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VARIATION IN THE JUVENAL PLUMAGE OF THE RED-LEGGED SHAG (*PHALACROCORAX GAIMARDI*) AND NOTES ON BEHAVIOR OF JUVENILES

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ABSTRACT.—The juvenal plumage of the Red-legged Shag (*Phalacrocorax gaimardi*) was found to be highly variable individually and geographically, based on examination of 16 specimens, 23 birds in photographs, and observations of 48 living birds. Juveniles from the Pacific coast of South America ranged from very dark to pale-plumaged, while juveniles from the Atlantic coast were very pale in plumage color. Gular pouch color, foot color, and extent of filoplumes of the neck patch varied as well among juveniles. This variation supports recognition of the race *P. g. cirriger* for the Atlantic population, and may facilitate parental recognition in the Pacific population. Fledged juvenile Red-legged Shags creche below nest cliffs where their parents locate them for feeding; this behavior may be correlated with obligate cliff-nesting in small colonies. *Received 24 Feb. 1988, accepted 20 May 1988.*

The Red-legged Shag (*Phalacrocorax gaimardi*) is a distinctive, gray cormorant that nests on narrow ledges of sheer cliffs and caves of coastal Peru, Chile, and Santa Cruz Province, Argentina (Doello-Jurado 1917, Murphy 1936, Johnson 1965, Meyer de Schauensee 1966, Zapata 1967, Humphrey and Bridge 1970, Brown et al. 1975, Siegel-Causey 1987). The juvenal plumage has been described as: "paler [than subadults] . . . whitish throats and a conspicuous sprinkling of white plumules on the center of the throat and the sides of the neck" (Murphy 1936:p. 874). Other descriptions (Alexander 1928, Blake 1977, Tuck and Heinzel 1978, Harrison 1983, Araya and Millie 1986) did not differentiate recently fledged juveniles from subadults (undergoing the prolonged first prebasic molt; Rasmussen, unpubl. data). Figures in Tuck and Heinzel (1978) and in Harrison (1983) depict subadults; although these figures and associated descriptions are essentially correct, as is the illustration of a juvenile in Murphy (1936: facing p. 1144), they do not acknowledge the great variability in the juvenal plumage. Two subspecies have been recognized: *P. g. gaimardi* on the Pacific coast, and *P. g. cirriger* in Santa Cruz Province, Argentina; adults of the Atlantic subspecies are slightly smaller and paler than are Pacific birds (Humphrey and Bridge 1970, Blake 1977), but no information is available concerning differences in juvenal plumages of the two subspecies.

Juvenile cormorants are dependent on their parents for a variable period

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after fledging. Parental recognition of chicks is known in several cormorant species (Serventy 1952, Palmer 1962, Snow 1963, Derenne et al. 1976, Urban 1979), and is at least partially visual (Snow 1963, Derenne et al. 1976). In some species, fledglings are fed in creches (Serventy 1952; Snow 1960, 1963, 1966; Fenwick and Bourne 1975; Carter and Hobson 1988), while in others fledglings return to the nest to be fed (Palmer 1962; Morrison 1977; Urban 1979; Bernstein and Maxson 1984, 1985; Brothers 1985). These aspects of behavior have not been described previously in Red-legged Shags.

In this paper, variation in the juvenal plumage of this species is described, and frequencies and geographic origin of juvenal plumage types are presented. These data are examined in relation to the hypothesis that Atlantic and Pacific populations of *P. gaimardi* have diverged evolutionarily. The hypothesis that variability in the juvenal plumage facilitates recognition of fledglings by their parents is discussed, and location of parental feeding of fledglings is compared with that in other cormorant species.

