, and Buteogallus; of approximately equal width throughout in Harpyhaliaëtus, Spizaëtus, and Aquila); (5) tendinal groove restricted to external side of metacarpal II (proximal half of groove lies on anterior face and distal half of groove on external side of metacarpal II in Buteo, Geranoaëtus, Harpyhaliaëtus, Heterospizias, Buteogallus, and Aquila; proximal half lies on corner of shaft in Spizaëtus).

Tibiotarsus with (1) rotular crest low for length (internal end high, remainder low in Geranoaëtus and Buteo; moderately high for length in Heterospizias and Buteogallus; high for length in Harpyhaliaëtus, Spizaëtus, and Aquila); (2) internal edge of proximal end sloped slightly posteriorly in internal view (moderate slope

in Geranoaëtus, Buteo, Buteogallus, Harpyhaliaëtus, and Spizaëtus; steep slope in Heterospizias and Aquila).

Remarks. Buteoninae?, n. gen. n. sp. is a very distinctive genus, and perhaps should be placed in a separate subfamily. In such characters as the sharp angle to the coracoid shaft, the tendinal groove of carpometacarpus restricted to external side of metacarpal II, and having middle trochlea of tarsometatarsus lying almost parallel to midline of shaft, this genus resembles no known living accipitrid genus.

Although Oroaëtus isidori was not available for comparison its shorter tarsus and apparent relationship to the Spizaëtus group (Brown and Amadon, 1968) would seem to indicate that Buteoninae?, n. gen. n. sp. is different from that genus. Harpia is so distinctive that it is not necessary to draw a detailed comparison with that genus.

Buteoninae?, n. gen. n. sp. differs from Titanohierax gloveralleni Wetmore (1937) by having the middle trochlea turned externally only very slightly, and it differs from Aquila borrasii Arredondo (1970) by having the tubercle for tibialis anticus positioned farther distally and more externally. Both of these characters are readily seen in published illustrations of the types of these two large extinct eagles, and there are undoubtedly many other characters that cannot be detected from the illustrations.

Although there is still some question as to the generic position of Harpyhaliaëtus (Urubitornis) solitarius (Brown and Amadon, 1968; Wetmore, 1965) the species is used here as representative of Harpyhaliaëtus until a comparison can be made between H. solitarius and H. coronatus.

Table 6. Measurements of the scapula, coracoid, humerus, radius, ulna, carpometacarpus, femur, tibiotarsus, and tarsometatarsus of Geranoaëtus n. sp., Recent G. melanoleucus, G. melanoleucus from the Talara Tar Seeps (excluding scapula), Harpyhaliaëtus solitaria; and of the coracoid, carpometacarpus, tibiotarsus, and tarsometatarsus of Buteoninae?, n. gen. n. sp. (in mm).

		<u>Geranoaëtus melanoleucus</u>	
		Recent	Talara Tar Seeps
Scapula			
Proximal Height	OR	16.0-17.8	
	M	16.6	
	N	4	
Proximal Width	OR	6.8-8.1	
	M	7.4	
	N	4	
Coracoid			
Length	OR	48.3-55.7	51.1-52.3
	M	53.0	51.7
	N	4	2
Head to Scapular Facet	OR	21.2-24.7	22.4-22.7
	M	23.3	22.5
	N	4	2
Proximal Depth	OR	14.2-17.6	15.5-15.7
	M	16.1	15.6
	N	4	2
Least Depth of Shaft	OR	7.6-8.7	8.4
	M	8.2	-
	N	4	1
Length of Sternal Facet	OR	19.9-23.1	
	M	22.0	
	N	4	
Humerus			
Length	OR	129.7-150.7	
	M	142.9	
	N	4	
Proximal Width	OR	25.1-29.4	28.1-29.2
	M	27.9	28.7
	N	4	2

Table 6. Extended.

<u>Geranoaëtus</u> n. sp.	<u>Harpyhaliaëtus</u> <u>solitaria</u>	Buteoninae? n. gen. n. sp.
22.4-27.0	19.9	
24.0	-	
3	1	
11.8-14.7	9.6	
13.1	-	
3	1	
78.8-81.8	60.5	68.0
80.3	-	-
2	1	1
35.4-37.8	26.8	32.0
36.3	-	-
3	1	1
24.5-25.4	19.2	21.5
24.8	-	-
3	1	1
13.2-14.0	10.5	11.9
13.6	-	-
2	1	1
33.8	26.4	30.2
-	-	-
1	1	1
195.0	163.4	
-	-	
1	1	
39.3	33.7	
-	-	
1	1	

Table 6. Continued.

		<u>Geranoaëtus melanoleucus</u>			
		Recent	Talara	Tar	Seeps
Distal	OR	22.3-25.3		22.5	
Width	M	24.2		-	
	N	4		1	
Least	OR	9.1-10.2			
Width of	M	9.8			
Shaft	N	4			
Radius					
Length	OR	144.7-165.3			
	M	158.0			
	N	4			
Proximal	OR	5.7-6.1		5.7	
Width	M	5.8		-	
	N	4		1	
Distal	OR	9.8-11.0			
Width	M	10.6			
	N	4			
Ulna					
Length	OR	153.9-174.6			
	M	167.4			
	N	4			
Proximal	OR	16.5-18.6			
Width	M	17.7			
	N	4			
Distal	OR	13.1-14.6		12.5-13.9	
Depth	M	14.0		13.5	
	N	4		4	
Least	OR	6.6-7.8			
Width of	M	7.5			
Shaft	N	4			
Carpometacarpus					
Length	OR	74.1-86.8			
	M	80.8			
	N	4			

Table 6. Extended.

<u>Geranoaëtus</u> n. sp.	<u>Harpyhaliaëtus</u> <u>solitaria</u>	Buteoninae? n. gen. n. sp.
33.4-38.3	29.7	
35.9	-	
2	1	
14.1-14.5	12.0	
14.3	-	
2	1	
	179.0	
	-	
	1	
7.1-8.5	7.2	
7.7	-	
4	1	
16.5	13.0	
-	-	
1	1	
	189.8	
	-	
	1	
25.5	20.2	
-	-	
1	1	
17.6-19.1	15.3	
18.4	-	
4	1	
	8.4	
	-	
	1	
110.8	83.8	86.1
-	-	-
1	1	1

Table 6. Continued.

		<u>Geranoaetus melanoleucus</u>	
		Recent	Talara Tar Seeps
Height	OR	18.6-21.4	18.3-20.5
Through	M	20.2	19.7
Metacarpal I	N	4	3
Proximal	OR	7.0-8.2	8.3-9.7
Width	M	7.7	8.7
	N	4	3
Least	OR	5.7-6.5	6.4
Width of	M	6.2	-
Shaft	N	4	1
Length of	OR	6.5-7.8	
Distal	M	7.1	
Fornix	N	4	
Femur			
Length	OR	93.7-102.9	90.3-105.1
	M	99.5	97.7
	N	4	2
Proximal	OR	18.0-20.6	17.5-20.9
Width	M	19.6	19.0
	N	4	4
Distal	OR	19.3-22.5	18.6-21.3
Width	M	21.3	19.7
	N	4	3
Least	OR	8.7-9.4	8.2-9.3
Width of	M	9.1	8.8
Shaft	N	4	2
Tibiotarsus			
Length	OR	128.8-142.9	
	M	137.1	
	N	4	
Proximal	OR	14.3-16.7	16.8
Width	M	15.9	-
	N	4	1
Distal	OR	15.3-17.9	16.7
Width	M	17.0	-
	N	4	1

Table 6. Extended.

<u>Geranoaëtus</u> n. sp.	<u>Harpyhaliaëtus</u> <u>solitaria</u>	Buteoninae? n. gen. n. sp.
28.2	21.9	21.0
-	-	-
1	1	1
12.0	9.1	10.0
12.0	-	-
2	1	1
8.0-8.8	7.1	7.3
8.4	-	-
2	1	1
9.5	8.1	
-	-	
1	1	
127.4	106.4	
-	-	
1	1	
27.4	23.7	
-	-	
1	1	
29.0	25.7	
-	-	
1	1	
12.9	11.3	
-	-	
1	1	
	162.1	
	-	
	1	
23.0	20.0	20.2-20.4
-	-	20.3
1	1	2
21.8-22.6	20.2	
22.7	-	
7	1	

Table 6. Continued.

		<u>Geranoaëtus melanoleucus</u>	
		Recent	Talara Tar Seeps
Least	OR	8.0-8.6	
Width of	M	8.2	
Shaft	N	4	
Depth of	OR	10.0-11.2	
Internal	M	10.8	
Condyle	N	4	
Tarsometatarsus			
Length	OR	98.1-107.7	100.3
	M	102.9	-
	N	4	1
Proximal	OR	16.2-18.8	16.3-19.6
Width	M	17.4	18.4
	N	4	5
Distal	OR	17.8-20.2	19.3-20.6
Width	M	18.9	20.0
	N	4	2
Least	OR	6.5-7.3	6.3-8.2
Width of	M	6.8	7.5
Shaft	N	4	3
Width of	OR	4.9-5.6	5.3-5.7
Middle	M	5.2	5.5
Trochlea	N	4	3

Table 6. Extended.

<u>Geranoaëtus</u> n. sp.	<u>Harpyhaliaëtus</u> <u>solitaria</u>	Buteoninae? n. gen. n. sp.
	10.0	
	-	
	1	
13.9-14.8	13.1	
14.3	-	
5	1	
132.3-136.5	124.8	145
134.3	-	(Estimated)
3	1	
22.2-25.0	20.7	20.8-20.9
23.7	-	20.9
3	1	2
25.2-29.3	23.6	
27.1	-	
6	1	
10.1-11.7	9.9	8.8
10.9	-	-
2	1	1
6.9-8.1	6.2	6.3-6.5
7.4	-	6.4
8	1	2

A large long-legged eagle, Buteoninae?, n. gen. n. sp. was probably of similar habits as Heterospizias or Harpyhaliaëtus.

Genus Geranoaëtus Kaup

Geranoaëtus n. sp.

Holotype. Complete left tarsometatarsus (inner calcaneal ridge and external trochlea broken). (Pl. VI, Fig. A)

Paratypes. One complete right and 1 complete left tarsometatarsus, shaft of 1 left tarsometatarsus, proximal ends of 1 right and 1 left tarsometatarsus, distal ends of 6 right and 2 left tarsometatarsi.

Diagnosis. Agrees with Geranoaëtus and differs from all other living South American accipitrid genera and Buteoninae?, n. gen. n. sp. (with the possible exception of Leptodon Sundevall, Leucopternis Kaup, Busarellus Lafresnaye, Oroaëtus Ridgway, and Spizastur G. R. Gray which were unavailable for comparison) by having (1) intercotylar area moderately elevated; (2) anterior metatarsal groove proximal to attachment of tibialis anticus a deep depression, extending proximally well under intercotylar area; (3) internal calcaneal ridge projecting posteriorly at almost right angle to vertical axis of shaft; (4) midpoint of long attachment of tibialis anticus located approximately 19 per cent of total length of shaft distally; (5) proximal end of metatarsal facet protruding sharply from shaft, providing a point of inflection distal to which lies a curvature of small radius; (6) internal trochlea with prominent angular projection on interno-proximal edge which provides endpoint for afore mentioned curve; (7) posterior projection of internal trochlea deep, of moderate length; (8) middle trochlea of moderate length anteriorly, short posteriorly; (9) internal trochlea projecting distally slightly more and external

trochlea slightly less than middle trochlea.

Differs from Geranoaëtus melanoleucus (Vieillot) by having (1) external calcaneal ridge proportionately larger, with excavation between external and internal calcaneal ridges shallow and notch external to external calcaneal ridge very shallow; (2) posterior end of internal calcaneal ridge projecting slightly farther proximally; (3) proximal attachment of ligamental bridge prominent, located immediately distal to internal edge of internal cotyla; (4) proximal portion of anterior metatarsal groove more clearly defined depression; (5) tubercle for tibialis anticus projecting farther anteriorly than leading edge of shaft; (6) internal trochlea turned slightly more medially; (7) posterior corners of middle trochlea projecting farther from shaft; (8) shaft much broader through distal foramen, giving less curvature to shaft proximal to external trochlea; (9) marked groove present on postero-external corner of shaft running from proximo-external corner of external trochlea to point proximal to metatarsal facet; (10) metatarsal facet with depression deep; (11) curvature of postero-external edge of shaft much greater; (12) considerably larger size.

For measurements see Table 6. Measurements of the holotype are as follows: length, 134.1; proximal width, 25.0; distal width, 27.1; least width of shaft, 11.7.

Referred material. Two rostra, 1 right ramus, 1 right and 2 left scapulae, 2 complete left coracoids, humeral end of 1 right coracoid, 1 complete right humerus, proximal end and shaft of 1 right humerus, proximal end of 1 left humerus, distal end of 1 left humerus; proximal end of 1 right ulna, distal ends of 2 right and 2 left ulnae, proximal ends of 2 right and 2 left radii, distal end of 1 left radius, 1 almost complete right carpometacarpus, proximal end of

1 right carpometacarpus, shaft of 1 right carpometacarpus, distal end of 1 right carpometacarpus, 1 complete right femur, proximal ends of 2 left tibiotarsi, distal ends of 2 right and 6 left tibiotarsi. The 52 elements, including holotype and paratypes, represent a minimum of 7 individuals.

Characters. Geranoaëtus n. sp. differs from G. melanoleucus by having rostrum with (1) external nares proportionately longer and deeper anteriorly.

Ramus with (1) very slight curvature; (2) post-articular process projecting less posteriorly; (3) ventral corner of articular more angular; (4) internal articular process directed more anteriorly.

Scapula with (1) dorso-internal corner of acromion process well developed, giving straight dorsal edge; (2) glenoid facet proportionately wider anteriorly and shorter, with antero-ventral corner well developed.

Coracoid with (1) coracohumeral surface proportionately much wider but shorter, and facing more dorsally, giving more rounded head; (2) attachment of Lig. humero-coracoideum anterieus superius prominent elevated platform; (3) external edge of glenoid facet more rounded; (4) ventral extension of glenoid facet large; (5) depression distal to intermuscular line and dorsal to external posterior sternal facet deep; (6) distal half of internal edge of sternal facet projecting more internally, giving much deeper sterno-coracoidal impression.

Humerus with (1) attachment of M. coracobrachialis posterior proportionately much larger; (2) edge of bicipital crest straighter posteriorly; (3) base of deltoid crest much thicker distally; (4) impression of M. brachialis anticus positioned more internally, giving narrower ridge leading proximally from attachment of anterior

articular ligament; (5) entepicondyle more rounded, projecting less distally but more internally; (6) ectepicondylar prominence proportionately less developed.

Ulna with (1) olecranon very rounded proximally on anconal side; (2) internal cotyla with greater external slope; (3) external cotyla lacking prominent palmar projection; (4) external condyle proportionately shorter and more rounded; (5) carpal tuberosity much shorter, projecting more sharply internally.

Radius with (1) ligamental papilla proportionately more prominent; (2) carpal facet more rounded internally and extending farther proximally anconally; (3) distal external corner more rounded.

Carpometacarpus with (1) proximal corner of metacarpal I positioned more posteriorly, and distal corner more rounded, giving more arrow-shaped appearance; (2) internal ligamental fossa shallower; (3) external ligamental attachment positioned more posteriorly; (4) large ridge from shaft of metacarpal II to base of distal metatarsal symphysis.

Femur with (1) greater pneumaticity proximally; (2) trochanter more rounded; (3) postero-external corner of iliac facet more distinct; (4) external surface curved more internally proximally; (5) proximal end of fibular condyle proportionately much smaller and directed more externally; (6) attachment of *M. gastrocnemius*, pars externa, shallow; (7) external condyle slanting more externally proximally; (8) antero-proximal end of internal condyle lying in line with internal edge of shaft; (9) antero-proximal end of external condyle deflected externally.

Tibiotarsus with (1) internal corner of inner cnemial crest elevated; (2) internal articular surface sloping less posteriorly; (3) proximal fibular attachment proportionately more developed;

(4) outer cnemial crest shorter; (5) notch between internal articular surface and external articular surface very marked; (6) external condyle more rounded and projecting slightly less distally than internal condyle; (7) anterior edge of internal condyle projecting farther internally; (8) opening of tendinal groove distal to supratendinal bridge does not extend distal to proximal edge of internal condyle; (9) internal condyle less undercut proximally.

Position of *Morphnus woodwardi*. Through the courtesy of Dr. Hildegard Howard I have been able to compare a representative coracoid, humerus, femur, and tarsometatarsus of *Morphnus woodwardi* L. Miller from Rancho La Brea with corresponding elements of *Geranoaëtus* n. sp. The two species are identical in size, and *woodwardi* agrees with *Geranoaëtus* n. sp. in having those characters of *Geranoaëtus* listed for the tarsometatarsus that distinguish it from other accipitrid genera. A body skeleton of *Morphnus guianensis* has recently become available from the U.S. National Museum and a comparison of the coracoid, humerus, and femur of that specimen with *woodwardi* quickly reveals that *woodwardi* is not of that genus. The very close resemblance of *woodwardi* to *Geranoaëtus* n. sp. in all elements examined indicates that the two species should be considered congeneric, and that *woodwardi* be removed from *Morphnus* and placed in *Geranoaëtus*.

Geranoaëtus n. sp. differs from *G. woodwardi* by having the coracoid with (1) coracohumeral surface longer; (2) posterior edge of glenoid facet projecting much farther from shaft and more rounded; (3) attachment of M. coracobrachialis anterior and Lig. humero-coracoideum anterius superius more elevated and distinctly marked; (4) ventral end of furcular facet projecting more externally; (5) head much more rounded; (6) anterior internal sternal facet longer,

ending less abruptly; (7) area dorsal to distal external sternal facet more concave.

Humerus with (1) internal tuberosity more prominent; (2) concavity at base of median crest deep, not shallow; (3) capital shaft ridge more prominent, lying more internally; (4) external tuberosity more prominent, set off from head by slight groove; (5) bicipital crest longer; (6) attachment of Lig. humero-coracoideum anterius inferius larger in area and deeper; (6) shaft more curved in anconal view; (7) distal end flexed less palmarly; (8) ectepicondylar process slightly more produced; (9) intercondylar furrow deeper, particularly in palmar view.

Femur with (1) head turned more proximally; (2) shaft less stout, more curved antero-posteriorly; (3) internal condyle less rounded, and proximal ridge elevated more above shaft and joining shaft more abruptly; (4) rotular groove narrower and deeper; (5) proximal end of external condyle more rounded, and turned more externally; (6) fibular condyle much more prominent, projecting more sharply externally; (7) attachment of M. gastrocnemius, pars externa, larger in area, but much shallower.

Tarsometatarsus with (1) inner calcaneal ridge longer through base; (2) intercalcaneal furrow narrower; (3) tubercle for tibialis anticus larger, positioned more externally; (4) shaft curving externally less at level of metatarsal facet, giving larger external angle between line drawn along distalmost points of trochlea and perpendicular axis of shaft; (5) internal trochlea narrower through base, thus having more distinct corner to interno-proximal end; (6) external trochlea rotated less posteriorly, extending farther distally.

Geranoaëtus melanoleucus (Vieillot)

Black-chested Buzzard Eagle

Material. One complete right coracoid, proximal ends of 2 right and 2 left humeri, distal end of 1 right humerus, distal ends of 3 right and 1 left ulna, proximal end of 1 left radius, 1 complete right carpometacarpus, proximal ends of 1 right and 1 left carpometacarpus, 1 complete right and 1 complete left femur, proximal ends of 2 right and 1 left femur, distal end of 1 right femur, proximal end of 1 left tibiotarsus, distal ends of 1 right and 1 left tibiotarsus, 2 complete left tarsometatarsi, proximal end of 1 right and 2 left tarsometatarsi, distal ends of 2 right tarsometatarsi, shaft of 1 right tarsometatarsus. The 31 specimens represent a minimum of 4 individuals.

Characters. G. melanoleucus, and two following species, Buteo polyosoma (Quoy & Gaimard) and Parabuteo unicinctus (Temminck), are easily separated from one another and other species of the family Accipitridae by their respective sizes and numerous distinctive osteological characters.

Remarks. Widely distributed in western South America, G. melanoleucus is common along coastal hills and western slopes of the Peruvian Andes.

Genus Buteo LacépèdeButeo polyosoma (Quoy & Gaimard)

Red-backed Hawk

Material. Two left articulars, 1 right scapula, 1 complete right and 4 complete left coracoids, humeral end of 1 right coracoid, proximal end of 1 right humerus, distal end of 1 right humerus, distal ends of

2 right ulnae, proximal end of 1 right radius, proximal ends of 1 right and 1 left carpometacarpus, 1 left femur, proximal end of 1 left femur, proximal ends of 1 right and 1 left tibiotarsus, distal end of 1 right tibiotarsus, 2 complete right tarsometatarsi, proximal ends of 1 right and 1 left tarsometatarsus, distal ends of 2 right and 3 left tarsometatarsi. The 30 specimens represent a minimum of 4 individuals.

Remarks. B. polyosoma occurs all along the west coast of South America, and is very common in northwestern Peru.

Buteo sp. 1

Material. Complete right ulna, proximal ends of 2 left ulnae, 1 complete left carpometacarpus.

Characters. Size larger than Buteo nitidus (Latham) and overlapping that of small B. polyosoma. Agrees with Buteo and differs from related genera by having those characters for carpometacarpus listed for Buteo in description of Buteoninae?, n. gen. n. sp.

Carpometacarpus with (1) internal side of metacarpal II deeply excavated with ridge separating internal ligamental fossa from anterior portion (slightly excavated in B. polyosoma; moderately excavated in B. swainsoni Bonaparte; similar but lacking ridge in B. platypterus (Vieillot); excavated more anteriorly in B. nitidus and Parabuteo unicinctus (Temminck); (2) external rim of carpal trochlea parallel with shaft and internal rim of carpal trochlea almost straight (external rim at angle to shaft and internal rim moderately to strongly curved in B. polyosoma; similar in B. swainsoni; external similar but internal at greater angle to shaft in B. platypterus and Parabuteo unicinctus; external rim similar, internal rim curved in B. nitidus); (3) process of metacarpal I very short, rounded on proximal corner

(long, not rounded in B. polyosoma, B. nitidus, and Parabuteo unicinctus; moderately long, not rounded in B. swainsoni; slightly rounded in B. platypterus); (4) external edge of pollical facet long (short in B. polyosoma, B. swainsoni, B. platypterus, and Parabuteo unicinctus; moderately long in B. nitidus). Length, 51.4; proximal width, 5.9; height through metacarpal I, 13.5; least width of shaft, 4.4.

Ulna with (1) anconal side of olecranon continuing curve of shaft (reflected anconally, interrupting curve of shaft in B. polyosoma, B. swainsoni, B. platypterus, B. nitidus, and Parabuteo unicinctus); (2) olecranon long and broad in anconal view (long and narrow in B. polyosoma, B. swainsoni, B. nitidus, and Parabuteo unicinctus; short and broad in B. platypterus); (3) external cotyla greatly produced (similar in B. polyosoma and B. nitidus; less produced in B. swainsoni and B. platypterus; more produced in Parabuteo unicinctus); (4) carpal tuberosity short, well set off from shaft (long, not well set off from shaft in B. polyosoma, B. platypterus, B. nitidus; moderately long and moderately set off from shaft in B. swainsoni and Parabuteo unicinctus). Length, 110.1 (N = 1); proximal width, 11.5-12.4; mean, 11.9 (N = 3); distal depth, 9.7 (N = 1); least shaft width, 5.4 (N = 1).

Remarks. Although distinct from the species on hand the material described above is referred to genus only because of lack of comparative material of B. brachyurus and B. leucorrhous. Although the latter species is much smaller than the fossil material, B. brachyurus is in the right size range and until the fossil specimens can be compared with specimens of that species the question of whether the fossil material represents a living or extinct species must remain unanswered.

Buteo sp. 2

Material. Proximal end of 1 left ulna, distal end of 1 left ulna, proximal ends of 2 right carpometacarpi, distal ends of 4 right tibiotarsi, proximal end of 1 right tarsometatarsus, distal end of 1 left tarsometatarsus.

Characters. Smaller than B. poecilochrous, larger than B. polyosoma, B. swainsoni, and B. nitidus, and with longer leg and shorter wing elements than B. albonotatus.

Ulna with (1) olecranon thick, not much wider distally than proximally, and straight along anconal edge; (2) external condyle long with deep depression at proximal end; (3) internal condyle ending proximally at about middle of carpal tuberosity. Proximal width, 12.6 (N = 1); distal depth, 10.3 (N = 1).

Carpometacarpus with (1) process of metacarpal I moderately long; (2) attachment of M. flexor digitalis III and internal rim of carpal trochlea broadly overlapping; (3) carpal trochlea narrowing sharply distal to external ligamental attachment giving curved external rim of carpal trochlea. Proximal width, 6.0 (N = 2); height through metacarpal I, 14.5-14.8 (N = 2); least width of shaft, 4.5 (N = 1).

Tibiotarsus with (1) tendinal groove passing under tendinal bridge large distance from external condyle; (2) internal condyle long, with marked depression at postero-proximal end; (3) external condyle long, produced posteriorly. Distal width, 12.0-12.8; mean, 12.4 (N = 4); least width of shaft, 6.3-6.4 (N = 2); depth of internal condyle, 8.2-8.7; mean, 8.5 (N = 2).

Tarsometatarsus with (1) postero-proximal edge of shaft a straight edge; (2) proximal portion of anterior metatarsal groove broad; (3) tubercle for tibialis anticus long, bordered internally by

deep groove; (4) internal and external trochleae projecting distally slightly more than middle trochlea; (5) large corner on postero-proximal edge of internal trochlea. Proximal width, 13.3 (N = 1); distal width, 14.5 (N = 1); depth of middle trochlea, 4.1 (N = 1).

Remarks. Buteo sp. 2 probably represents a new species, but until specimens of B. ventralis, B. albicaudatus, and B. brachyurus are available for comparison its exact status must remain unknown.

Genus Parabuteo Ridgway

Parabuteo unicinctus (Temminck)

Bay-winged Hawk

Material. Two right and 1 left scapula, humeral end of 1 right coracoid, distal ends of 1 right and 1 left humerus, distal ends of 1 right and 2 left ulnae, proximal ends of 2 right and 2 left radii, 1 complete right carpometacarpus, proximal end of 1 left carpometacarpus, proximal end of 1 left femur, distal ends of 1 right and 2 left femora, proximal ends of 3 right tibiotarsi, distal ends of 4 right and 1 left tibiotarsus, 2 complete left tarsometatarsi, distal ends of 1 right and 1 left tarsometatarsus. The 30 specimens represent a minimum of 4 individuals.

Remarks. The proximal end of the left carpometacarpus differs from the other fossil carpometacarpus and the one Recent carpometacarpus available by having internal rim of carpal trochlea longer, extending to level of pollical facet. Without a greater series to determine variation of this character the specimen is placed with P. unicinctus, as it is essentially identical otherwise.

P. unicinctus occurs along the west coast of South America south to Aysen, Chile.

Family Falconidae Vigors

Subfamily Falconinae (Vigors)

Genus Falco LinnaeusFalco peregrinus Tunstall

Peregrine Falcon

Material. One left quadrate, 1 left articular, 3 mandibular symphyses, 2 right scapulae, 1 complete left coracoid, humeral ends of 2 right and 1 left coracoid, 1 complete right humerus, proximal end of 2 right humeri, 1 complete left ulna, distal ends of 2 left radii, 1 complete right and 2 complete left femora, proximal ends of 1 right and 1 left femur, 1 complete right tibiotarsus, distal ends of 2 right and 1 left tibiotarsus, 1 complete right and 3 complete left tarso-metatarsi, proximal end of 1 right tarsometatarsus. The 32 specimens represent a minimum of 3 individuals.

Characters. F. peregrinus, and the following two species, F. femoralis Temminck and F. sparverius Linnaeus, are easily identified on size.

Remarks. F. peregrinus occurs on the Peruvian coast as a migrant from both North America and southern South America.

Falco femoralis Temminck

Aplomado Falcon

Material. Two complete right and 1 complete left coracoid, 1 complete right ulna, distal end of 1 left ulna, distal end of 1 right radius, 1 complete right carpometacarpus. The 7 specimens represent a minimum of 2 individuals.

Remarks. F. femoralis is generally distributed throughout Ecuador and Peru.

Falco sparverius Linnaeus

Kestrel

Material. One premaxillary, 1 right and 2 left scapulae, 2 complete left coracoids, sternal end of 1 left coracoid, 3 complete right and 1 complete left humerus, distal ends of 3 left humeri, 3 complete right and 4 complete left carpometacarpi, 1 proximal and 2 distal ends of left carpometacarpi, 2 complete right and 1 complete left femur, distal end of 1 right femur, 1 complete right tibiotarsus, distal ends of 3 right and 2 left tibiotarsi, 2 complete right and 3 complete left tarsometatarsi, proximal ends of 2 right and 1 left tarsometatarsus, distal ends of 2 right and 3 left tarsometatarsi. The 47 specimens represent a minimum of 6 individuals.

Remarks. F. sparverius is generally and commonly distributed throughout Peru.

Falco sp.

Material. One complete right coracoid, humeral end of 1 left coracoid, distal end of 1 left humerus, proximal end of 1 right ulna, distal end of 1 right ulna, proximal end of 1 right femur, distal end of 1 right femur. The six specimens represent a minimum of 1 individual.

Characters. Falco sp. is intermediate in size between F. peregrinus and F. femoralis, and differs from them by having coracoid with (1) head long, with slight curvature to dorsal edge in external view (long, well rounded in F. peregrinus; short, subrounded in F. femoralis); (2) attachment of Lig. humero-coracoideum anterius superius large, with depression lying posterior to it (large, no depression in F. peregrinus; small, no depression in F. femoralis); (3) attachment of M.

coracobrachialis anterior small oval (elongated in F. peregrinus, small oval in F. femoralis); (4) coracohumeral surface moderately long (long in F. peregrinus, short in F. femoralis); (5) brachial tuberosity large, extending farther internally than head (small, flush with head in F. peregrinus; of moderate size, extending slightly farther internally than head in F. femoralis); (6) glenoid facet wide, widest near ventral end (wide, widest at dorsal end in F. peregrinus; narrow in F. femoralis). Length, 36.8 (N = 1); head to scapular facet, 13.5-13.9 (N = 2); proximal depth, 8.0-8.1 (N = 2); least depth of shaft, 4.1 (N = 1).

Humerus fragmentary, with (1) attachment of anterior articular ligament low, wider than long (high, longer than wide in F. peregrinus; high, width about equal to length in F. femoralis); (2) attachment of M. pronator brevis very deep pit (similar in F. peregrinus; not as deep, longer in F. femoralis); (3) attachment of M. extensor metacarpi radialis large and slightly elevated (large and very elevated in F. peregrinus, small and moderately elevated in F. femoralis). Distal width, 12.9; least width of shaft, 5.9.

Ulna with (1) external cotyla large (large in F. peregrinus, small in F. femoralis); (2) pronounced concavity between tricipital attachment and external cotyla (slight concavity in F. peregrinus and F. femoralis); (3) carpal tuberosity short and stout (long and more slender in F. peregrinus and F. femoralis). Proximal width, 10.0; distal depth, 8.4.

Femur with (1) attachment of M. gluteus profundus and M. obturator externus very deep (deep in F. peregrinus, moderately deep in F. femoralis); (2) protrusion between neck and trochanter broad (small in F. peregrinus and F. femoralis); (3) anterior intermuscular

ridge prominent (similar in F. peregrinus, interrupted proximally in F. femoralis); (4) attachment of M. gastrocnemius, pars externa, large, very shallow (large, deep in F. peregrinus; small, shallow in F. femoralis); (5) ridge at base of internal condyle high with internal surface rotated to face distally (moderately high, not rotated in F. peregrinus; high, not rotated in F. femoralis); (6) internal condyle angular distally in internal view (rounded in F. peregrinus, subrounded in F. femoralis). Proximal width, 9.0; distal width, 8.8.

Remarks. The material listed above belongs without question in the genus Falco, and it probably represents a new species. It is not named at this time, however, on the slight chance that it represents F. deiroleucus, specimens of which were not available for comparison.

Subfamily Polyborinae Lafresnaye

Genus Polyborus Vieillot

Polyborus plancus (Miller)

Crested Caracara

Material. One cranium, 4 right and 6 left quadrates, 4 left articulars, 6 mandibular symphyses, 2 premaxillaries, 4 right and 10 left scapulae, 9 complete right and 15 complete left coracoids, humeral ends of 6 right and 4 left coracoids, sternal ends of 4 right and 2 left coracoids, 1 complete right and 1 complete left humerus, proximal ends of 4 right and 3 left humeri, distal ends of 9 right and 2 left humeri, 5 complete right ulnae, proximal ends of 7 right and 2 left ulnae, distal ends of 15 right and 6 left ulnae, proximal ends of 3 right and 1 left radius, distal ends of 7 right and 6 left radii, 6 complete right and 6 complete left carpometacarpi, proximal ends of 6 right and 3 left carpometacarpi, distal ends of

4 right and 4 left carpometacarpi, 2 complete right and 3 complete left femora, proximal ends of 2 right and 4 left femora, distal ends of 3 right femora, 1 complete right tibiotarsus, proximal end of 2 right and 3 left tibiotarsi, distal ends of 16 right and 14 left tibiotarsi, 8 complete right and 5 complete left tarsometatarsi, proximal ends of 12 right and 11 left tarsometatarsi, distal ends of 19 right and 11 left tarsometatarsi. The 293 specimens represent a minimum of 27 individuals.

Remarks. Although the material listed above is considerably smaller than the subspecies of Polyborus living in northwestern Peru today, P. p. cheriway, it is still larger than specimens of P. p. plancus from Bolivia. Despite numerous minor differences from living forms I do not feel there is sufficient basis for placing the fossil material in a new species, especially when considering the great range of variation found in living forms. Instead, this material should be regarded as a temporal subspecies. As I do not believe there is any value in naming fossil subspecies I have not put a separate name on this material.

Howard (1938) named the Rancho La Brea caracara as a new species and stated that she believed P. prelutosus represented an ancestral form of the living caracara. At the time she indicated disbelief in temporal subspecies. After examining specimens of "P. prelutosus" from Florida, and comparing her descriptions with the Peruvian material and Recent forms available I do not believe P. prelutosus is a valid species, but rather represents another temporal subspecies, if it is in fact separable from the highly variable living forms. Unfortunately Howard did not have available for comparison any representatives of the smallest members of P. p. plancus which are smaller

than measurements given for P. prelutosus. Obviously the problem of P. prelutosus needs further study before it can be settled.

Although P. plancus is found in northwestern Peru today, the living subspecies is much larger, perhaps an indication of replacement of the fossil subspecies by an invasion from the north, possibly after extinction of the fossil form owing to climatic changes.

Milvago n. sp.

Holotype. Complete left tarsometatarsus. (Pl. IV, Fig. F)

Paratypes. One complete right and 4 complete left tarsometatarsi, proximal ends of 2 right and 3 left tarsometatarsi, distal ends of 7 right and 6 left tarsometatarsi.

Diagnosis. Agrees with Milvago and differs from all other South American falconid genera by having (1) internal calcaneal ridge short; (2) external calcaneal ridge directed proximally; (3) shaft with prominent ridges bordering both sides of anterior metatarsal groove; (4) trochleae compressed; (5) area internal to proximal end of internal calcaneal ridge depressed.

Differs from M. chimachima and M. chimango by having (1) intercotyler prominence high and broad (low and broad in M. chimachima, high and narrow in M. chimango); (2) external calcaneal ridge large, with external side long (slender, external side short in M. chimachima and M. chimango); (3) tubercle for M. tibialis anticus very prominent (moderately prominent in M. chimachima, similar in M. chimango); (4) trochlear groove of middle trochlea very deep (moderately deep in M. chimachima, similar in M. chimango); (5) distal projection of internal trochlea long, broad, and only slightly

depressed on internal surface (long, narrow, deeply notched on internal surface in M. chimachima; short, broad, deeply notched on internal surface in M. chimango); (6) internal intertrochlear notch deep and wide (moderately deep and narrow in M. chimachima, shallow and narrow in M. chimango); (7) external trochlea of moderate depth (lesser in M. chimachima, greater in M. chimango); (8) trochleae very slightly compressed (compressed in M. chimachima and M. chimango); (9) shaft large (small in M. chimachima and M. chimango).

For measurements see Table 7. Measurements of the holotype are as follows: length, 61.5; proximal width, 9.8; distal width, 10.4; least width of shaft, 4.1; width of middle trochlea, 4.0.

Referred material. Four right and 4 left scapulae, 9 complete right and 6 complete left coracoids, humeral ends of 4 right coracoids, proximal ends of 3 right humeri, distal ends of 4 right and 2 left humeri, 3 complete right and 3 complete left ulnae, proximal ends of 7 right and 3 left ulnae, distal ends of 5 right and 2 left ulnae, 2 complete right radii, proximal ends of 4 right and 4 left radii, distal ends of 1 right and 3 left radii, 12 complete right and 5 complete left carpometacarpi, proximal ends of 5 right and 1 left carpometacarpus, distal ends of 3 right and 1 left carpometacarpus, 1 complete right femur, proximal ends of 1 right and 1 left femur, distal ends of 1 right and 3 left femora, 2 complete right tibiotarsi, proximal ends of 4 right tibiotarsi, distal ends of 10 right and 13 left tibiotarsi. The 160 specimens, including holotype and paratypes, represent a minimum of 17 individuals.

Characters. Scapula with (1) acromion broad and rounded proximally in distal view (narrow and straight in M. chimachima and M. chimango); (2) groove dorsal to proximal end of glenoid facet

shallow to moderately deep (deep in M. chimachima and M. chimango);
 (3) glenoid facet broad (narrow in M. chimachima and M. chimango).

Coracoid with (1) external side with pronounced internal curvature at dorsal end (slight curvature in M. chimachima and M. chimango); (2) coracohumeral surface long (short in M. chimachima and M. chimango); (3) attachment of Lig. humero-coracoideum anterieus superius greatly elevated anteriorly (slightly elevated in M. chimachima, moderately elevated in M. chimango); (4) external intermuscular line lying on pronounced ridge (slight ridge in M. chimachima, similar in M. chimango); (5) external face in distal view very concave (moderately concave in M. chimachima, similar in M. chimango); (6) concavity dorsal to sternal facet and anterior to external intermuscular line pronounced (slightly developed in M. chimachima, similar in M. chimango).

Humerus with (1) profile of head low in palmar view (high in M. chimachima and M. chimango); (2) anconal surface of shaft immediately distal to external tuberosity very concave (moderately concave in M. chimachima and M. chimango); (3) attachment of M. proscapulohumeralis brevis located midway between head and base of median crest (located near base of median crest in M. chimachima, similar in M. chimango); (4) internal tuberosity large (small in M. chimachima, moderate in M. chimango); (5) impression of M. brachialis anticus long and wide (moderately long and wide in M. chimachima and M. chimango); (6) attachment of anterior articular ligament rotated distally (rotated only slightly in M. chimachima, similar in M. chimango); (7) entepicondyle very produced internally (moderately produced in M. chimachima and M. chimango); (8) attachment of M. pronator brevis a large shelf (pit in M. chimachima, slight shelf in M. chimango).