METHODS

Specimens and characters examined.—Sixteen juvenal-plumaged study skins of Red-legged Shags were examined in this study (12 from the Pacific coast, 4 from the Atlantic coast). P. S. Humphrey collected four of the specimens (KUMNH 83594–83597, for abbreviations see Acknowledgments) at Punta Guapacho (41°45′S, 73°53′W), Península Lacuy, Chiloé Island, Chile on 12 January 1987, and 1 (KUMNH 81201) at Puerto Deseado, (47°45′S, 66°40′W), Santa Cruz Province, Argentina, on 29 January 1985. I recorded soft part colors immediately after the death of these specimens. Other skin specimens examined were from Peru (AMNH 443220, 443225, 443235, 73019; ANSP 104124; NMNH 212036), other localities in Chile (AMNH 113431, CMNH 120832), and Río Gallegos, Santa Cruz Province, Argentina (DMNH 16288, 16289, 16297). The four plumage classes into which I categorized each specimen were (Fig. 1A–D): (A) dark—very few (as in Fig. 2A) or no pale feathers in throat and neck, crown blackish gray, underparts medium gray, general coloration very dark; (B) intermediate—throat pale but blotchy and streaked (as in Fig. 2B–D), crown blackish gray, underparts pale, upperparts dark gray; (C) light—throat white or nearly so, crown medium gray (as in Fig. 2E), underparts pale, upperparts medium dark gray; (D) very pale—throat white (as in Fig. 2F), ventral neck very pale, no dark pectoral band, very pale gray underparts, and crown and back paler than in 2C. In the few cases in which a specimen did not fit exactly into a category, decisions were based on throat and crown color. Specimens undergoing the first prebasic molt (which appears to begin at about one year of age; Rasmussen, unpubl. data) were excluded, as were those that showed noticeable wear of feathers (other than rectrices), because wear is usually accompanied by bleaching of feathers. Rectrices, however, may be appreciably worn prior to fledging, as shown by some specimens with remnant nestling down and worn rectrix tips (e.g., AMNH 443220).

I recorded whether the gular pouch color was blackish (mostly or totally) or orange (mostly or totally) on these museum skins; this appears to be justified because, while there was some color change after preservation, soft part colors of specimens of *P. gaimardi* collected in 1985 were still clearly assignable to the original category in 1988. Older museum specimens appeared comparable (but duller) in gular pouch color.