Ulna with (1) internal cotyla with deep concavity (moderate in

M. chimachima, similar in M. chimango); (2) external corner of external condyle projecting greatly palmarly (projecting only slightly in M. chimachima, projecting moderately in M. chimango); (3) impression of M. brachialis anticus shallow to moderately deep (very deep in M. chimachima, similar in M. chimango); (4) ligamental attachment at base of internal side of internal condyle a deep pit (shallow in M. chimachima, moderately deep in M. chimango).

Radius with (1) bicipital tubercle large (small in M. chimachima and M. chimango); (2) capital tuberosity large (small in M. chimachima and M. chimango); (3) tendinal groove deep (shallow in M. chimachima, moderate in M. chimango); (4) external end of carpal facet extending well onto ligamental prominence (extending only slightly onto prominence in M. chimachima, similar in M. chimango).

Carpometacarpus with (1) external rim of carpal trochlea moderately produced proximally, giving a moderate slope to carpal trochlea (greatly produced in M. chimachima, giving a steep slope to carpal trochlea; similar in M. chimango); (2) process of metacarpal I large, greatly produced internally (small, moderately produced in M. chimachima; small, slightly to moderately produced in M. chimango); (3) internal ligamental fossa deep (shallow in M. chimachima, moderate in M. chimango); (4) internal rim of carpal trochlea very large (small in M. chimachima, moderate in M. chimango); (5) depression distal to pisiform process deep (similar in M. chimachima, moderate in M. chimango); (6) attachment of M. flexor digitalis III greatly produced internally (moderately produced in M. chimachima and M. chimango).

Femur with (1) attachments of M. gluteus profundus, M. flexor ischiofemoralis, and M. iliacus long (all short in M. chimachima and M. chimango); (2) attachment of M. flexor perforans et perforatus

digiti II large, but shallow (small and deep in M. chimachima, of moderate size and depth in M. chimango); (3) rotular groove broad (narrow in M. chimachima and M. chimango); (4) internal condyle angular in internal view (subangular in M. chimachima and M. chimango); (5) external condyle rounded, with moderate posterior projection (subrounded, with large posterior projection in M. chimachima; less rounded, with moderate posterior projection in M. chimango); (6) ridge dorsal to internal condyle long and very prominent (short and moderately prominent in M. chimachima and M. chimango); (7) shaft with strong curvature in external view (slight curvature in M. chimachima and M. chimango).

Tibiotarsus with (1) area distal to internal articular surface deeply excavated, giving a prominent lip to posterior side of head (moderately excavated, with small lip in M. chimachima and M. chimango); (2) external condyle with very deep concavity in side (deep in M. chimachima, moderate in M. chimango); (3) internal condyle with moderate concavity in side (deep in M. chimachima, shallow in M. chimango).

Remarks. Although quite distinct from M. chimango, it is apparent from the above comparisons that Milvago n. sp. is more similar to it than to M. chimachima. As M. chimango is found today west of the Andes in Chile, and M. chimachima only east of the Andes, a closer relationship between it and Milvago n. sp. is perhaps to be expected.

The two living species of Milvago are residents of savannas and lightly wooded areas, and feed often as scavengers. If the fossil material represented a living species its presence in a currently unsuitable habitat could be attributed to its feeding habits and the long distance attraction of the tar pits for scavengers, but as the

Table 7. Measurements of the scapula, coracoid, humerus, radius, ulna, carpometacarpus, femur, tibiotarsus, and tarsometatarsus of Milvago n. sp., M. chimachima, and M. chimango (in mm).

		<u>Milvago</u> <u>n. sp.</u>	<u>Milvago</u> <u>chimachima</u>	<u>Milvago</u> <u>chimango</u>
Scapula	OR			
	Proximal	9.9-10.7	9.0	9.8-10.1
	Height	10.3	-	9.9
	M	8	1	2
	N			
Proximal	OR	4.0-4.9	4.2	3.9-4.5
	M	4.4	-	4.2
	N	8	1	2
Coracoid	OR			
	Length	35.0-36.9	32.0	30.9-31.0
	M	36.0	-	30.9
	N	9	1	2
Head to	OR	12.3-13.7	11.3	11.5-15.1
	Scapular	12.9	-	13.3
	Facet	17	1	2
Proximal	OR	6.6-7.5	6.4	6.2-6.4
	Depth	7.0	-	6.3
	M	19	1	2
	N			
Least	OR	5.3-6.6	5.3	4.5
	Depth of	5.9	-	4.5
	Shaft	9	1	2

Table 7. Continued.

		<u>Milvago</u> <u>n. sp.</u>	<u>Milvago</u> <u>chimachima</u>	<u>Milvago</u> <u>chimango</u>
Length of	OR			
Sternal	M	14.1-15.6	13.7	12.8-13.5
Facet	N	14.9 3	- 1	13.2 2
Humerus				
Length	OR		71.2	67.9-69.3
	M		-	68.6
	N		1	2
Proximal				
Width	OR		14.4	15.1-15.3
	M		-	15.2
	N		1	2
Distal				
Width	OR	13.6-14.6	11.9	12.0-12.2
	M	14.0	-	12.1
	N	6	1	2
Least				
Width of	OR	6.1-6.2	5.4	5.2-5.3
Shaft	M	6.1	-	5.2
	N	2	1	2
Radius				
Length	OR	74.7-75.5	70.4	69.4-72.8
	M	75.1	-	71.1
	N	2	1	2

Table 7. Continued.

		<u>Milvago</u> <u>n. sp.</u>	<u>Milvago</u> <u>chimachima</u>	<u>Milvago</u> <u>chimango</u>
Proximal Width	OR	3.1-3.7	3.1	3.1-3.2
	M N	3.3 10	- 1	3.1 2
Distal Width	OR	6.5-7.2	5.9	5.7-6.0
	M N	6.8 6	- 1	5.9 2
Ulna				
Length	OR	77.3-82.9	75.1	74.6-77.2
	M N	80.6 4	- 1	75.9 2
Proximal Width	OR	9.3-10.0	8.5	8.7-8.8
	M N	9.6 13	- 1	8.8 2
Distal Depth	OR	8.3-9.3	7.7	7.7-8.0
	M N	8.8 13	- 1	7.8 2
Least Width of Shaft	OR	4.3-4.7	4.2	3.9
	M N	4.5 6	- 1	3.9 2

Table 7. Continued.

		<u>Milvago</u> n. sp.	<u>Milvago</u> chimachima	<u>Milvago</u> chimango
Carpometacarpus				
Length	OR	41.7-46.7	39.6	40.7-42.2
	M	43.8	-	41.8
	N	15	1	2
Height				
Through	OR	11.0-12.2	9.5	10.1-10.5
	M	11.5	-	10.3
	N	18	1	2
Metacarpal I				
Proximal	OR	4.8-5.5	4.5	4.2-4.5
	M	5.1	-	4.4
	N	20	1	2
Least				
Width of	OR	4.1-4.6	3.7	3.7-3.9
	M	4.4	-	3.8
	N	23	1	2
Length of				
Distal	OR	4.1-5.4	4.1	4.3-4.9
	M	4.8	-	4.6
	N	16	1	2
Femur				
Length	OR	56.2	50.6	47.6-49.3
	M	-	-	48.4
	N	1	1	2

Table 7. Continued.

		<u>Milvago</u> <u>n. sp.</u>	<u>Milvago</u> <u>chimachima</u>	<u>Milvago</u> <u>chimango</u>
Proximal Width	OR	10.5-11.2	8.8	8.9
	M	10.8	-	8.9
	N	3	1	2
Distal Width	OR	10.1-10.8	9.3	8.7-8.9
	M	10.4	-	8.8
	N	5	1	2
Least Width of Shaft	OR	5.3	4.9	4.1
	M	-	-	4.1
	N	1	1	2
Tibiotarsus				
Length	OR	78.2-80.6	70.4	69.0-72.4
	M	79.4	-	70.7
	N	2	1	2
Proximal Width	OR	8.5-9.2	7.5	7.1-7.3
	M	8.9	-	7.2
	N	5	1	2
Distal Width	OR	8.2-9.9	8.2	7.9-8.0
	M	9.1	-	7.9
	N	23	1	2

Table 7. Continued

		<u>Milvago</u> <u>n. sp.</u>	<u>Milvago</u> <u>chimachima</u>	<u>Milvago</u> <u>chimango</u>
Least	OR	4.3-5.1	4.3	3.9
Width of	M	4.7	-	3.9
Shaft	N	9	1	2
Depth of	OR	7.2-8.6	7.1	6.6-6.9
Internal	M	7.7	-	6.8
Condyle	N	22	1	2
Tarsometatarsus				
Length	OR	57.9-61.8	52.7	58.2-60.8
	M	59.8	-	59.5
	N	5	1	2
Proximal	OR	9.4-10.9	8.9	8.6-8.9
Width	M	10.0	-	8.8
	N	9	1	2
Distal	OR	9.1-10.4	8.8	8.4-8.9
Width	M	9.7	-	8.7
	N	14	1	2
Least	OR	3.6-4.4	3.6	3.0-3.1
Width of	M	4.0	-	3.1
Shaft	N	15	1	2
Width of	OR	3.4-4.1	3.3	3.2-3.3
Middle	M	3.7	-	3.3
Trochlea	N	19	1	2

material represents an extinct species it implies a change in the habitat.

Order Galliformes (Temminck)

Family Cracidae Vigors

Subfamily Penelopinae Bonaparte

Genus Penelope Merrem

Penelope cf. purpurascens Wagler

Crested Guan

Material. One right scapula, proximal end of 1 left humerus, distal end of 1 right humerus, distal end of 1 right tibiotarsus.

The 4 specimens represent a minimum of 1 individual.

Characters. The specimens listed above are readily recognizable as belonging to the genus Penelope by their size and many distinctive characters. They compare favorably with Recent P. purpurascens from Central America (none were available from South America), except in being slightly smaller, corresponding to the current trend toward smaller size in South American forms.

The fossil material appears closer to Central American P. purpurascens than to one available Bolivian P. jacquacu Spix, but the great in raspecific variation makes a definitive statement impossible without a larger series.

Remarks. The known range of P. purpurascens extends along the western slopes of the Andes only as far south as Naranjo (Naranjito), Ecuador, slightly over 200 miles from the fossil site. However, suitable habitat does exist today south of its known range, and it may simply not have been found there yet. The presence in the fossil collection of a tropical forest bird such as P. purpurascens gives

strong evidence that a heavy stand of forest, or at least a good riparian forest, was very near.

The fragmentary nature of the fossil material, a lack of comparative material from South America, and the availability of only one P. jacquacu prevents any comment on whether P. purpurascens and P. jacquacu are conspecific or distinct species (Vuilleumier, 1965; Hellmayr and Conover, 1942).

Order Ralliiformes (Reichenbach)

Suborder Ralli (Reichenbach)

Family Rallidae Vigors

Subfamily Rallinae (Vigors)

Genus Porzana Vieillot

Porzana carolina (Linnaeus)

Sora

Material. Distal end of 1 left humerus, distal end of 1 left tibiotarsus, distal end of 1 left tarsometatarsus. The 3 specimens represent a minimum of 1 individual.

Characters. The specimens are well within the size range of P. carolina, and all characters lie within the range of variation found in Recent specimens.

Remarks. A North American migrant, P. carolina occurs as far south as central Peru.

Order Charadriiformes (Huxley)

Suborder Charadrii (Huxley)

Family Charadriidae (Vigors)

Coracoid with (1) procoracoid perforated by coracoidal fenestra.

Subfamily Vanellinae Blyth

Vanellinae, n. gen.

Holotype. Vanellinae, n. gen. n. sp.

Diagnosis. Coracoid agrees with that of Belonopterus Reichenbach and Vanellus Brisson (sensu stricto) by having (1) attachment of Lig. humero-coracoideum antierius superius long, lying close to internal side of head; (2) procoracoid long; (3) sterno-coracoidal impression deep.

Coracoid differs from that of Belonopterus chilensis (Molina) and Vanellus vanellus (Linnaeus) by having (1) head turned approximately 85° from line drawn along scapular facet and procoracoid (turned approximately 65° in B. chilensis, 70° in V. vanellus); (2) furcular facet with anterior portion without large dorsal and ventral projections (present in B. chilensis and V. vanellus); (3) head very deeply excavated internally (deeply excavated internally in B. chilensis, moderately excavated in V. vanellus); (4) shaft with side between glenoid facet and head markedly concave (essentially flat in B. chilensis and V. vanellus); (5) attachment of M. coracobrachialis anterior large (smaller in B. chilensis and V. vanellus); (6) glenoid facet rotated internally (not rotated internally in B. chilensis and V. vanellus); (7) scapular facet large (smaller in B. chilensis and V. vanellus); (8) depression immediately dorsal to sternal facet and anterior to external intermuscular line pronounced, with deeper internal pits (absent in B. chilensis and V. vanellus); (9) internal sternal shelf very large (smaller in B. chilensis and V. vanellus); (10) external sternal angle very long, projecting sharply ventro-distally so that attachment of M. coracobrachialis posterior does not reach sternal facet (external sternal angle of moderate length, not projecting sharply distally in B. chilensis and V. vanellus).

Differs from Belonopterus (Ptiloscelys) resplendens (Tschudi) in all ways that it differs from B. chilensis, and additionally by having (1) scapular facet positioned much lower on shaft; (2) glenoid facet much larger.

The coracoid of Hoploxypterus Bonaparte is characterized by having (1) head lying at an angle of approximately 55° to line drawn along scapular facet and procoracoid; (2) shaft with side excavated so that large shelf is formed extending from distal end of glenoid facet to middle of head; (3) furcular facet with large dorsal projection at anterior end; (4) depression dorsal to sternal facet and anterior to external intermuscular line very shallow.

Vanellinae, n. gen. n. sp.

Holotype. Complete right coracoid, procoracoid broken. (Pl. VI, Fig. B)

Diagnosis. As for genus. For measurements see Table 8.

Remarks. An exhaustive comparative study of the osteology of the genera of lapwings is beyond the scope of this paper. However, osteological evidence cited above and in the following description of Belonopterus n. sp., and a cursory examination of other skeletal elements, indicates that the inclusion of the genera Belonopterus, Ptiloscelys, and Hoploxypterus in the genus Vanellus as proposed by Bock (1958) is unwarranted and serves only to confuse relationships of the several species of lapwings rather than clarify them.

The suggestion by Bock (1958) that Belonopterus chilensis and Ptiloscelys resplendens be placed in a single genus is supported by their similar osteological characters, but these characters require they be placed in the genus Belonopterus, not combined with Vanellus.

Vanellinae, n. gen. n. sp. and Belonopterus n. sp. (described

Table 8. Measurements of the humerus, coracoid, and femur of Belonopterus chilensis, B. resplendens, and Hoploxypterus cayanus; of the humerus and femur of Belonopterus n. sp.; and of the coracoid of Vanellinae, n. gen. n. sp. (in mm).

		<u>Belonopterus chilensis</u>	<u>Belonopterus resplendens</u>	<u>Belonopterus n. sp.</u>	<u>Vanellinae n. gen. n. sp.</u>	<u>Hoploxypterus cayanus</u>
Coracoid						
Length	OR	23.6-26.1	23.8-25.8		25.4	17.3
	M	24.7	25.3		-	-
	N	3	5		1	1
Head to	OR	9.1-10.0	8.4-9.3		10.3	6.0
Scapular	M	9.6	9.0		-	-
Facet	N	3	5		1	1
Proximal	OR	6.6-6.9	5.6-7.1		7.1	4.0
Depth	M	6.7	6.4		-	-
	N	3	5		1	1
Least	OR	3.1-3.4	2.8-3.3		3.4	2.2
Depth of	M	3.3	3.2		-	-
Shaft	N	3	5		1	1
Length of	OR	8.4-9.0	8.4-9.2		9.1	5.4
Sternal	M	8.6	8.9		-	-
Facet	N	3	5		1	1
Humerus						
Length	OR	67.0-71.1	59.8-65.5	43.5		40.1
	M	68.6	63.1	-		-
	N	3	5	1		1

Table 8. Continued.

		<u>Belonopterus chilensis</u>	<u>Belonopterus resplendens</u>	<u>Belonopterus n. sp.</u>	<u>Vanellinae n. gen. n. sp.</u>	<u>Hoploxypterus cayanus</u>
Proximal Width	OR	12.6-14.1	12.4-13.5	9.5		9.0
	M	13.3	13.2	-		-
	N	3	5	1		1
Distal Width	OR	9.8-11.1	9.2-9.8	6.7-7.4		6.4
	M	10.3	9.5	7.0		-
	N	3	5	2		1
Least Width of Shaft	OR	4.1-4.8	3.8-4.3	2.8		2.4
	M	4.4	4.0	-		-
	N	3	5	1		1
Depth of External Condyle	OR	5.7-6.2	5.5-6.0	4.2-4.3		3.7
	M	5.9	5.8	4.2		-
	N	3	5	2		1
Femur Length	OR	37.7-40.7	37.9-42.9	24.9		25.9
	M	39.1	40.7	-		-
	N	3	5	1		1
Proximal Width	OR	7.1-7.8	6.6-7.6	4.3		4.7
	M	7.4	7.1	-		-
	N	3	5	1		1
Distal Width	OR	7.9-8.5	7.2-7.9	4.9		5.1
	M	8.1	7.6	-		-
	N	3	5	1		1

Table 8. Continued.

		<u>Belonopterus</u> <u>chilensis</u>	<u>Belonopterus</u> <u>resplendens</u>	<u>Belonopterus</u> n. sp.	<u>Vanellinae</u> n. gen. n. sp.	<u>Hoploxypterus</u> <u>cayanus</u>
Least	OR	3.0-3.2	2.6-3.1	1.9		1.9
Width of	M	3.1	3.0	-		-
Shaft	N	3	5	1		1
Least	OR	3.1-3.3	5.4-6.1	1.7		2.0
Depth of	M	3.2	5.9	-		-
Shaft	N	3	5	1		1

below) represent the second and third paleospecies of lapwings to be described from the Pleistocene of the New World, Dorypaltus prospatus Brodkorb (1959) being recorded from two localities in Florida. The appearance of these three paleospecies of lapwings in the late Pleistocene suggests that perhaps even more paleospecies will be found in earlier deposits. It also indicates the hazards of describing current worldwide distributions of the members of a group (Bock, 1958) without knowledge of their fossil record.

Genus Belonopterus Reichenbach

Belonopterus n. sp.

Holotype. Complete left humerus. (Pl. V, Fig. C)

Paratype. Distal end of 1 left humerus.

Diagnosis. Humerus agrees with Belonopterus (including Ptiloscelys) and differs from Vanellus (sensu stricto) and Hoploxypterus by having (1) ectepicondyle reduced, not forming prominent spur (very prominent spur in Vanellus; moderately prominent spur in Hoploxypterus); (2) attachment of M. extensor metacarpi radialis, pars anconalis, with proximal end forming prominent projection equal to, or slightly lower than, proximal end of ectepicondylar prominence (attachment not projecting, much lower than proximal end of ectepicondylar prominence in Vanellus; not forming projection, but only slightly lower than proximal end of ectepicondylar prominence in Hoploxypterus); (3) olecranal fossa very poorly developed (moderate to deep, undercutting proximal end of internal condyle in Vanellus and Hoploxypterus); (4) brachial depression deep (shallow to moderately deep in Vanellus and Hoploxypterus).

Humerus characterized by having (1) head more rounded anconally

than palmarly in external view; (2) attachment of M. triceps, external head, very deep, excavated below attachment of M. proscapulo humeralis and undercutting head; (3) bicipital crest very wide; (4) entepicondyle with entire side very concave; (5) entepicondyle oblique, moderately produced; (6) olecranal fossa poorly developed; (7) concavity extending to internal side of external tricipital groove immediately proximal to ectepicondyle deep, giving ectepicondyle a very prominent external projection; (8) ectepicondylar prominence with external side concave; (9) attachment of M. flexor metacarpi radialis, pars anconalis, with proximal end very prominent, equal in height and separated by concavity from, proximal end of ectepicondylar prominence; (10) external condyle wide, undercut externally and proximally by narrow groove, and flat internally; (11) brachial depression deep, extending less than 25 per cent of length proximal to proximal end of ectepicondylar prominence; (12) attachment of anterior articular ligament with proximal third rotated to face internal condyle; (13) shaft strongly sigmoid in external view.

Humerus resembles B. chilensis more than B. (Ptiloscelys) resplendens, but is less than two-thirds the size of both of those species. For measurements see Table 8. Measurements of the holotype are as follows: length, 43.5; proximal width, 9.5; distal width, 6.7; least width of shaft, 2.8; depth of external condyle, 4.2.

Referred material. One complete left femur. The 3 specimens, including holotype and paratype, represent a minimum of 2 individuals.

Characters. Femur with (1) head facing approximately equally dorsally and internally; (2) concavity distal to posterior edge of iliac facet very deep; (3) concavity undercutting anterior edge of iliac facet and proximal end of anterior intermuscular line, which

remains parallel to edge of trochanter to its end; (4) shaft flattened, with deep depression on internal side of shaft at point of flexure distally; (5) internal condyle slightly rounded, with distal-most point centrally located; (6) external condyle moderately rounded; (7) attachment of M. gastrocnemius, pars externa, very large and elevated; (8) shaft relatively straight, with only slight antero-posterior curvature. The femur agrees with the humerus in resembling B. chilensis more than B. (Ptiloscelys) resplendens.

Remarks. Belonopterus n. sp. is clearly related to B. chilensis and B. (Ptiloscelys) resplendens, and is distinct from Vanellus (sensu stricto) and Hoploxypterus, providing additional evidence for the inclusion of B. chilensis and B. (Ptiloscelys) resplendens in the genus Belonopterus.

Subfamily Charadriinae (Vigors)

Genus Pluvialis Brisson

Pluvialis dominica (Muller)

Golden Plover

Material. One left scapula, 4 left coracoids, 3 complete right humeri, shaft and distal end of 2 right and 1 left humerus, proximal ends of 2 left humeri, distal ends of 3 right and 5 left humeri, 1 complete left carpometacarpus, distal ends of 1 right and 1 left tibiotarsus, 1 complete left tarsometatarsus, proximal ends of 2 right and 3 left tarsometatarsi, distal ends of 1 right and 1 left tarsometatarsus. The 32 specimens represent a minimum of 6 individuals.

Characters. The smaller size of P. dominica is generally sufficient to separate its elements from those of Squatarola squatarola (Linnaeus). For those elements of the two species that are of similar

length, S. squatarola is much heavier. Additional characters of P. dominica separating the two species are coracoid with (1) angle between furcular facet and edge of triosseal canal approximately 135° (approximately 125° in S. squatarola).

Humerus with (1) base of median crest slightly nearer capital shaft ridge; (2) internal condyle narrow; (3) olecranal fossa narrow, and deepest on internal side.

Carpometacarpus with (1) process of metacarpal I lower; (2) carpal trochlea with internal rim projecting less distally.

Femur with (1) head much smaller; (2) ridge at internal corner of internal condyle turned externally at greater angle.

Tibiotarsus with (1) posterior rim of internal condyle extending less proximally.

Tarsometatarsus with (1) proximal foramina situated more proximally.

Remarks. A North American migrant, P. dominica occurs on the west coast of South America as far south as Santiago, Chile.

Genus Squatarola Cuvier

Squatarola squatarola (Linnaeus)

Black-bellied Plover

Material. One complete left femur, distal end of 1 right tibiotarsus, distal end of 1 left tarsometatarsus. The 3 specimens represent a minimum of 1 individual.

Remarks. A North American migrant, S. squatarola occurs along the west coast of South America as far south as Concepcion, Chile.

Genus Charadrius Linnaeus

Charadrius vociferous Linnaeus

Killdeer

Material. Two left coracoids, 1 complete right humerus, distal end of 1 right humerus, proximal end and shaft of 1 right femur, 1 complete right and 1 complete left tibiotarsus. The 7 specimens represent a minimum of 2 individuals.

Characters. Size is sufficient to distinguish this species from all other species of the subfamily Charadriinae.

Remarks. C. vociferous is resident on the coast of Peru today.

Charadrius collaris Vieillot

Collared Plover

Material. Proximal end of 1 left humerus, shaft and distal end of 1 right humerus, 1 complete left tarsometatarsus. The 3 specimens represent a minimum of 1 individual.

Characters. C. collaris is separated from C. alexandrinus Linnaeus, the only other plover of similar size, by having humerus with (1) proximal end narrower; (2) deltoid crest smaller; (3) head less undercut; (4) ectepicondyle and entepicondyle less produced; (6) external condyle wider and shorter.

Tarsometatarsus with (1) internal trochlea placed farther distally.

Remarks. C. collaris occurs all along the west coast of South America.

Charadrius semipalmatus Bonaparte

Semipalmated Plover

Material. Complete left tarsometatarsus.

Characters. Although the specimen represents an immature bird

the size and proportions of C. semipalmatus are sufficient to distinguish it from all other species of the genus.

Remarks. A North American migrant, C. semipalmatus winters as far south as Llanquihue, Chile.

Family Scolopacidae Vigors

Coracoid with (1) procoracoid not perforated by coracoidal fenestra.

Genus Tringa Linnaeus

Tringa solitaria Wilson

Solitary Sandpiper

Material. Two complete right and 5 complete left coracoids, 2 complete right and 3 complete left humeri, 1 complete right carpometacarpus, proximal end of 1 right carpometacarpus, proximal end of 1 right tibiotarsus, distal ends of 1 right and 2 left tibiotarsi, 1 complete right tarsometatarsus, distal ends of 1 right and 1 left tarsometatarsus. The 21 specimens represent a minimum of 5 individuals.

Characters. The elements of T. solitaria are separated from those of other scolopacid species of similar size by the following characters:

Coracoid with (1) external surface wide, and channel on anterior half shallow and wide; (2) procoracoid set off sharply from shaft distally; (3) attachment at base of internal side of procoracoid prominent; (4) scapular facet more round than elliptical.

Humerus with (1) proximal end small and bicipital surface small and narrow; (2) groove between capital shaft ridge and base of median crest very deep, deeply undercutting head; (3) line of M. latissimus dorsi anterioris prominent, lying near top of capital shaft ridge; (4) impression of M. brachialis anticus elliptical, ending distally in

deep, pointed pit; (5) area between ectepicondylar process and ectepicondyle only slightly concave; (6) entepicondyle produced.

Carpometacarpus with (1) ligamental attachment of pisiform process well developed; (2) external side of metacarpal I sharply concave.

Tibiotarsus with (1) internal articular surface small; (2) external condyle joining shaft abruptly distally; (3) tendinal groove positioned near internal condyle.

Tarsometatarsus with (1) hypotarsus high and rectangular; (2) distal foramen long; (3) shaft long and narrow, and anterior face channeled for more than half its length; (4) shaft widening gradually to meet outer and inner trochleae; (5) trochleae compressed.

Remarks. A North American migrant, T. solitaria occurs all along the Peruvian coast.

Tringa n. sp.

Holotype. Complete left coracoid. (Pl. V, Fig. D)

Diagnosis. Agrees with Tringa and differs from all other scolopacid genera by having (1) head of moderate height, rectangular, with antero-dorsal corner extending farthest anteriorly; (2) external side of shaft between glenoid facet and attachment of Lig. humero-coracoideum anteriorly flat; (3) length of procoracoid through base short; (4) internal ridge of shaft leading dorsally from internal distal angle similarly developed and at similar angle as in T. solitaria; (5) sterno-coracoidal impression deep, extending more than halfway up shaft.

Differs from Tringa solitaria by having (1) shaft ventral to coracohumeral surface very flat, excavated from glenoid facet to base

Table 9. Measurements of the coracoid and tarsometatarsus of Tringa n. sp., Recent T. solitaria, and T. solitaria from the Talara Tar Seeps (in mm).

		<u>Tringa n. sp.</u>		<u>Tringa solitaria</u>	
		Talara Tar Seeps		Recent	
Coracoid Length	OR	16.2	15.9-16.6	15.0-15.5	
	M	-	16.3	15.2	
	N	1	6	3	
Head to Scapular Facet	OR	5.8	5.8-6.2	5.1-5.5	
	M	-	6.0	5.3	
	N	1	7	3	
Proximal Depth	OR	4.8	4.8-5.1	4.1-4.5	
	M	-	5.0	4.4	
	N	1	5	3	
Least Width of Shaft	OR	1.9	1.9-2.2	1.7-1.8	
	M	-	2.0	1.8	
	N	1	7	3	
Length of Sternal Facet	OR	5.1	5.3-5.7	4.3-5.1	
	M	-	5.4	4.7	
	N	1	5	3	
Tarsometatarsus Proximal Width	OR	3.6	4.0	3.8	
	M	-	-	-	
	N	1	1	1	

of attachment of Lig. humero-coracoideum anterius superius so that external edge of coracohumeral surface forms a lip and large ridge extends from end of coracohumeral surface to attachment of Lig. humero-coracoideum anterius superius; (2) angle between line drawn along furcular facet and plane of procoracoid approximately 10 -15 less; (3) internal distal angle lie at greater angle to horizontal in internal view; (4) scapular facet directed more posteriorly. For measurements see Table 9.

Referred material. Proximal end of 1 right tarsometatarsus.

Characters. Tarsometatarsus differs from that of T. solitaria by having (1) proximal end narrower, with shaft flaring more gradually toward cotylae; (2) external cotyla positioned more distally; (3) proximal foramina and tubercle for tibialis anticus located more distally.

Remarks. Although there are not a large number of differences between Tringa n. sp. and T. solitaria (including fossil specimens) the few present are very good specific characters.

Tringa n. sp. is the first recorded paleospecies of the genus. While it cannot be proven, it is probable that Tringa n. sp. was a northern migrant, as are all related species and genera today.

Genus Totanus Bechstein

Totanus flavipes (Gmelin)

Lesser Yellowlegs

Material. Seven complete right and 9 complete left coracoids, humeral end of 1 left coracoid, 6 complete right and 7 complete left humeri, proximal ends of 1 right and 7 left humeri, distal ends of 4 right and 3 left humeri, 6 complete right and 2 complete left carpo-metacarpi, proximal ends of 1 right and 2 left carpometacarpi, distal

ends of 2 right and 6 left tibiotarsi, distal ends of 1 right and 1 left tarsometatarsus, proximal ends of 2 right and 3 left tarsometatarsi. The 69 specimens represent a minimum of 16 individuals.

Characters. T. flavipes differs from other species of similar size by having coracoid with (1) anterior furcular facet with large dorsal extension and small ventral extension; (2) protrusion distal to attachment of Lig. humero-coracoideum anterius superius.

Humerus with (1) external tuberosity facing anconally, giving a strong shelf; (2) area between attachment of M. supracoracoideus and deltoid crest usually concave; (3) capital shaft ridge large, with anconal projection of head at its proximal end; (4) internal tuberosity prominent and slender; (5) ectepicondyle well developed; (6) attachment of M. anconeus, M. extensor digitorum communis, and M. flexor metacarpi radialis strongly developed; (7) brachial depression moderately deep, not extending to internal condyle.

Carpometacarpus with (1) metacarpal I long; (2) internal rim of carpal trochlea slanting externally only slightly; (3) lobe at end of external rim of carpal trochlea well developed; (4) concavity at distal end of tendinal groove deep.

Tibiotarsus with (1) distal end compressed; (2) condyles raised above shaft antero-proximally.

Tarsometatarsus with (1) hypotarsus distinctive; (2) trochleae long and compressed; (3) shaft widening gradually distally.

Remarks. A North American migrant, T. flavipes occurs all along the Pacific coast of South America.

Totanus melanoleucus (Gmelin)

Greater Yellowlegs

Material. One complete right coracoid, humeral end of 1 left coracoid, 1 complete left humerus, proximal end of 1 right humerus, proximal end of 1 left carpometacarpus, distal end of 1 left tibiotarsus, proximal ends of 2 right and 1 left tarsometatarsus, distal ends of 1 right and 1 left tarsometatarsus. The 11 specimens represent a minimum of 2 individuals.

Characters. Size is sufficient to separate T. melanoleucus from other species of scolopacids.

Remarks. A North American migrant, T. melanoleucus occurs all along the Pacific coast of South America.

Genus Actitis Illiger

Actitis macularia (Linnaeus)

Spotted Sandpiper

Material. Distal end of 1 left humerus.

Characters. Humerus with (1) attachment of M. flexor carpi ulnaris large and round; (2) attachment of anterior articular ligament short and high; (3) impression of M. brachialis anticus completely inset; (4) ectepicondylar process small.

Remarks. A North American migrant, A. macularia occurs all along the coast of Peru.

Genus Catoptrophorus Bonaparte

Catoptrophorus semipalmatus (Gmelin)

Willet

Material. Humeral end of 2 right coracoids, 1 complete right and 2 complete left humeri, proximal end of 1 left humerus, distal end of 1 right and 2 left humeri, 2 complete right and 2 complete left carpometacarpi, distal ends of 2 left tibiotarsi, distal end of 1 left

tarsometatarsus. The 16 specimens represent a minimum of 4 individuals.

Characters. Size is sufficient to separate C. semipalmatus from all other species of scolopacids.

Remarks. A North American migrant, C. semipalmatus occurs all along the coast of Peru.

Genus Erolia Vieillot

Erolia minutilla (Vieillot)

Least Sandpiper

Material. One complete left coracoid, 9 complete right and 9 complete left humeri, proximal ends of 3 right humeri, distal ends of 2 right and 1 left humerus, 1 complete left femur, 1 complete right tarsometatarsus, distal end of 1 left tarsometatarsus. The 28 specimens represent a minimum of 12 individuals.

Characters. Erolia minutilla is the smallest species of the genus and is readily separated on size. As this species is approximately the same size as Ereunetes mauri and Ereunetes pusillus the following characters were used to distinguish it from the genus Ereunetes:

Coracoid with (1) external rim of glenoid facet rotated more posteriorly; (2) distal rim of scapular facet small. Additional characters are listed by Brodkorb (1963a).

Humerus with (1) internal condyle/external condyle ratio high (Brodkorb, 1955); (2) bicipital crest usually not extending as far distally; (3) internal condyle less produced; (4) attachment of anterior articular ligament lower; (5) impression of M. brachialis anticus long and moderately deep.

Carpometacarpus with (1) internal rim of carpal trochlea less rounded; (2) proximal area of fusion of metacarpal II and metacarpal III longer; (3) pisiform process deflected slightly more outward; (4) attachment of M. flexor carpi ulnaris brevis not positioned as far posteriorly.

Femur with (1) rotular groove wide, and internal condyle appearing to taper and run off shaft proximally (rather than curving with edge of shaft as in Ereunetes).

Tibiotarsus with (1) length short; (2) outer cnemial crest directed more toward fibular crest; (3) distal rim of internal condyle much more developed.

Tarsometatarsus with (1) length short; (2) trochleae less compressed; (3) external trochlea extending farther distally.

Remarks. A North American migrant, E. minutilla occurs all along the Peruvian coast.

Erolia melanotos (Vieillot)

Pectoral Sandpiper

Material. Five complete right and 8 complete left coracoids, humeral ends of 2 left coracoids, 19 complete right and 16 complete left humeri, proximal ends of 10 right and 6 left humeri, distal ends of 32 right and 41 left humeri, 22 complete right and 16 complete left carpometacarpi, proximal ends of 4 right and 2 left carpometacarpi, 2 complete left femora, distal end of 1 left femur, 1 complete right and 1 complete left tibiotarsus, distal ends of 6 right and 7 left tibiotarsi, 5 complete right and 2 complete left tarsometatarsi, proximal ends of 2 right and 2 left tarsometatarsi, distal ends of 4 right and 4 left tarsometatarsi. The 220 specimens represent a

minimum of 57 individuals.

Characters. E. melanotos differs from other species of scolopacids by having coracoid with (1) brachial tuberosity large, and protrusion posterior to attachment of Lig. humero-coracoideum anterius superius large, combining to give very wide head; (2) coracohumeral surface short, wide, and sharply curved; (3) shaft large.

Humerus with (1) proximal end wide, capital shaft ridge dropping off sharply on either side; (2) attachment of M. supracoracoideus long; (3) area between ectepicondyle and ectepicondylar process usually quite concave; (4) impression of M. brachialis anticus deep distally, undercutting attachment of anterior articular ligament, and becoming gradually shallower proximally; (5) entepicondyle rectangular; (6) external condyle curving slightly toward anterior articular ligament.

Carpometacarpus with (1) internal rim of carpal trochlea rounded posteriorly; (2) lobe at end of external rim of trochlea long and well developed, tapering sharply to end; (3) ligamental attachment of pisiform process well developed; (4) ligamental attachment of ulnare deep, separated from ligamental attachment of pisiform process.

Femur with (1) trochanter high; (2) attachment of M. gluteus profundus wide; (3) attachment of M. obturator externus deep; (4) space between anterior intermuscular line and trochanteric ridge narrow; (5) internal condyle more oval than elliptical; (6) external condyle quite produced; (7) attachment of M. gastrocnemius, pars externa, large, positioned near base of fibular condyle.

Tibiotarsus with (1) internal articular surface undercut distally; (2) outer cnemial crest directed away from fibular crest; (3) shaft convex externally and concave internally between fibular

crest and articular surface in distal view; (4) tendinal groove directed toward inner condyle; (5) posterior intercondylar surface wide, but short.

Tarsometatarsus with (1) shaft moderately large, widening abruptly both proximally and distally; (2) intercotylar prominence produced; (3) hypotarsus roughly triangular, long on external side, very short on internal side; (4) trochleae not greatly compressed or widened.

Remarks. A North American migrant, E. melanotos occurs all along the Peruvian coast.

Genus Ereunetes Illiger

Ereunetes mauri (Cabanis)

Western Sandpiper

Material. One complete right and 1 complete left coracoid, humeral end of 1 left coracoid, 1 complete right and 2 complete left humeri, shaft and distal end of 1 left humerus, 2 complete right and 2 complete left carpometacarpi, 1 complete right tibiotarsus, distal ends of 2 right and 1 left tibiotarsus, 1 complete left tarsometatarsus. The 16 specimens represent a minimum of 3 individuals.

Characters. E. mauri and E. pusillus are very similar osteologically, but some elements of the two species can be separated from one another. Of the material listed above I was not able to find any reliable characters for separating carpometacarpi and tibiotarsi of the two species. However, as all other elements were identifiable as E. mauri and not E. pusillus, I have assigned the carpometacarpi and tibiotarsi to E. mauri. The following characters of E. mauri separate it from E. pusillus:

Coracoid with (1) coracohumeral surface rising at steeper angle; (2) brachial tuberosity larger: the combined effect of (1) and (2) being a larger, thicker head.

Humerus with (1) deltoid crest slightly larger; (2) attachment of anterior articular ligament slightly shorter and significantly higher.

Tarsometatarsus with (1) external rims of internal and external cotylae higher, the cotylae more produced anteriorly; (2) distal extension of internal trochlea more distinctly set off from rest of trochlea.

Remarks. A North American migrant, E. mauri occurs as far south as central Peru.

Genus Micropalama Baird

Micropalama himantopus (Bonaparte)

Stilt Sandpiper

Material. One complete right femur.

Characters. Femur with (1) anterior intermuscular line lying along center of shaft for almost its entire length; (2) iliac facet moderately undercut distally for its entire width; (3) ridge leading to external rim of internal condyle from posterior intermuscular line; (4) attachment of M. gastrocnemius, pars externa, large, and positioned proximally from base of fibular condyle.