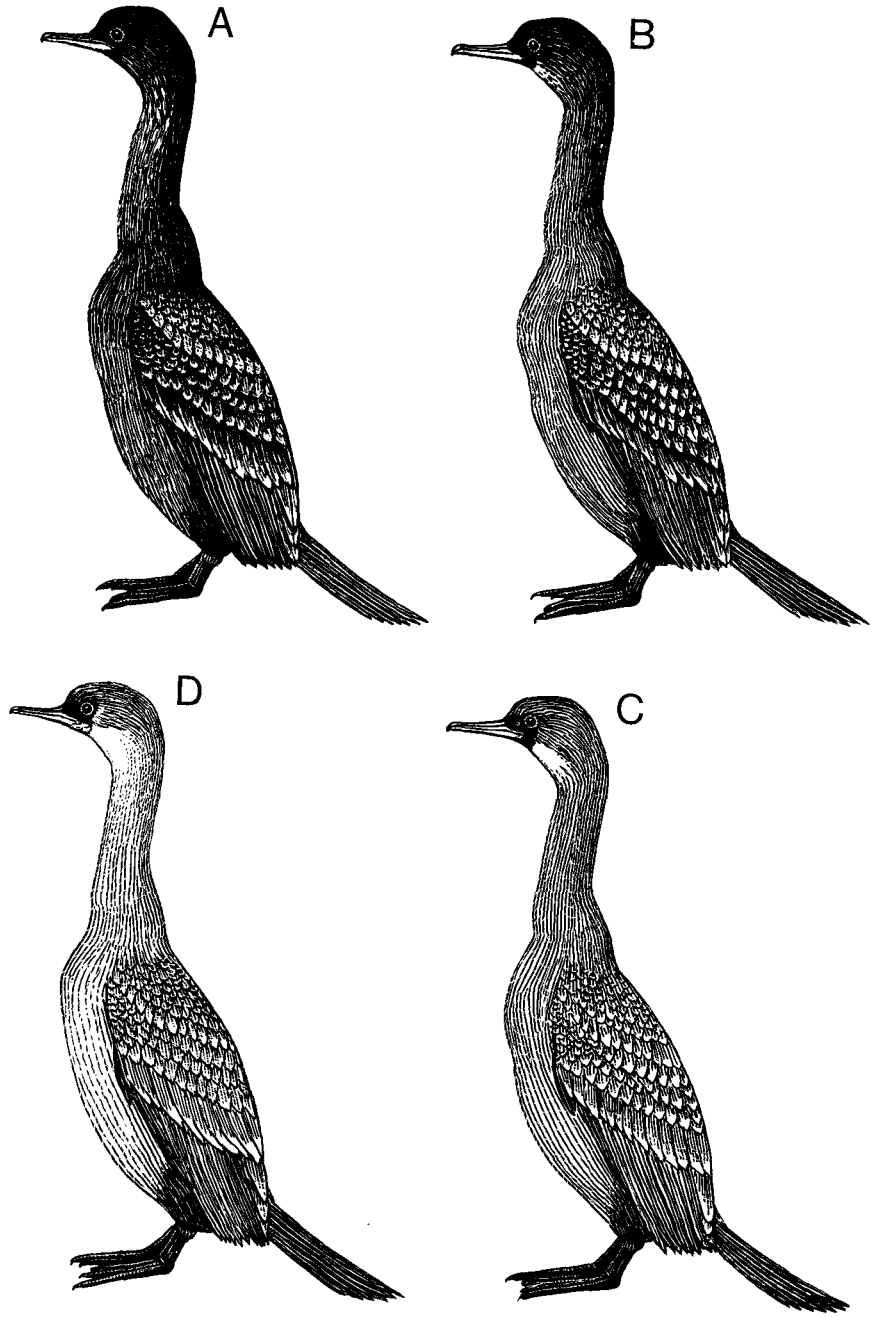

FIG. 1. The four general plumage patterns of juvenal *P. gaimardi* into which birds examined in this study were grouped. (A) Dark (AMNH 443225); (B) intermediate; (C) light; (D) very light (KUMNH 81201). The light-colored gular pouch in Fig. 1D is orange.

Although foot color varied among juveniles, most museum specimens lacked adequate color notes, so few data on foot color were available. Juveniles were classed as to whether the feet were slightly dusky orange, dark dusky orange, or reddish-black. The color of webs, toes between joints, and tarsi was recorded; the skin of the joints and the soles tended to be darker.

The white neck patches of adults were composed of wide filoplumes which grew among and covered the gray contour feathers of the patch area. Juveniles showed variable development of these filoplumes at fledging; specimens were grouped in the following four classes of presence of filoplumes in the presumptive neck patch: (1) very few; (2) few; (3) moderate numbers; and (4) sufficient filoplumes to form a sparse neck patch.

Living juveniles and photographs examined.—At the cormorant nesting colony at Punta Guapacho I examined fledged juvenal-plumaged birds through a 45× scope in good light on 16 January 1987, and repeated this on 18 January. I classified each juvenile into one of the four plumage categories, and one of the two gular pouch colors. I did not judge foot color or filoplume development for these birds. The birds were determined to be recently fledged juveniles by their food-begging behavior and/or their fresh plumage. Subadults were easily distinguished from juveniles, because the former have a mottled appearance to the back, wings, and underparts due to bleached, brownish, worn juvenal feathers mixed with fresh gray basic feathers; they also have well-developed neck patches, bright orange to red facial skin and feet, and yellow sides to the bill (Rasmussen, unpubl. data).

Juveniles photographed at Punta Guapacho on 16 January 1987 were classified as to plumage color, gular pouch color, and (when possible) foot color and neck patch development (each photograph was taken on different sections of the loafing rocks. During photography, no juveniles were seen to move between sections, so probably no individuals occurred in more than one photograph. These photographs were taken in a different section of the colony from where observations of living juveniles were made). Plumage and gular pouch data were also taken from juveniles in other color slides (one by D. Siegel-Causey, February 1985, Puerto Deseado, Argentina; one by T. A. Parker III, Peru), and black and white photos (one from Santa Cruz Province, Argentina [J. Heinrich]; one photo from Cabo Blanco, Santa Cruz Province, Argentina [Daciuk 1977]; in this photo only 1 juvenile was in good light so was classified, and 3 others were in class C or D, but were not classified).