Remarks. A North American migrant, M. himantopus occurs all along the coast of Peru.

Genus Arenaria Brisson

Arenaria interpres (Linnaeus)

Ruddy Turnstone

Material. Proximal end of 1 right humerus, 1 complete left carpometacarpus. The 2 specimens represent a minimum of 1 individual.

Characters. Humerus with (1) proximal end wide, and head large; (2) capital groove wide; (3) groove between capital shaft ridge and base of median crest moderately deep; (4) pneumatic fossa wide; (5) shaft widening considerably to meet bicapital crest.

Carpometacarpus with (1) trochlear surface wide, and internal rim of carpal trochlea very high; (2) pisiform process positioned near pollical facet; (3) shaft rather large.

Remarks. A North American migrant, A. interpres occurs all along the coast of Peru.

Genus Numenius Brisson

Numenius cf. borealis (Foster)

Eskimo Curlew

Material. Complete right coracoid.

Characters. Agrees with Numenius and differs from all other scolopacid genera by having (1) head extending only short distance anterior to shaft, and with dorso-ventral length very large; (2) attachment of Lig. humero-coracoideum antierius superius very long, shallow, with only slight convexity distal to it; (3) internal edge of coracohumeral surface elevated; (4) internal excavation of head external to furcular facet shallow.

Differs from N. phaeopus (Linnaeus) by having (1) much smaller size; (2) head proportionately longer dorso-ventrally, and extending less anteriorly; (3) dorsal and anterior edge of head straight in external view.

Remarks. Although the specimen listed above probably represents

N. borealis it can only be referred tentatively to that species until a comparative specimen is examined. If the specimen does represent N. borealis it indicates a considerable reduction in the distribution of this species in South America over time, as the historic range of this almost extinct species along the west coast of South America is from Arica, Chile, south.

Scolopacidae, n. gen.

Holotype. Scolopacidae, n. gen. n. sp.

Diagnosis. Coracoid differs from that of other scolopacid genera by having (1) head approximately two-thirds as high as long in external view, with antero-dorsal corner protruding farther anteriorly than antero-ventral corner, and dorsal edge essentially straight (length-height ratio similar or greater, with antero-ventral corner protruding farther anteriorly than antero-dorsal corner, and dorsal edge convex in Limnodromous griseus (Gmelin)); (2) head turned internally at anterior end (turned externally in L. griseus); (3) internal excavation of head deep (shallower in L. griseus); (4) coracohumeral surface short and narrow (longer and wider in L. griseus); (5) area between furcular facet and coracohumeral surface slightly convex, sloping slightly (moderately to strongly convex along dorsal half and essentially vertical in L. griseus); (6) angle between line drawn along glenoid facet and from ventral edge of glenoid facet to tip of external distal angle approximately 160 (approximately 170 in L. griseus); (7) glenoid facet narrow (wider in L. griseus); (8) procoracoid with short base, large anterior end and broad dorsal edge that does not dip below level of anterior corner of scapular facet (short base, small anterior end, and narrow dorsal edge that dips below level of anterior

corner of scapular facet in L. griseus); (9) sternocoracoidal impression very deep (moderately deep in L. griseus); (10) shaft moderately convex at anterior end of ridge leading along internal side of internal distal angle in internal view (slightly convex in L. griseus); (11) internal distal angle directed anteriorly in internal view (directed more ventrally in L. griseus); (12) hyposternal process directed sharply internally (not turned as much internally in L. griseus); (13) sternal facet narrow, with tips of both internal and external distal angles projecting internally well beyond internal edge (wide, with both distal angles projecting only slightly, if at all, internal to internal edge in L. griseus).

Scolopacidae, n. gen. n. sp.

Holotype. Complete right coracoid. (Pl. VI, Fig. C)

Diagnosis. As for genus. Measurements of the holotype are as follows: length, 16.7; head to scapular facet, 5.9; proximal depth, 4.6; least width of shaft, 2.1; sternal facet length, 5.6.

Referred material. One complete right femur, 1 complete left tarsometatarsus. The three specimens, including holotype, represent a minimum of 1 individual.

Characters. Femur with (1) head of moderate size, dorsal surface flush with iliac facet (head large, directed dorsally in L. griseus); (2) shaft stout and slightly convex anteriorly (less stout, moderately convex anteriorly in L. griseus); (3) internal condyle long antero-posteriorly and moderately rounded (similar in L. griseus); (4) attachment of M. gastrocnemius, pars externa, elongated, facing more externally than posteriorly, and positioned more than own length proximal to base of external condyle (of moderate length, round,

facing more posteriorly than externally, and positioned less than own length proximal to base of external condyle in L. griseus); (5) antero-posterior end of internal condyle very slightly undercut (moderately undercut in L. griseus); (6) rotular groove very narrow and deep (broad and moderately deep in L. griseus). Length, 23.2; proximal width, 4.0; distal width, 4.3; least width of shaft, 1.7; least depth of shaft, 1.9.

Tarsometatarsus with (1) intercondylar prominence of moderate width and very prominent (broad and moderately prominent in L. griseus); (2) hypotarsus long and broad, proximal end lying almost at level of internal condyle (shorter and narrower, proximal end placed well distal to internal condyle in L. griseus); (3) shaft narrows abruptly distal to condyles, widens slightly immediately distal to proximal foramina, and narrows markedly proximal to trochleae (narrows abruptly distal to condyles and then narrows gradually until where begins widening for trochleae in L. griseus); (4) trochleae spread (similar in L. griseus); (5) middle trochleae of moderate size (larger in L. griseus in specimen of same length); (6) anterior edge of internal trochlea lies anterior to midline of middle trochlea in internal view (lies posterior to midline in L. griseus); (7) trochlear grooves of middle and external trochlea narrow, with well marked edges (broader and more rounded in L. griseus); (8) middle trochlea ends posteriorly elevated above shaft (merges with shaft in L. griseus); (9) trochlear surfaces of moderate length (longer in L. griseus); (10) metatarsal facet well marked (similar in L. griseus); (11) posterior projection of internal trochlea broad dorso-ventrally and set off from rest of condyle by groove (narrower and not set off from rest of condyle in L. griseus); (12) distal third of shaft flattened

antero-posteriorly (not as flattened in L. griseus). Length, 35.0; proximal width, 4.4; distal width, 4.3; least width of shaft, 1.6; width of middle trochlea, 1.4.

Remarks. Scolopacidae, n. gen. n. sp. is compared with L. griseus because the former species bears a closer superficial resemblance to Limnodromus than to any other scolopacid genus, and also to provide a reference point for the characters of Scolopacidae, n. gen. n. sp. No relationship between the two species is implied, and indeed, the two are quite different in numerous critical areas.

Although the femur and tarsometatarsus are referred to Scolopacidae, n. gen. n. sp. there is no strong justification for this except that they also bear a close superficial resemblance to L. griseus and are of similar size. They do not resemble Tringa solitaria sufficiently to warrant consideration as elements of Tringa n. sp.

Family Phalaropodidae Bonaparte

Femur with (1) attachment of M. gastrocnemius, pars externa, elevated, lying on corner of shaft, and connected by ridge to base of fibular condyle.

Genus Lobipes Cuvier

Lobipes lobatus (Linnaeus)

Northern Phalarope

Material. Two complete left humeri.

Characters. The humerus of L. lobatus is distinguished from humeri of other phalaropes by size, and from humeri of scolopacids of similar size by having (1) groove between capital shaft ridge and base of median crest very deep, undercutting head; (2) capital shaft ridge depressed, so that it curves anconally to meet base of head;

(3) impression of *M. brachialis anticus* deeply inset proximally as well as distally; (4) entepicondyle little produced.

Remarks. A North American migrant, *L. lobatus* occurs south on the Pacific coast of South America to Santiago, Chile.

Genus Steganopus Vieillot

Steganopus tricolor Vieillot

Wilson's Phalarope

Material. Five complete right and 6 complete left coracoids, 8 complete right and 8 complete left humeri, proximal ends of 3 right and 2 left humeri, distal ends of 1 right and 3 left humeri, 3 complete right and 6 complete left carpometacarpi, proximal ends of 1 right and 2 left carpometacarpi, distal ends of 6 right and 3 left tibiotarsi, 1 complete left tarsometatarsus, proximal ends of 3 right and 3 left tarsometatarsi, distal ends of 1 left tarsometatarsus. The 65 specimens represent a minimum of 11 individuals.

Characters. *S. tricolor* is the largest of the three species of phalaropes and can generally be separated easily on a size basis.

In addition to size *S. tricolor* is characterized by having coracoid with (1) shaft long and slender; (2) glenoid facet deeply concave; (3) anterior portion of head long and narrow; (4) coracohumeral surface long; (5) scapular facet elliptical.

Humerus with (1) proximal end narrow, and bicipital surface small; (2) attachment of *M. supracoracoideus* moderately long; (3) impression of *M. brachialis anticus* deeply inset on all sides and undercutting attachment of anterior articular ligament; (4) external condyle straight; (5) entepicondyle merging smoothly with shaft proximally, and curving slightly palmarly; (6) area between ectepicondyle and ectepicondylar prominence moderately to slightly concave.

Carpometacarpus with (1) external side of metacarpal I noticeably concave; (2) internal rim of carpal trochlea flattened posteriorly, distal end protruding farther posteriorly than proximal end.

Femur with (1) head prominently elevated above shaft on all sides but dorsally, where it extends slightly above level of iliac facet; (2) shaft convex anteriorly; (3) attachment of M. gastrocnemius, pars externa, elevated, facing dorsally, and connected to base of fibular condyle by marked ridge; (4) pit at base of fibular condyle deep; (5) external condyle deep and short.

Tibiotarsus with (1) proximal end of external condyle joining shaft gradually; (2) tendinal groove curving slightly under internal condyle; (3) internal condyle of moderate size.

Tarsometatarsus with (1) shaft long and narrow; (2) proximal and distal ends laterally compressed; (3) hypotarsus high, narrow, and rectangular; (4) anterior face of shaft flat.

Remarks. A North American migrant, S. tricolor occurs all along the west coast of South America.

Steganopus n. sp.

Holotype. Complete right femur. (Pl. VI, Fig. E)

Diagnosis. Agrees with Steganopus and differs from Lobipes and Phalaropus Brisson by having (1) head small, with dorsal surface essentially flush with iliac facet (large, protruding well above iliac facet in Lobipes and Phalaropus); (2) shaft narrows rather abruptly distal to head in posterior view (narrows more gradually in Lobipes and Phalaropus); (3) trochanter narrow (slightly wider in Lobipes and Phalaropus); (4) shaft slender (slender in Lobipes, stout in Phalaropus); (5) attachment of M. gastrocnemius, pars externa, of moderate length,

greatly elevated, with marked ridge leading to base of fibular condyle (long, moderately elevated, with moderate ridge, and located more on side of shaft in Lobipes and Phalaropus); (6) size large (small in Lobipes and Phalaropus).

Differs from Steganopus tricolor by having (1) head smaller, not extending as far proximally; (2) trochanter narrower, more concave on internal side; (3) shaft much more concave distal to anterior edge of iliac facet; (4) shaft more compressed laterally, less compressed antero-posteriorly, with greater internal flexure at distal end; (5) internal and external condyles deep, with anterior end markedly elevated above shaft (of moderate depth, with anterior end slightly, if any, elevated above shaft in S. tricolor); (6) attachment of M. gastrocnemius, pars externa, more elevated, positioned more distally, with a larger ridge leading to base of fibular condyle. For measurements see Table 10.

Remarks. Steganopus n. sp. is the first recorded paleospecies of the family Phalaropodidae. The greater development of the attachment of M. gastrocnemius, pars externa, the greater lateral compression of the shaft, and the greater elevation of the condyles at their antero-proximal ends suggest that perhaps Steganopus n. sp. was a much stronger swimmer than S. tricolor.

Family Jacanidae (Stejneger)

Subfamily Jacaninae (Stejneger)

Genus Jacana Brisson

Jacana spinosa (Linnaeus)

Jacana

Material. Distal end of 1 left humerus.

Table 10. Measurements of the femur of Steganopus n. sp., Recent S. tricolor, and S. tricolor from the Talara Tar Seeps (in mm).

		<u>Steganopus n. sp.</u>		<u>Steganopus tricolor</u>	
		Talara Tar Seeps		Recent	
Femur Length	OR	21.6	23.4	20.7-23.5	
	M	-	-	22.5	
	N	1	1	3	
Proximal Width	OR	3.5	4.1	3.2-3.9	
	M	-	-	3.6	
	N	1	1	3	
Distal Width	OR	3.8	4.3	3.7-4.0	
	M	-	-	3.8	
	N	1	1	3	
Least Width of Shaft	OR	1.3	1.9	1.4-1.5	
	M	-	-	1.5	
	N	1	1	3	
Least Depth of Shaft	OR	1.7	2.0	1.5-1.6	
	M	-	-	1.6	
	N	1	1	3	

Characters. Humerus with (1) ectepicondylar prominence large, but small compared with other charadriiform species; (2) impression of M. brachialis anticus deep, undercutting attachment of anterior articular ligament; (3) entepicondyle produced.

Remarks. J. spinosa is resident in areas with abundant floating aquatic vegetation, and was recorded by Chapman (1926) as abundant along tropical lowlands of southern coastal Ecuador. Although the single specimen may represent a vagrant, it is probable that the range of the species previously extended farther south.

Family Burhinidae Mathews

Genus Burhinus Illiger

Burhinus superciliaris (Tschudi)

Peruvian Thick-knee

Material. Two right and 3 left scapulae, 2 complete right and 2 complete left coracoids, humeral end of 1 left coracoid, proximal ends of 1 right and 4 left humeri, distal ends of 2 right humeri, distal ends of 1 right and 1 left radius, 2 complete right femora, distal ends of 3 right and 3 left tibiotarsi, proximal end of 1 right tarsometatarsus, distal end of 1 left tarsometatarsus. The 29 specimens represent a minimum of 4 individuals.

Characters. Once specimens of Burhinus are recognized as belonging to the order Charadriiformes identification is quite easy because there are no other species of the order with anything similar to their specialized osteology.

Remarks. B. superciliaris is quite common all along the arid littoral of the Pacific coast of Peru, and it is also present on the Santa Elena Peninsula of Ecuador. A bird of dry areas with little

ground cover, B. superciliaris is primarily nocturnal, although I have seen them moving about during the day.

Family Thinocoridae (Gray)

Humerus with (1) attachment of external head of triceps very deep, undercutting head; (2) attachment of M. proscapulohumeralis brevis large, very prominent; (3) attachment of M. brachialis anticus extending under attachment of anterior articular ligament.

Genus Attagis Saint-Hilaire & Lesson

cf. Attagis sp.

Material. Complete right coracoid.

Characters. Coracoid with (1) procoracoid non-perforate (similar in Thinocorus rumicivorus Eschscholtz); (2) head long, antero-dorsal corner rounded, and area ventral to attachment of Lig. humero-coracoideum antierius superius subangular, extending far ventrally (head longer, antero-dorsal corner subangular, and ventral projection rectangular and longer antero-posteriorly in T. rumicivorus); (3) head moderately high (very high and angular in T. rumicivorus); (4) internal excavation of head deep (moderate in T. rumicivorus); (5) external side of head concave ventral to dorsal end of coracohumeral surface (similar in T. rumicivorus); (6) internal edge of coracohumeral surface raised considerably above that surface (only slightly elevated in T. rumicivorus); (7) glenoid facet broad and rounded (broad and less rounded in T. rumicivorus); (8) postero-ventral corner of scapular facet prominent (similar in T. rumicivorus); (9) external surface of procoracoid markedly elevated above shaft (slightly elevated in T. rumicivorus); (10) sternal facet long and narrow (short and broad in T. rumicivorus); (11) external surface of shaft dorsal to external

distal angle slightly concave (deeply concave in T. rumicivorus); (12) sterno-coracoidal impression moderately deep (deep in T. rumicivorus); (13) anterior edge of attachment of M. supracoracoideus marked by prominent ridge (small ridge in T. rumicivorus). Length, 21.4; head to scapular facet, 7.5; proximal depth, 5.6; least width of shaft, 2.4; length of sternal facet, 6.7.

Remarks. The specimen listed above resembles Thinocorus more than any other charadriiform genus, particularly in the ventral projection of the anterior end of the head and the concavity on its external side. There are too many differences, however, between the fossil specimen and Thinocorus for the two to be considered congeneric. No specimens of Attagis were available for comparison, but the specimen is tentatively referred to that genus because it represents the only other living genus of the family Thinocoridae.

Neither of the two living species of Attagis occurs on the coast of Peru today, although A. gayi Lesson occurs in the Andes from Ecuador southward.

Genus Thinocorus Eschscholtz

Thinocorus rumicivorus Eschscholtz

Least Seedsnipe

Material. One complete left humerus.

Characters. The single specimen of T. rumicivorus agrees in all ways except size with Recent specimens of the species examined.

Remarks. T. rumicivorus is the smallest of the four living species of the family Thinocoridae, and is the only one that occurs on the Pacific coast of South America today. T. rumicivorus is represented by five subspecies. The smallest, T. r. pallidus, which occurs on the Santa Elena Peninsula of southwestern Ecuador, was not available for comparison.

Thinocorus n. sp.

Holotype. Complete left humerus (internal tuberosity and bicipital crest broken). (Pl. VI, Fig. D)

Diagnosis. Agrees with Thinocorus by having (1) capital groove extremely deep, very deeply undercutting head.

Differs from T. rumicivorus by having (1) head shorter but wider; (2) capital groove smaller; (3) attachment of M. supracoracoideus shorter, more shelf-like; (4) capital shaft ridge straighter; (5) ligamental furrow more distinct, with deep, narrow distal extension; (6) concavity internal to attachment of M. pectoralis superficialis deeper; (7) attachment of M. pectoralis superficialis rotated less palmarly, located more on deltoid crest; (8) impression of M. brachialis anticus longer, extending proximally beyond proximal edge of ectepicondyle; (9) attachment of anterior articular ligament much smaller, as wide as long (much longer than wide in T. rumicivorus); (10) internal condyle narrower, extending farther distally than external condyle; (11) external condyle narrower, with proximal end not directed toward attachment of anterior articular ligament; (12) internal face of entepicondyle at very small angle to long axis of shaft (rotated approximately 45° to long axis of shaft in T. rumicivorus); (13) area proximal to entepicondylar prominence slightly concave (deeply concave in T. rumicivorus); (14) external side of ectepicondylar prominence slightly concave (deeply concave in T. rumicivorus); (15) posterior edge of ectepicondylar prominence straight, not bowing externally, and with slight palmar convexity (slightly concave in T. rumicivorus); (16) shaft much less sigmoid in external view; (17) shaft more slender. Thinocorus n. sp. is smaller than T. rumicivorus (Table 11), and much smaller than T. orbignyianus (Lesson).

Remarks. Although no specimens of Attagis were available for

Table 11. Measurements of the humerus of Thinocorus n. sp., Recent T. rumicivorus, and T. rumicivorus from the Talara Tar Seeps (in mm).

		<u>Thinocorus n. sp.</u>		<u>Thinocorus rumicivorus</u>	
		Talara Tar Seeps		Recent	
Humerus Length	OR	23.6	24.5	28.8-34.1	
	M	-	-	30.6	
	N	1	1	3	
Distal Width	OR	3.8	4.3	4.8-5.6	
	M	-	-	5.1	
	N	1	1	3	
Least Depth of Shaft	OR	1.6	2.0	2.1-2.3	
	M	-	-	2.2	
	N	1	1	3	
Depth of External Condyle	OR	2.5	2.8	3.1-3.5	
	M	-	-	3.2	
	N	1	1	3	

comparison, no great differences between Thinocorus n. sp. and T. rumi-
civorus were found to justify their being put in separate genera.

Thinocorus n. sp. is the first recorded paleospecies of the family.

Suborder Lari Sharpe

Family Laridae Vigors

Subfamily Larinae (Vigors)

Genus Larus Linnaeus

Larus atricilla Linnaeus

Laughing Gull

Material. Two premaxillaries, 1 right scapula, 2 complete right and 1 complete left coracoid, humeral end of 1 right coracoid, proximal ends of 2 right and 3 left humeri, distal ends of 6 right and 1 left humerus, 1 complete left carpometacarpus, proximal ends of 2 right and 1 left carpometacarpus, distal ends of 1 right and 1 left tibiotarsus, 2 complete left tarsometatarsi, proximal end of 1 right tarsometatarsus, distal ends of 3 left tarsometatarsi. The 31 specimens represent a minimum of 8 individuals.

Characters. Although considerable intraspecific size variation occurs in gulls, four of the nine species of gulls found in Peru are readily separated from the fossil specimens on a size basis, either because they are too large (Larus belcheri Vigors, L. dominicanus Lichtenstein, and Creagrus furcatus (Neboux)) or too small (Xema sabini Sabine). Of the remaining five species, L. modestus Tschudi, L. cirrocephalus Vieillot, and L. serranus Tschudi are rather distinctive and easily separated from the fossil material, but L. atricilla and L. pipixcan Wagler are very similar osteologically, and the usual intraspecific variation found in gulls makes their identification very difficult. L. atricilla tends to be larger than L. pipixcan, but the

two species overlap broadly in size.

L. atricilla differs from L. pipixcan, L. modestus, L. cirrocephalus, and L. serranus by having scapula with (1) coracoidal articulation of moderate size (similar in L. modestus and L. cirrocephalus; large in L. serranus; small in L. pipixcan); (2) glenoid facet long, narrow, and elliptical (short and triangular in L. modestus; long and triangular in L. cirrocephalus; long, notched, and elliptical in L. serranus; long, narrow, and elliptical, with very abrupt distal termination in L. pipixcan).

Coracoid with (1) anterior projection of head short (long in L. modestus and L. cirrocephalus; similar in L. serranus; short to long in L. pipixcan); (2) glenoid facet elliptical and of moderate width (wide and round in L. modestus and L. serranus; long, elliptical, and of moderate width in L. cirrocephalus; narrow elliptical to round in L. pipixcan); (3) concavity where M. biceps attaches moderate (deep in L. modestus and L. serranus; shallow in L. cirrocephalus; moderate in L. pipixcan); (4) anterior furcular facet elliptical and of moderate length (long and broad in L. serranus; of moderate length and rectangular in L. pipixcan); (5) attachment of Lig. humero-coracoideum antierius superius elliptical, deep, and narrow (large and round in L. modestus and L. serranus; short, deep, and narrow in L. cirrocephalus; small, round to long oval, and deep in L. pipixcan).

Humerus with (1) head large (large in L. modestus, L. cirrocephalus, and L. serranus; small in L. pipixcan); (2) capital groove wide and shallow (wide and deep in L. modestus and L. cirrocephalus; narrow in L. serranus; moderately wide and deep in L. pipixcan); (3) distal end laterally compressed with condyles of moderate size (broad, with wide condyles in L. modestus and L. cirrocephalus;

laterally compressed with large condyles in L. serranus; laterally compressed with small condyles in L. pipixcan; (4) intercondylar groove of moderate depth (very deep in L. modestus; deep in L. cirrocephalus, L. serranus, and L. pipixcan); (5) brachial depression deep (very deep in L. modestus, L. cirrocephalus, and L. serranus; of moderate depth in L. pipixcan); (6) ectepicondylar prominence large, projecting palmarly almost perpendicular to palmar surface (broader, but shorter, in L. modestus; larger in L. cirrocephalus and L. serranus; of moderate size and projecting palmarly at angle to palmar surface in L. pipixcan).

Carpometacarpus with (1) internal ligamental fossa deep (deep in L. modestus, L. serranus, and L. pipixcan; shallow in L. cirrocephalus); (2) metacarpal I long with moderately prominent process (short and thick, with prominent process in L. modestus; short, with moderately prominent process in L. cirrocephalus and L. serranus; moderate, with moderately prominent process in L. pipixcan); (3) groove in carpal trochlea moderately deep (deep in L. modestus and L. serranus; moderately deep in L. cirrocephalus and L. pipixcan); (4) external slant to internal carpal trochlea moderate (similar in L. modestus; less in L. cirrocephalus; greater in L. serranus and L. pipixcan); (5) shaft depth immediately posterior to pollical facet great (great in L. modestus; moderate in L. cirrocephalus and L. serranus; small in L. pipixcan).

Tibiotarsus with (1) condyles narrow and not well rounded (wide external and narrow internal condyle in L. modestus; wide and rounded condyles in L. cirrocephalus; narrow external and wide internal condyle in L. serranus; narrow, well rounded condyles in L. pipixcan); (2) anterior intercondylar fossa wide with internal condyle undercut

internally (narrow in L. modestus; wide in L. cirrocephalus, L. serranus, and L. pipixcan); (3) external distal ligamental attachment shallow (deep, set in deep concavity in L. modestus; deep, not set in concavity in L. cirrocephalus; deep, set in poorly defined concavity in L. serranus; deep, set in moderate concavity in L. pipixcan); (4) notch in distal edge of internal condyle of moderate size (moderate size in L. modestus; deep in L. cirrocephalus, L. serranus, and L. pipixcan).

Tarsometatarsus with (1) cotylae very concave (similar in L. modestus; small degree of concavity in outer cotyla in L. serranus and L. pipixcan); (2) hypotarsus wide (similar in L. modestus and L. serranus; narrow in L. pipixcan); (3) trochleae proportionately narrow, with pointed posterior termination of inner trochlea and shallow groove in external trochlea (inner trochlea narrow, and articular surface of outer trochlea with prominent dorsal projection in L. modestus; trochleae thick, with posterior projection of medial edge of inner trochlea small in L. serranus; middle trochlea large in L. pipixcan, with inner and outer trochleae not projecting posteriorly as much as in L. atricilla, and a greater postero-medial slant to inner and outer trochleae than is found in L. atricilla). The tarsometatarsus of L. cirrocephalus is readily identified by incomplete fusion of middle and internal trochleae in the adult.

Remarks. A migrant to the coast of Peru, L. atricilla occasionally reaches as far south as Lima, but usually it does not go beyond the Gulf of Guayaquil. The presence of warm water apparently determines the southward range of this species along the west coast of South America (Murphy, 1936). In years when the warm northern current known as El Niño moves farther south than usual, the range of

L. atricilla extends correspondingly. Primarily a coastal bird, L. atricilla occasionally occurs inland around bodies of water. Considering the current ranges and habitat preferences of L. atricilla and L. pipixcan, it appears that there are more specimens of L. atricilla in the fossil collection than would be expected, a possible indication of recent climatic changes.

Larus pipixcan Wagler

Franklin's Gull

Material. One premaxillary, 3 right and 1 left quadrate, 3 right and 4 left scapulae, 3 complete right and 14 complete left coracoids, humeral ends of 4 right and 3 left coracoids, 1 complete right and 1 complete left humerus, proximal ends of 3 right and 4 left humeri, distal ends of 6 right and 4 left humeri, 4 complete right and 3 complete left carpometacarpi, proximal ends of 7 right and 2 left carpometacarpi, distal ends of 7 right and 6 left tibiotarsi, 1 complete right and 2 complete left tarsometatarsi, proximal ends of 2 right tarsometatarsi, distal ends of 6 right tarsometatarsi. The 95 specimens represent a minimum of 17 individuals.

Remarks. A North American migrant, L. pipixcan occurs in great numbers along the Peruvian coast, and also inland wherever there is sufficient food.

Order Columbiformes (Latham)

Suborder Columbidae Latham

Family Columbidae (Illiger)

Subfamily Columbinae (Illiger)

Genus Zenaida Bonaparte

Zenaida auriculata (Des Murs)

Eared Dove

Material. Three left scapulae, 3 complete right and 7 complete left coracoids, humeral ends of 1 right and 1 left coracoid, 4 complete right and 2 complete left humeri, proximal end of 1 left humerus, distal ends of 2 right and 1 left humerus, 9 complete right and 3 complete left ulnae, proximal ends of 3 right and 1 left ulna, distal ends of 4 right and 2 left ulnae, 4 complete right and 2 complete left radii, 8 complete right and 8 complete left carpometacarpi, proximal ends of 1 right and 1 left carpometacarpus, distal end of 1 left carpometacarpus, 2 complete right and 2 complete left femora, proximal end of 1 right and 1 left femur, distal end of 1 left femur, 5 complete left tibiotarsi, proximal end of 1 left tibiotarsus, distal ends of 1 right and 1 left tibiotarsus, 1 complete right and 5 complete left tarsometatarsi, proximal ends of 1 right and 2 left tarsometatarsi, distal ends of 2 right and 4 left tarsometatarsi. The 102 specimens represent a minimum of 13 individuals.

Characters. Z. auriculata differs considerably in numerous osteological characters from Leptotila verreauxi (Bonaparte), which is of similar size. Size is sufficient to distinguish it from all other species of doves from coastal Peru and southern Ecuador.

Remarks. Generally distributed throughout South America, Z. auriculata is very common in coastal Peru.

Zenaida asiatica (Linnaeus)

White-winged Dove

Material. One right scapula, 1 complete left coracoid, humeral end of 1 right coracoid, 1 complete right humerus, distal end of 1

right humerus, 1 complete left ulna, proximal end of 1 left carpometacarpus. The 7 specimens represent a minimum of 2 individuals.

Characters. Readily distinguished from the genera Columba Linnaeus and Geotrygon Gosse by many characters, Z. asiatica differs considerably from Z. auriculata in size, Z. asiatica being a much larger and heavier bodied bird.

Remarks. Z. asiatica is relatively common in South America from southwestern Ecuador down the coast to northern Chile.

Genus Columbina Spix

Columbina talpacoti (Temminck)

Ruddy Ground Dove

Material. Two complete left coracoids, 1 complete right carpometacarpus. The 3 specimens represent a minimum of 2 individuals.

Remarks. The range of C. talpacoti in coastal northwestern Peru today is limited to those areas of the northernmost departments that have any amount of heavy vegetation. This species apparently prefers a heavy brush cover, and the isolated specimens in the fossil material may indicate that a heavy brush cover existed close to the fossil, but at the same time the small numbers may indicate that such cover was also not very close.

Columbina cruziana (Knip & Pervost)

Croaking Ground Dove

Material. Three left and 1 right scapula, 49 complete right and 39 complete left coracoids, humeral ends of 6 right and 4 left coracoids, 45 complete right and 56 complete left humeri, proximal ends of 12 right and 12 left humeri, distal ends of 10 right and 6 left humeri, 29 complete right and 23 complete left ulnae, proximal ends of 7 right

and 6 left ulnae, 8 complete right and 13 complete left radii, proximal ends of 4 right and 4 left radii, distal ends of 2 right and 3 left radii, 27 complete right and 29 complete left carpometacarpi, proximal ends of 3 right carpometacarpi, 16 complete right and 26 complete left femora, distal ends of 11 right and 4 left femora, 6 complete right and 10 complete left tibiotarsi, proximal ends of 6 right and 6 left tibiotarsi, distal ends of 11 right and 15 left tibiotarsi, 25 complete right and 26 complete left tarsometatarsi, proximal ends of 3 right and 3 left tarsometatarsi, distal ends of 6 right and 4 left tarsometatarsi. The 578 specimens represent a minimum of 68 individuals.

Characters. Columbina cruziana differs from Claravis pretosia (Ferrari-Perez) (larger) and Columbina minuta (Linnaeus) (smaller) sufficiently in size so as to readily separate these three species. However, C. cruziana is essentially the same size as C. talpacoti, and they are very similar osteologically. No specimens of C. talpacoti buckleyi were available, so the following comparison with characters of C. cruziana is based on specimens of C. t. rufipennis from Panama.

C. cruziana differs from C. talpacoti by having scapula with (1) acromion smaller and more rounded; (2) glenoid facet smaller, with dorsal edge more set off from shaft; (3) antero-medial edge between glenoid facet and acromion straighter, less rounded.

Coracoid with (1) procoracoid much smaller.

Humerus with (1) head rotated more anconally and of less depth; (2) capital groove narrower, but deeper, cutting more into head; (3) impression of M. brachialis anticus deeper, undercutting a more elevated attachment of anterior articular ligament; (4) entepicondyle rotated slightly anconally.

Ulna with (1) olecranon smaller; (2) external cotyla smaller;

(3) intercotylar area lacking a high ridge.

Radius with (1) bicipital tubercle larger; (2) capital tuberosity more pointed; (3) palmar surface of shaft at distal end more rounded.

Carpometacarpus with (1) groove separating metacarpal II and metacarpal III under carpal trochlea deep; (2) internal face proximal to pisiform process much more excavated.

Femur with (1) attachment of *M. gastrocnemius*, pars externa, large and elongated, positioned anteriorly (small, oval, situated on posterior side of shaft in *C. talpacoti*); (2) posterior end of external condyle extending less dorsally; (3) opening between base of internal condyle and ridge leading toward center of shaft posteriorly lacking.

Tibiotarsus with (1) rotular crest lower; (2) outer cnemial crest rotated less proximally; (3) external condyle of greater depth.

Tarsometatarsus with (1) external cotyla better developed; (2) proximal third of internal edge of shaft very angular, and middle third flat, the transition effected by passing of angular edge posteriorly (in *C. talpacoti* the proximal third may not be as angular, and the edge does not pass posteriorly, giving a more rounded edge to the middle third of shaft); (3) ridge leading from metatarsal facet to base of internal trochlea much larger.

Remarks. *C. cruziana* is very common from coastal Ecuador to the coast of northern Chile, often occurring in large flocks.

Order Psittaciformes (Wagler)

Family Psittacidae (Illiger)

Subfamily Psittacinae (Illiger)

Genus Forpus Boie

Forpus coelestis (Lesson)

Pacific Parrotlet

Material. One complete left humerus.

Remarks. The smallest parrotlet in northwestern Peru, F. coelestis is relatively common throughout its range. As an arboreal species that lives throughout the year in areas with little or no water, its occurrence in the fossil material must be regarded as a fortunate accident.

Order Strigiformes (Wagler)

Family Tytonidae Ridgway

Genus Tyto BillbergTyto alba (Scopoli)

Barn Owl

Material. Five right and 8 left scapulae, 8 complete right and 1 complete left coracoid, distal end of 1 right humerus, 1 complete right ulna, proximal end of 1 left ulna, distal ends of 4 left ulnae, proximal ends of 2 right radii, distal ends of 2 right radii, 2 complete left carpometacarpi, proximal end of 1 right carpometacarpus, distal ends of 2 left carpometacarpi, 1 complete right and 1 complete left femur, proximal ends of 4 right and 2 left femora, proximal end of 1 right tibiotarsus, distal ends of 7 right and 8 left tibiotarsi, 2 complete right and 2 complete left tarsometatarsi, proximal ends of 5 right and 4 left tarsometatarsi, shaft of 1 left tarsometatarsus, distal ends of 4 right and 3 left tarsometatarsi. The 83 specimens represent a minimum of 8 individuals.

Characters. T. alba, and the following three species of owls, Bubo virginianus (Gmelin), Speotyto cunicularia (Molina), and Asio flammeus (Pontoppidan), are all very distinctive species and easily identified.

Remarks. T. alba is generally but often locally distributed throughout South America.

Family Strigidae Vigors

Subfamily Buboninae (Vigors)

Genus Bubo Dumeril

Bubo virginianus (Gmelin)

Great Horned Owl

Material. One premaxillary, 1 mandibular symphysis, 3 right and 3 left scapulae, 2 complete left coracoids, humeral ends of 2 right and 2 left coracoids, sternal ends of 1 right and 1 left coracoid, distal ends of 4 right and 3 left humeri, proximal end of 1 right ulna, distal ends of 2 right and 3 left ulnae, proximal ends of 3 right and 3 left radii, distal ends of 1 right and 4 left radii, 3 complete right and 1 complete left carpometacarpi, proximal ends of 3 right and 1 left carpometacarpi, distal ends of 1 right and 1 left carpometacarpus, 3 complete right and 4 complete left femora, proximal ends of 2 right and 3 left femora, distal ends of 1 right and 1 left femur, proximal ends of 2 left tibiotarsi, distal ends of 5 right and 4 left tibiotarsi, 3 complete right and 6 complete left tarsometatarsi, proximal ends of 4 right and 4 left tarsometatarsi, distal ends of 3 right and 5 left tarsometatarsi, shaft of 1 tarsometatarsus. The 101 specimens represent a minimum of 11 individuals.

Remarks. Generally, although often locally, distributed throughout South America, B. virginianus is uncommon in coastal Peru but increases in numbers on the western slopes of the Andes in northern Peru.

Genus Speotyto Gloger

Speotyto cunicularia (Molina)

Burrowing Owl

Material. One complete right and 1 complete left coracoid, proximal end of 1 left carpometacarpus, 1 complete left femur, proximal end of left tibiotarsus, distal end of 1 left tibiotarsus. The 6 specimens represent a minimum of 1 individual.

Remarks. Generally distributed throughout South America, S. cunicularia is very common in coastal Peru today.

Subfamily Striginae (Vigors)

Genus Asio BrissonAsio flammeus (Pontoppidan)

Short-eared Owl

Material. One mandibular symphysis, 1 right scapula, 2 complete right coracoids, 1 complete left femur, distal end of 1 right tibiotarsus, 2 complete left tarsometatarsi, proximal ends of 2 right tarsometatarsi, distal ends of 2 right tarsometatarsi. The 12 specimens represent a minimum of 2 individuals.

Remarks. Generally distributed in open areas throughout South America, A. flammeus occurs in northwestern Peru today, although not in large numbers.

Order Caprimulgiformes (Ridgway)

Suborder Caprimulgi Ridgway

Family Caprimulgidae Vigors

Genus Chordeiles SwainsonChordeiles acutipennis (Hermann)

Lesser Nighthawk

Material. One left scapula, 1 complete right and 1 complete

left coracoid, distal end of 1 right humerus, 1 complete right and 1 complete left carpometacarpus. The 6 specimens represent a minimum of 1 individual.

Characters. In addition to its larger size, C. acutipennis differs from C. minor (Forster) by having scapula with (1) acromion smaller, projecting less anteriorly; (2) concavity between distal end of glenoid facet and ventral edge of shaft slightly deeper.

Coracoid with (1) head shorter, more rounded, and wider; (2) attachments for M. coracobrachialis anterior and Lig. humero-coracoid-eum antierius superius smaller and shallower.

Humerus with (1) attachment of anterior articular ligament less elevated; (2) curvature of shaft in region of attachment of M. gastrocnemius, pars externa, greater, resulting in ectepicondylar prominence appearing more produced; (3) concavity in proximal side of ectepicondyle greater.

Carpometacarpus with (1) process of metacarpal I shorter and slightly curved; (2) area immediately posterior to pisiform process more excavated; (3) external side of metacarpal I more concave; (4) internal ligamental fossa much deeper.

Remarks. C. acutipennis is common in river valleys of coastal Peru.

Genus Caprimulgus Linnaeus

Caprimulgus n. sp.

Holotype. Complete left coracoid. (Pl. VI, Fig. F)

Diagnosis. Agrees with Caprimulgus and differs from Chordeiles, Nyctidromus Gould, Nyctiphrynus Bonaparte, and Hydropsalis Wagler by having (1) head projecting moderately beyond anterior edge of shaft;

(2) brachial tuberosity small. The remaining six genera of South American caprimulgids were unavailable for comparison.

Differs from Caprimulgus longirostris Bonaparte and C. parvulus Gould, the only species of the genus occurring today in southwestern Ecuador and northwestern Peru, and from C. cayennensis Gmelin, the only other small South American species of the genus available, by having (1) head narrow, and anterior projection small (narrow with much larger anterior projection in C. longirostris, wide with much larger anterior projection in C. cayennensis, wide with larger anterior projection in C. parvulus); (2) angle between furcular facet and triosseal canal approximately 125° (approximately 125° in C. longirostris, 135° in C. cayennensis, and 115° in C. parvulus); (3) attachment of M. coracobrachialis of moderate depth, separated anteriorly from attachment of Lig. humero-coracoideum anterius superius by a high ridge (attachment shallow, ridge very small in C. longirostris and C. parvulus; attachment of moderate depth, ridge of moderate size in C. cayennensis); (4) attachment of Lig. humero-coracoideum anterius superius deep, consisting of deep dorsal and moderately deep ventral part separated from each other by high ridge (shallow and of one part in C. longirostris, deep and of one part in C. cayennensis, moderately deep and of one part in C. parvulus); (5) brachial tuberosity undercut by deep concavity (deep in C. longirostris and C. cayennensis, moderate in C. parvulus). For measurements see Table 12.

Referred material. Proximal end and shaft of 1 right carpometacarpus.

Characters. Carpometacarpus with (1) process of metacarpal I long through base (short in C. longirostris, C. cayennensis, and C. parvulus); (2) external side of metacarpal I deeply concave (similar

in C. cayennensis, less concave in C. longirostris and C. parvulus); (3) external ligamental attachment long (short in C. longirostris, C. cayennensis, and C. parvulus); (4) fusion of metacarpal II and metacarpal III long and deeply excavated in internal view (similar in C. cayennensis, shorter and less excavated in C. longirostris and C. parvulus); (5) proximal end of metacarpal III wide and flat (narrow and rounded in C. longirostris and C. cayennensis, narrow and flat in C. parvulus); (6) shaft very robust (slender in C. longirostris, C. cayennensis, and C. parvulus); (7) tendinal groove wide (similar in C. cayennensis, narrow in C. longirostris and C. parvulus).

Remarks. Caprimulgus n. sp. is the first recorded paleospecies of the family Caprimulgidae. It appears more similar to C. cayennensis than to either C. longirostris or C. parvulus. Although five species of similar size (C. maculicaudus, C. maculosus, C. nigrescens, C. whiteleyi, and C. hirundinaceus) were not available for comparison, current distribution and habitat of those five make it very unlikely that Caprimulgus n. sp. represents any of them.

Table 12. Measurements of the coracoid and carpometaacarpus of Caprimulgus n. sp., C. cayennensis, C. longirostris, and C. parvulus (in mm).

		<u>Caprimulgus</u> <u>n. sp.</u>	<u>Caprimulgus</u> <u>cayennensis</u>	<u>Caprimulgus</u> <u>longirostris</u>	<u>Caprimulgus</u> <u>parvulus</u>
Coracoid Length	OR	14.1	14.3-14.8	15.0	14.5-14.9
	M	-	14.6	-	14.6
	N	1	2	1	4
Head to Scapular Facet	OR	4.3	4.7-5.0	4.6	4.8-5.1
	M	-	4.8	-	4.9
	N	1	2	1	4
Proximal Depth	OR	2.8	2.9-3.0	3.1	2.9-3.2
	M	-	3.0	-	3.0
	N	1	2	1	4
Least Depth of Shaft	OR	1.4	1.3-1.4	1.4	1.3-1.5
	M	-	1.4	-	1.4
	N	1	2	1	4
Carpometacarpus Proximal Width	OR	2.7	2.3-2.5	2.4	2.3-2.6
	M	-	2.4	-	2.4
	N	1	2	1	4
Height Through Metacarpal I	OR	5.3	5.0-5.4	5.1	5.2-5.4
	M	-	5.2	-	5.2
	N	1	2	1	4

ECOLOGY

From the northern limit of the Santa Elena Peninsula of southwestern Ecuador (approximately 2° S) to Coquimbo in central Chile (30°) the western coast of South America is essentially an unbroken 2000 mile strip of desert. The desert is delimited on the west by the Pacific Ocean and on the east by the Andes Mountains. The only interruption in this long desert between those two points is the forested coastal area along the eastern side of the Gulf of Guayaquil.

Variation in local orographic conditions and distances from the coast permit slight variations in precipitation amounts and cloud cover, and a corresponding variation in vegetation. Following the Holdridge system of life zone ecology (Holdridge, 1967), Tosi (1960) divided the coastal desert into a western subtropical desert and an eastern tropical scrub desert, with local patches of differing vegetation found in both major zones. Zonation at the borders of the desert, both horizontally at the northern and southern ends and vertically up the western slopes of the Andes, is abrupt. For example, along the southern edge of the Gulf of Guayaquil mean annual rainfall at Zorritos is about 10 inches while only 60 miles southwest at Lobitos it is less than 2 inches. The vegetation cover decreases correspondingly.

La Brea, Peru, the site of the Talara Tar Seeps, lies approximately two-thirds the distance from the nearest point on the coast and the mountains, and on Tosi's map (Tosi, 1960) it falls on the

dividing line between the subtropical desert and the tropical scrub desert. While there is some vegetation present at the site it consists only of scattered thorn shrubs and epiphytes.

In northern coastal Peru during the local summer from September 21 to March 23 the skies are clear with few scattered clouds and no precipitation, except in years that El Niño appears. Heavy rains may then fall and temporary streams and lakes may form (see section on climatology). Winds are usually strong, hot, and very dry.

During the local winter from March 23 to September 21 there exists a heavy cloud cover, or garúa, near the coast and reaching variable distances inland, usually to the mountains when they are near the coast. At this time light mists may occasionally prevail near the coast, but inland no precipitation occurs except well up the western slopes of the mountains. Winds are strong, cooler than in summer, and have a higher relative humidity.

Recent Avifauna

No thorough analysis of the avifauna of northwestern Peru has ever been done. The work of Marchant (1958, 1959, 1960) on the avifauna of the Santa Elena Peninsula of Ecuador gives the most comprehensive list of birds to be expected in northwestern Peru because the two areas show a very high correlation between their avifaunas. Although Chapman (1926) did not discuss this area of Peru, his comments on the avifauna of the arid region of Ecuador also pertain in part to the avifauna of northwestern Peru, particularly that area north of the Sechuran Desert.

Basically the avifauna consists of two groups of species, specific

examples of which are listed in the following section on paleoecology. One group consists of species adapted to the arid habitat and most are representative of what Chapman (1926) termed the Equatorial Arid Fauna found in portions of both Ecuador and Peru.

The second group consists of opportunistic species that are able to live for short periods of time in the arid regions when there has been a sufficient amount of precipitation. Within this group are those species living in habitats adjoining the arid regions that extend their range, especially along river courses, during those summers when a short heavy rain may cause an increase in the desert vegetation. If the rains are sufficiently heavy and of sufficient duration these species may be able to breed. They are, however, forced to contract their ranges when the desert resumes its normal arid state.

Transient, or migrating, species and wandering individuals of wide-ranging species are also found in this second group. These species may temporarily stop to feed while the desert vegetation is abundant after rains, or to take advantage of temporary ponds or streams that may form. If the summer rains appear, they come during the northern hemisphere winter. Migrating species are very likely to find and stay in these temporary bodies of water. Water being the powerful attractant that it is in a desert, most of the wandering individuals of local species will represent such groups as herons, ibises, ducks, shore-birds, cormorants, coots, etc. Marchant (1958) listed numerous species that occurred in the arid Santa Elena Peninsula only when a man-made dam created a lake.

Paleoecology

Earlier work on various faunal components of the Talara Tar Seeps

(Churcher, 1959, 1962, 1965, 1966; Churcher and van Zyll de Jong, 1965; Lemon and Churcher, 1961) all indicate that at the time of deposition the region was much more hospitable to a greater variety of animals than at present.

Vertebrate remains other than birds include those of a frog, crocodilians, tortoises, armadillos, ground sloths, bats, skunks, canids, felids, mastodonts, horses, deer, camelids, and rodents. The insect fauna contains several families of coleopterans, lepidopterans, and orthopterans, with aquatic forms a leading element. The molluscan fauna includes a fresh-water pulmonate.

The paleoavifauna can be broken into several component groups with each group analyzed for its role in the interpretation of the site.

First, a few species are well adapted to arid conditions. These include Burhinus superciliaris, Thinocorus rumicivorus, Columbina cruziana, and Forpus coelestis. Although these species suggest the presence of nearby arid or semi-arid habitats, almost all may be found in cultivated areas and oases within arid zones today. This suggests that while these species may be arid-adapted forms, they are not bound to that habitat but do wander into savanna habitats. This might be particularly true during dry seasons when the vegetation cover decreases. None of these species would occur in wooded areas as they are all open ground species.

A second group consists of wide-ranging species that may colonize suitable habitats over long distances for short periods of time. Examples of such species would include all northern hemisphere migrants, Jabiru mycteria, Anas bahamensis, the condors and vultures, and Polyborus plancus. All of these species can cover large distances in short periods of time and could be expected in any suitable habitat, no

matter how limited in size, anywhere that they could range.

A third group consists of savanna or open woodland species that could not survive in an arid habitat. Examples of these species include Geranoaetus melanoleucus, Buteo polyosoma, Parabuteo unicinctus, Zenaida auriculata, Speotyto cunicularia, and Asio flammeus. While individuals of these species may occasionally wander into arid or semi-arid areas, or even nest there, as does S. cunicularia, they are dependent on food resources that are greater than can be provided in arid areas.

A fourth group consists of those species found only in forested or heavy scrub habitats. Examples of these species would include Crypturellus transfasciatus, Dendrocygna autumnalis, Cairina moschata, and Penelope purpurascens. These species require at least a heavy scrub or riparian forest within their range. D. autumnalis and C. moschata also require the presence of suitable amounts of water.

A fifth group consists of those species that require large aquatic areas, either as lakes, streams, or swamps. In addition to migrating or wide-ranging species that also fall into this group because of their attraction for water, there are included the grebes, a number of the ardeiform species, and Porzana carolina.

Many species cannot fit into a specific category and some of those listed above as examples of one category may also be considered in another. Nevertheless, the overwhelming indication of all groups considered together is that northwestern Peru was considerably wetter during the period of entrapment of the fauna, and the habitat was probably that of a savanna woodland, or savanna with extensive riparian forests. This is also the conclusion reached by considering the fossil mammals and insects from the deposit.

Perhaps the best indicator that the habitat of northwestern Peru has changed considerably as a result of climatic change, rather than slightly or not at all, is the very high number of extinct species, at least 23 per cent of the non-passerine portion of the avifauna. Some of the species probably became extinct, as did similar species at Rancho La Brea, California, because their primary food source of large land mammals became extinct. Examples are the condors and large eagles.

More important, however, are the supposedly non-migratory extinct ardeiform (3), anseriform (4), and charadriiform (3?) species that make up at least half of the known extinct portion of the avifauna. What this suggests is that these species adapted to a specific habitat during the Wisconsin glaciation, and once this habitat began to disappear there was no alternative place for the species to survive. Being non-migratory these species could not have survived elsewhere, and once their habitat had deteriorated past a certain point their fate was sealed. To the south there probably existed only the desert conditions found today; to the north the humid forests of Ecuador would not provide suitable habitat for savanna or aquatic species, and neither would the mountains to the west.

Although savanna or thorn scrub habitat does exist between the arid and humid habitats in this area today, the zonation is so abrupt that the total area is simply too small to support a varied avifauna, especially those species that require permanent or semi-permanent bodies of water for feeding and breeding.

CLIMATOLOGY OF NORTHWESTERN PERU

As stated above, most of the west coast of South America is a long, narrow desert. Recorded annual precipitation in this arid zone ranges from zero to several inches, with greatest amounts falling in very northern Peru and southwestern Ecuador. Normal precipitation in northern areas of this desert is augmented on an irregular, unpredictable seven-year cyclical basis by heavy rains which may bring several inches of precipitation in only a few days.

This coastal desert is maintained by a series of complex inter-relationships between atmospheric and oceanic circulations. The following discussion is an attempt to explain these inter-relationships and offer a possible explanation for the existence of a savanna habitat in northwestern Peru during the period of deposition of the Talara Tar Seeps, and therefore for the remainder of the Wisconsin glaciation.

Neoclimatology

Atmospheric Circulation

The large scale weather patterns relevant to this discussion are those existing in the air space over the Pacific Ocean, particularly between 30° N latitude and 30° S latitude. These weather patterns are determined by the position and strength of the subtropical anticyclonic cells, or Hadley cells. The intensity of the polar circulation directly affects the size and position of these subtropical anticyclonic cells. During periods of high intensity, i.e., the winter circulation, a high

zonal index of atmospheric circulation (Garbell, 1947, p. 55) is established and the subtropical anticyclonic cells expand their circulation longitudinally and move their centers toward the east until further movement is blocked by continental land masses. During periods of a low zonal index, i.e., the summer season, the subtropical anticyclonic cells decrease in size and intensity, move slightly westward, and they may break up into smaller cells.

The intertropical front is the area that lies between the subtropical anticyclonic cells of the two hemispheres. The intertropical front moves latitudinally coincident with the latitudinal movement of the thermal equator and the fluctuations in size of the subtropical anticyclonic cells. Along the west coast of the Americas this movement is from approximately 5° N during the southern solstice season to 15° N during the northern solstice season. The position of the intertropical front will be very important later in consideration of the El Niño current and the paleoclimatology of western South America.

For more detailed and authoritative treatments of the above the reader is referred to Garbell (1947), Petterssen (1958), Lamb (1961), and Crowe (1971).

Oceanic Circulation

Frictional forces established by wind movement over ocean surfaces result in the existence of widespread ocean currents that roughly parallel the wind directions. The ocean currents pertain to this study because they are a basic cause for the desert conditions along coastal South America. The Peru Coastal Current (also known as the Humboldt Current) and the Peru Counter Current have a greater effect on land than the other oceanic currents because of their greater proximity.

The two coastal currents have been well known for a considerable period of time (Gunther, 1936), but only recently has accurate information become available as to their origin and movement. Gunther (1936), Posner (1957), and Wyrтки (1963) present comprehensive reports on the coastal currents, with Wyrтки giving the most detailed and up-to-date information available.

The coastal currents consist of cold water, the normal surface temperature lying below 24°C (75°F). Early workers believed the cold water was carried northward along the coast by the Peru Coastal Current. Later the cold water was shown to result from centers of upwelling along the coast, but the belief that the cold water was of Antarctic or sub-Antarctic origin persisted. Wyrтки (1963) demonstrated that the Peru Coastal Current proper, consisting of sub-Antarctic water, flows northward only to the vicinity of Callao, Peru (approximately 10°S), where it loses strength and disappears as a current. North of Callao, the source of upwelling water lies in equatorial subsurface water and is carried southward to the coast of Peru by the Peru Counter Current.

It is the cold surface waters of the coastal current, a result of upwelling, that maintain the coastal desert. The upwelling is a result of the orientation of the South American continent and the southerly winds of the eastern side of the South Pacific subtropical anticyclonic cell. With the coast of the continent oriented almost north-south, the southerly winds blow almost parallel to it. Frictional forces established by this wind circulation parallel to the coast result in offshore movement of the surface water. This is explained by Ekman's Law (Garbell, 1947, p. 20), which essentially states that in the southern hemisphere the flow of surface water, or Ekman transport,

will be at approximately 45° to the left of the prevailing winds. Considerable movement of water away from the coast results from Ekman transport, and to replace it nearshore centers of upwelling water appear. The centers of upwelling vary in size and intensity depending on the season and local factors, and probably not all have even been discovered. The source of the upwelling water is less than 100 meters in depth.

Climatological Effects of the Atmospheric and Oceanic Circulations

The combined atmospheric and oceanic circulations result in the maintenance of stable desert conditions along most of the west coast of South America. Only very irregular alterations in this climatic regime occur in the northernmost regions of the coastal desert. Although at times the relative humidity may approach 100 per cent at various sites along the coast, rain very seldom occurs, and in fact, as explained later net movement of water is out of the coastal area.

Although quite different from seasons as they are known in temperate regions, the coast of tropical western South America does experience annual "summer" and "winter" seasons that coincide with the southern solstice season and northern solstice season, respectively. "Summer" is characterized by partly cloudy or clear skies, relatively high relative humidity, and the highest diurnal fluctuations in temperature. "Winter" is characterized by heavy clouds and fog cover, very high humidity, and low diurnal fluctuations in temperature.

During the southern solstice season from September 23 to March 21 the South Pacific subtropical anticyclonic cell is at its smallest and its center lies at its most southwestern position. This places the intertropical front at its southernmost limit, and the southerly winds

of the anticyclonic cell blow parallel to the coast, either just on-shore or offshore, north to approximately Punta Parinas (approximately 5° S) where they turn offshore and become easterly trades. Ekman transport is greatest, and the centers of upwelling are most active, at this time. Advection fog or low stratus clouds may form as a result of the cold surface water, but since the wind blowing parallel to the coast does not have an onshore gradient no moist air is carried over the land and no precipitation occurs there. Although diurnal onshore-offshore winds do exist, the cool offshore winds are heated as they move inland. As warm air is capable of carrying more water than cool air, the warming of the cool air over the land results in the removal of water from the land to the air, and ultimately out over the ocean.

During the northern solstice season from March 21 to September 23 the South Pacific subtropical anticyclonic cell develops to its greatest size, spreading both latitudinally and longitudinally and its center moves northeastward. This results in the southerly winds of its eastern side being moved onshore, up against the Andes. In this position an onshore gradient exists, reducing the Ekman transport to its lowest amount of the year and, therefore, reducing the intensity of the centers of upwelling. Mechanical lifting along the coast range resulting from the onshore gradient produces a dense layer of clouds with its upper surface lying between 2000 feet and 4000 feet, increasing with latitude. The cloud layer, termed garúa, results from a subsidence inversion, a condition that results when cool dry subsiding upper atmosphere air comes into contact with cool moist rising air. Because moist air radiates heat faster than dry air, a temperature inversion is maintained and this prevents the formation of rain clouds. Although the upper limit of the cloud layer is maintained at a certain altitude depending

on latitude, the lower limit varies. The cloud layer exists unbroken for up to six or eight months at a time, and maximum precipitation is in the form of fine mist or light drizzle very near the coast line.

The contrasting seasons are indicated by figures for cloud cover, relative humidity, and temperature. In Lima, cloud cover has a yearly minimum of 44 per cent in April and yearly maximum of 91 per cent in August when the cloud bank is "about 2600 feet in altitude, and it is about 2000 feet thick" (Rumney, 1968, p. 412); relative humidity varies from a minimum of 64 per cent in March to a maximum of 90+ per cent in August; and temperature varies from a maximum of 72° F in March to a minimum of 59° F in August. Average annual precipitation is 1.0 inch, occurring in the months of March through October (most figures after Rumney, 1968). The figures for Lima, centrally located in the long coastal desert, are very similar from one year to the next. In the northern limits of the desert, where the Talara Tar Seeps are located, conditions are much more variable from year to year, with greater cloud cover in summer and less in winter. Unfortunately, accurate figures are not readily available for the more northerly areas.

El Niño

On a very irregular and unpredictable seven-year cycle, with additional intervening occurrences, the normal weather patterns along the northern areas of the coastal desert are interrupted. Occasionally the effects of these climatic interruptions are felt as far south as Lima or Pisco and they have often been disastrous, as described by Murphy (1926).

Traditionally, El Niño is thought of as a wedge of warm water that flows southward along the coast of South America once every seven years,

usually appearing right after Christmas. The seven-year cycle is not constant, however, because the current often appears between the years it should, and sometimes it does not appear during the expected year.

Northwesterly winds come with the warm water flowing southward that covers the colder upwelling water. These winds produce heavy monsoon-type rains, and because of the desert conditions in which these heavy rains occur, extensive flooding. For example, "At Trujillo, between 1918 and 1925, the total rainfall was only 1.4 inches; but during the month of March, 1925, a total of 15.5 inches fell, and on the three days from the 7th to the 9th rainfall was 8.9 inches" (James, 1959, p. 193). The desert vegetation is temporarily abundant after the rains, but unless precipitation has been unusually heavy it soon returns to its previous state.

Although most early, and some recent (Wyrтки, 1973), workers believed El Niño resulted from shifts in ocean currents, as early as 1926 Murphy (1926) was suggesting that the warm current resulted from meteorological conditions. Schott (1931, 1932) presented an explanation of meteorological conditions leading to the formation of an El Niño current. This explanation was followed by Garbell (1947) and enlarged and altered by Posner (1957). While the ultimate causes and all complex variables are not yet known the following explanation is adequate for this study.

As explained earlier, the intertropical front that lies between the southern and northern hemisphere anticyclonic cells moves latitudinally from approximately 5° N to 15° N with the change of solstices. With the northern edge of the south Pacific anticyclonic cell lying north of the equator its southeast and easterly tradewinds are turned into westerly winds by the Coriolis force as they cross the equator.

These westerly winds form the basis for the monsoon seasons in Colombia and southern Central America.

Similarly, if an increase in the seasonal shift of the intertropical front carried it south of the equator, the northeast trades of the North Pacific anticyclonic cell would be deflected by the Coriolis force as they crossed the equator and would become northwesterly winds. These northwesterly winds would then push southward a shallow wedge of warm equatorial water that would cover the normal cool coastal water, and bring essentially monsoon conditions to arid southwestern Ecuador and northern coastal Peru. Schott (1931, 1932) was able to point out that such a shift did occur in the disastrous year of 1891.

Posner (1957) suggests that rather than an increased seasonal north-south shift in the position of the intertropical front, there is instead a localized reduction in the seasonal shift. He argues that this would accomplish the same result by increasing the north-south component of the northeast trades, which would bring them across the equator. Unfortunately, long-range barometric pressure data of the sort necessary to satisfactorily pinpoint the position of the intertropical front near the coast of northern South America simply are not available.

If El Niño results from an increased seasonal north-south shift of the intertropical front, then an explanation for it can be sought in northern polar regions. An increase in polar activity there increases the zonal index, thus increasing the size of the North Pacific anticyclonic cell and moving it southward. If El Niño results from a localized reduction in the seasonal north-south shift of the intertropical front the explanation must be found in that area where the localized reduction takes place.

Paleoclimatology

As indicated earlier, the composition of the Pleistocene avifauna and other groups studied suggests that in the late Wisconsin the region around the Talara Tar Seeps consisted of a woodland savanna with abundant vegetation, or at least a savanna with extensive riparian forests. Naturally, those conditions could not have been present without more rainfall than occurs now. Any explanation for increased rainfall along the northern areas of the coastal desert must be sought in modifications of existing climate, and fortunately, El Niño acts as a beautiful model for the necessary modifications.

Much work has been done recently on Pleistocene and post-Pleistocene atmospheric circulation (Lamb and Woodroffe, 1970; Lamb, Lewis, and Woodroffe, 1966; Sawyer, 1966; Crowe, 1971). Unfortunately for this study, this work has been primarily directed toward an understanding of the onset of glaciations and Pleistocene atmospheric conditions over the North Atlantic, the continental regions of the northern hemispheres, and the north polar region. However, sufficient evidence is available to at least suggest a reasonable interpretation of the Pleistocene climate along the northern portions of the coastal desert of western South America.

Most workers agree that there was an increase in the zonal index during the glacial ages as a result of increased polar activity. However, there is no agreement on how this affected climatic zones as they are now known, opinions varying from no latitudinal change to considerable latitudinal change. Lamb (1966) suggested that latitudinal shifts toward the equator were greater in the Atlantic than in the Pacific. Evidence presented by Crowe (1971, p. 504) indicates

that while there is little latitudinal shift in climatic zones with an increase in the zonal index today, such an increase correspondingly increases the size and intensity of the anticyclonic cells. The existence of El Niño indicates that only a slight change in the normal position of the intertropical front is sufficient to provide the rains necessary to maintain a savanna habitat in what is now a desert.

Therefore, I suggest that during periods of glaciation the Pacific intertropical front had a greater annual seasonal north-south shift than today, or that it remained nearer the equator throughout the year. This would result in annual monsoon-type rains in the northern portions of the coastal desert during the southern solstice season. The subsequent seasonal movement of the South Pacific anticyclonic cell northwards during the northern solstice season would result in the formation, as today, of the heavy cloud bank, or garúa. This would prevent the ground from desiccating during this period and the riparian forests would receive abundant water from the increased ground water supplies in the western slopes of the mountains.

Rumney (1968, p. 476) states that a savanna woodland appears where a virtually rainless period of six months is followed by a rainy season with 80 inches of precipitation, or a rainless period of two months is followed by a rainy season of 40 to 50 inches of precipitation, fairly evenly distributed over the ten months. These figures for rainfall are not too great to be expected, especially considering what occurs during a strong El Niño. With the garúa and its attendant high relative humidity during the rainless season even much smaller rainfall amounts may have sufficed to maintain a savanna woodland.

Without the meteorological evidence that has come forward since their work, Lemon and Churcher (1961) and Churcher (1966) concluded

that although the region was probably as arid in the Pleistocene as now, numerous streams from the mountains crossed the desert. This conclusion requires that there was a climatic regime in the mountains much wetter than now. Without the occurrence of a large unknown orographic change, such as the formation of mountains high enough to alter wind circulation patterns, their conclusions are untenable on the basis of what is known about factors controlling the climate of western Peru today.

If the date of approximately 14,000 years B.P. for the Talara Tar Seeps is correct the climate of the region may already have begun changing to more arid conditions. As the region became progressively more arid the tar seeps may have acted as a temporary refuge for the now extinct species by holding water during times when rain fell. Fresh pools of tar may also have attracted individuals that mistook the appearance of the tar for water.

It is unfortunate that weather records such as those available for Europe are not available for this region. If they were it might be possible to correlate the aridity of the region with the advances and declines of European valley glaciers and polar ice during historic times. This would then permit testing of the above-suggested reasons for the existence of a savanna in northwestern Peru during the Wisconsin. For example, did rainfall increase markedly during the Little Ice Age, from approximately 1550 to 1850 A.D.?

DISCUSSION AND CONCLUSIONS

The Equatorial Arid Fauna

Chapman (1926, p. 62) named the avifauna occupying the arid and semi-arid portion of Ecuador the Equatorial Arid Fauna. He also stated that although the species of the Arid Fauna border, parallel, and penetrate the humid forest Colombian-Pacific Fauna from one end of tropical western Ecuador to the other, the two faunas are strikingly unlike. He concluded (1926, p. 74) that few forms were derived from arid regions to the south or humid regions to the east, and that the evidence indicated a pre-Andean connection between semi-arid Ecuador and similar regions to the north where most of the species closely related to those of the Equatorial Arid Fauna live.

Origin of the Equatorial Arid Fauna

As was seen earlier, it is the position of the intertropical front that determines the climate of northern coastal South America. At the present time along the coast of South America the front lies north of the equator at all times. While the front is in this position the southerly and southeast trades of the South Pacific anticyclonic cell cross the equator and become southwesterly winds. These winds carry great amounts of moisture from the warm tropical waters onto the coast where heavy monsoon rains maintain the humid forests of Colombia.

If, as suggested above, the intertropical front was pushed southward during periods of glaciation and remained very near the geographical

equator, then the southerly and southeast trades would not cross the equator. The climate of the western coast of Colombia would then be determined by the northerly and easterly trades of the northern hemisphere. With the western cordillera of the Andes Mountains acting as a blocking obstacle for these winds, it is very probable that the Pacific coastal area would have considerably less precipitation than today. In fact, lying in a rain shadow as it would under those conditions, the area could conceivably be as arid as southwestern Ecuador is today.

If the Pacific coastal areas of Colombia were drier than now, there would be an avenue for the spread of northern arid or semi-arid species down the western coast of South America. Once the intertropical front began moving northward again in response to decreased polar activity at the end of the Wisconsin the formation of the present humid tropical forests would have closed this avenue of distribution. This would account for the large gap in the ranges of such species as Zenaida asiatica and Columbina talpacoti.

If one accepts the traditional view that there were four major glaciations during the Pleistocene, this avenue of dispersal along the western coast of Colombia would have opened and closed four times. If a species had crossed from Central America into Ecuador during one of the earlier periods when the area was dry, but not during subsequent dry periods, then the southern population may have been isolated long enough to form a distinctive species. In this way Burhinus superciliaris may have evolved from B. bistriatus of Central America, and Dives warszewiczi from D. dives of Central America.

Speciation Within the Equatorial Arid Fauna

Chapman (1926, p. 63) listed a series of species and subspecies found in southwestern Ecuador and northwestern Peru. The large number of endemic species in these two areas with a separate subspecies on either side of the Gulf of Guayaquil suggests that the Ecuadorian and Peruvian populations of these species are isolated from each other. The separation is maintained by the forest barrier of southern Ecuador between the eastern shore of the Gulf of Guayaquil and the Andes Mountains.

If climatic conditions during the Wisconsin permitted the existence of a savanna woodland in northwestern Peru, the same climatic conditions would probably have permitted the existence of heavy forests in southwestern Ecuador. Once the forests disappeared as the climate deteriorated, unoccupied arid and semi-arid habitat appeared and was subsequently populated by species adapted to such habitat from northwestern Peru. In some cases this may have occurred through island hopping across the Gulf of Guayaquil via Puna Island. If this was the sequence of events in the formation of northern and southern subspecies, the subspecies can be dated as post-Wisconsin.

Speciation between the coastal forms of the Equatorial Arid Fauna and their related forms found in the semi-arid Marañon Valley of Peru also poses several interesting problems. For example, Chapman (1926, p. 69) listed at least eight species common to the coast and the Marañon Valley that had their origin in the interior of South America, and 21 in all that are common to the two areas. He stated that the ranges of some of the species are only slightly, if at all, separated at the present time.

If conditions at the present time permit the movement of species

across the western range of the Andes Mountains between the two areas, the primary question becomes whether or not this avenue of dispersal was closed during glacial periods when climatic conditions probably greatly increased the rainfall, and correspondingly the vegetation, along the western slopes of the Andes. If so, this would give an opening and closing effect during the different glaciations and different species would be expected to enter the coastal region from the east, or move in the opposite direction, at different times. This would account for some of the differences in degree of speciation between related forms in the two areas.

Dating Some Extinct Species

It was suggested earlier that a deteriorating habitat at the end of the Wisconsin brought about the extinction of certain species thought to be endemic to the area, i.e., the ducks, heron, ibises, and lapwings.

If these species became extinct at the end of the Wisconsin when the climate changed, they could not have lived in the area prior to the onset of the glaciation and the formation of the savanna woodland habitat. During the Sangamon interglacial the area would have been desert as it is now. The question then becomes whether or not they came into the area as distinct species from another region, or whether they speciated in situ.

Speciation in situ means that the species would have originated and become extinct within a period of less than 50,000 years, if one considers the onset of the Wisconsin glaciation to be 60,000 to 70,000 years ago and the age of the deposit to be 14,000 years B.P. Knowing

what we do of the rate of divergence of certain species common to southwestern Ecuador and northwestern Peru since the end of the Wisconsin, a figure of 50,000 years is not inconceivable as sufficient time for the formation of a distinct species. Selander (1971) suggests that speciation can occur even more rapidly than suggested in this case, particularly when new habitats appear, as would be the case here.

Comparison of Avifaunas of Talara Tar Seeps and Rancho La Brea

Howard (1962) summarized the known avifauna from Rancho La Brea, and from her list the following comparison can be drawn.

At least 98 non-passerine and 35 passerine species are known from Rancho La Brea, with 19 species, or approximately 14 per cent (17 per cent of the non-passerines) being extinct. From the Talara Tar Seeps 88 non-passerine species are known, with at least 20, or approximately 23 per cent, being extinct. When the passerine component of the Talara avifauna is completely studied and the few questionable non-passerine species resolved the final total of species may exceed that known from Rancho La Brea, and the percentage of extinct species should remain higher.

At least 16 species of non-passerines are common to the two faunas, most of these being wide-ranging accipitriform and ardeiform species, or northern hemisphere species that migrate to South America during the winter.

The woodpeckers are the only group found in significant numbers at Rancho La Brea and not found at all in the Talara Tar Seeps. Whether this means there were no stands of forest in the immediate vicinity of the tar seeps, or that their remains simply have not been

found yet is not known. Because remains of large tree limbs have been found in the matrix the latter is probably the most likely explanation.

Dating the Marine Terraces

The orogenic origin of the marine terraces of northwestern Peru precludes the possibility of correlating them with sea level strands in other parts of the world. Without absolute dates the ages of the terraces can only be suggested. In their discussion of the terraces, Lemon and Churcher (1961, p. 428) stated that the marine molluscan faunas of the Mancora and Talara Tablazos are closely related and reflect a cooler water environment than the Lobitos Tablazo and Recent deposits. They also indicated that the Talara Tablazo is not much younger than the Mancora Tablazo.

What this suggests is that the Mancora and Talara Tablazos were deposited during an interglacial period when polar activity was at a minimum in the northern hemisphere. The low zonal index at that time would have reduced the intensity of the North Pacific anticyclonic cell and resulted in the intertropical front lying well north of the equator. If the intertropical front remained far enough north so that the northeasterly trades never crossed the equator, the phenomenon known as El Niño would not exist and the northern coast of Peru would be washed by cold upwelled water at all times. The region would then be more arid than today. The fact that the Mancora Tablazo is the highest found in northwestern Peru, and that the molluscan fauna consists of living species (Lemon and Churcher, 1961), suggests that it is of Sangamon, or last interglacial.

The Lobitos Tablazo molluscan fauna is similar in composition to

that of the modern beach, an indication that it is of rather recent age. If the conditions leading to annual rains in northwestern Peru postulated above existed during the Wisconsin, the surface coastal waters would have been warmer than now, and probably warmer during the time of formation of the Lobitos Tablazo. The suggested age of the Lobitos Tablazo is, therefore, very late Wisconsin.

Lemon and Churcher (1961) suggested that the warmer fauna of the Lobitos Tablazo is a result of changes in the configuration of the coastline. They reasoned that as a result of such changes the Peru Coastal Current (Humboldt Current) did not carry cool water as far north during Lobitos Tablazo and Recent times as it did during Mancora and Talara Tablazo times. With the more complete information now available on the source of the cool surface coastal waters this explanation cannot be accepted. The fact that the cool water at the surface off northern Peru originates as subsurface equatorial water to the north argues that changes in coastal configurations were not an important factor in the change from a cool marine molluscan fauna to a warmer marine molluscan fauna. Coastal configurations do, however, create eddies in the local flow of ocean currents and do affect upwelling.

The age of the Talara Tar Seeps is considered to be post-Talara Tablazo and pre-Lobitos Tablazo. The average date given by Churcher (1966) of 13,944± B.P. places the age of the deposit after the maximum extent of the Wisconsin glaciation.

Correlation of Talara Tar Seeps with La Carolina of Ecuador

Lemon and Churcher (1961) argued that the Talaran faunas are

younger than those of the Carolinian of Ecuador, and that the two faunas cannot be of equal age nor can the Talaran faunas be older than the Carolinian faunas. Edmund (1965) stated that the Carolinian deposits are certainly very late Pleistocene.

Unfortunately, at this time only preliminary work has been done on the available material from the Carolinian avifauna. It does appear, however, that as in the case of the mammals there is a very close relationship between the two faunas.

If the Carolinian is older than the Talaran, but still similar in age as indicated by the similar faunas, it can be dated as late Sangamon or early Wisconsin. This would place it prior to the establishment of extensive forests in western Ecuador during the Wisconsin.

If the Carolinian is younger than the Talaran the deposits must have been formed early in the post-Wisconsin prior to the establishment of desert conditions and the extinction of the large land mammals. It is possible, of course, that some of the Carolinian deposits are pre- or early-Wisconsin and others are late- or post-Wisconsin.

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Appendix
Plates III to VI

Plate III

Holotypes of Eudocimus n. sp., Theristicus n. sp., Syrigma n. sp.,
Tadorninae, n. gen. n. sp., and Anas n. sp. 1.

- Fig. A. Anterior and posterior views of the holotype of Eudocimus
n. sp. (x 1).
- Fig. B. External and internal views of the holotype of Theristicus
n. sp. (x 1).
- Fig. C. External and internal views of the holotype of Syrigma
n. sp. (x 1).
- Fig. D. Anconal and palmar views of the holotype of Tadorninae,
n. gen. n. sp. (x 1).
- Fig. E. Anconal and palmar views of the holotype of Anas n. sp. 1
(x 1).

A

C

D

B

E

Plate IV

Holotypes of Vulturidae, n. gen. n. sp., Sarcoramphus? n. sp., Anas n. sp. 2, Anas n. sp. 3, and Milvago n. sp.

- Fig. A. Anterior and posterior views of the holotype of Vulturidae, n. gen. n. sp. (x 1).
- Fig. B. Proximal view of the holotype of Vulturidae, n. gen. n. sp. (x 1).
- Fig. C. Anterior and posterior views of the holotype of Sarcoramphus? n. sp. (x 1).
- Fig. D. Anconal and palmar views of the holotype of Anas n. sp. 2 (x 1).
- Fig. E. Anconal and palmar views of the holotype of Anas n. sp. 3 (x 1).
- Fig. F. Anterior and posterior views of the holotype of Milvago n. sp. (x 1).

A

C

B

D

E

F

Plate V

Holotypes of Gymnogyps n. sp., Belonopterus n. sp., Tringa n. sp., and Buteoninae?, n. gen. n. sp.

- Fig. A. Anterior and posterior views of the holotype of Gymnogyps n. sp. (x 1).
- Fig. B. Proximal view of the holotype of Gymnogyps n. sp. (x 1).
- Fig. C. Anconal and palmar views of the holotype of Belonopterus n. sp. (x 1).
- Fig. D. External and internal views of the holotype of Tringa n. sp. (x 2).
- Fig. E. Anterior and posterior views of the holotype of Buteoninae?, n. gen. n. sp. (x 1).

A

C

B

D

E

Plate VI

Holotypes of Geranoaetus n. sp., Vanellinae, n. gen. n. sp., Scolopacidae, n. gen. n. sp., Thinocorus n. sp., Steganopus n. sp., and Caprimulgus n. sp.

- Fig. A. Anterior and posterior views of the holotype of Geranoaetus n. sp. (x 1).
- Fig. B. External and internal views of the holotype of Vanellinae, n. gen. n. sp. (x 2).
- Fig. C. External and internal views of the holotype of Scolopacidae, n. gen. n. sp. (x 2).
- Fig. D. Anconal and palmar views of the holotype of Thinocorus n. sp. (x 2).
- Fig. E. Anterior and posterior views of the holotype of Steganopus n. sp. (x 2).
- Fig. F. External and internal views of the holotype of Caprimulgus n. sp. (x 2).

A

B

C

D

E

F

BIOGRAPHICAL SKETCH

Kenneth Eugene Campbell, Jr., was born November 4, 1943, in Jackson, Michigan. He graduated from Grass Lake High School in June, 1961. He enrolled in the University of Michigan and received the degree of Bachelor of Science with a major in geology in June, 1966. In June, 1967, he received the degree of Master of Science with a major in geology from the University of Michigan. While enrolled in the graduate school of the University of Michigan he held a teaching assistantship. From September, 1967, to the present he has pursued the requirements for the degree of Doctor of Philosophy at the University of Florida. During this time he has held positions in the Department of Zoology as a graduate teaching assistant and as an Interim Graduate Teaching Associate, and in the Florida State Museum as a research assistant and Research Associate in Natural Sciences.

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I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

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I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

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