Behavioral observations.—On 18 (09:30–14:00) and 19 (08:30–12:30) January 1987 at Punta Guapacho, I observed interactions between fledgling *P. gaimardi* in creches at the base of the colony and adults returning there from foraging. During my observations the group continually comprised 25–40 juvenal *P. gaimardi* and 10–15 adults, as well as similar numbers of fledgling and adult Blue-eyed Shags (*P. atriceps*) which nested in different portions of the colony.

RESULTS

Plumage, gular pouch, foot color, and filoplume development class frequencies.—Plumage class B was the most common (61%) of the three classes occurring at Punta Guapacho, and class A the least (13%; Table 1). Plumage class D did not occur among juveniles from the Pacific coast, but all six Atlantic coast juveniles were in plumage class D. Of 20–30 juveniles I observed at Puerto Deseado in February 1985, none differed noticeably in plumage from the class D juvenile collected there (KUMNH 81201). Most (77%) of the Pacific coast juveniles had black gular pouches; all 6 Atlantic coast juveniles had orange gular pouches. Based on variation

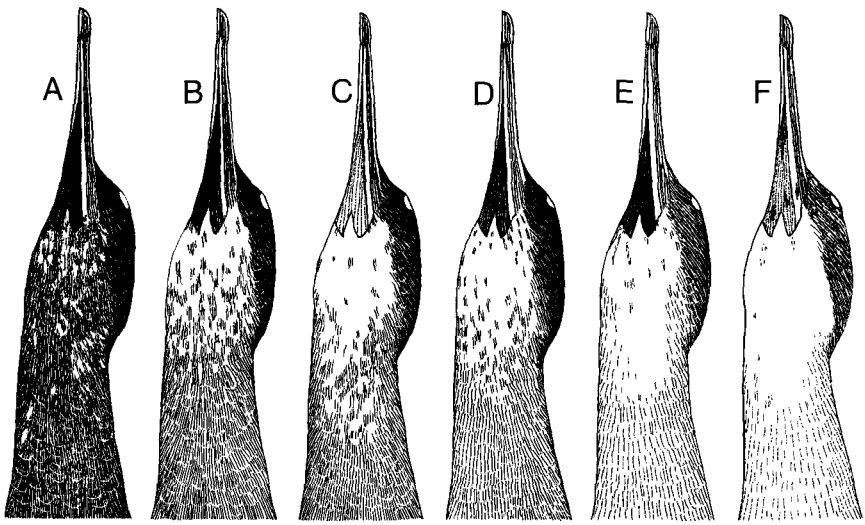

FIG. 2. Gular pouch, throat, and neck patterns of six juvenile *P. gaimardi* specimens. (A) AMNH 443225; (B) KUMNH 83597; (C) KUMNH 83596; (D) KUMNH 83585; (E) KUMNH 83594; (F) KUMNH 81201. The light-colored gular pouches in Fig. 2C and F are orange.

evident in these two characters, most specimens I examined were easily recognizable (Fig. 2).

Five juveniles from the Pacific coast had slightly dusky orange feet; three had very dusky orange feet; and four had reddish-black feet. The single Atlantic coast specimen examined had reddish-black feet.

Filoplume development was highly variable in juveniles. Twenty-five (73%) of the Pacific juveniles had very few filoplumes in the neck patch area; six (18%) had few filoplumes; two (6%) had moderate numbers of filoplumes; and one (3%) had a sparse neck patch. Of five Atlantic juveniles, two had very few and two had moderate numbers of filoplumes; one had a sparse neck patch. No obvious pattern was found, but the specimens with few filoplumes had filoplumes outlining the neck patch area and a very few scattered through the contour feathers of the neck. In all juveniles examined, contour feathers in the area of the presumptive neck patch tended to be shorter and downier than the surrounding contour feathers. No juveniles had well-developed white neck patches.

Behavior.—Juveniles in the creches at Punta Guapacho were frequently threatened by adults and the larger juvenile and adult Blue-eyed Shags, from which they retreated every time without contest. Upon the return of each adult Red-legged Shag from foraging at sea to the creches, a few

TABLE 1

NUMBERS OF JUVENAL *P. GAIMARDI* RECORDED WITH EACH PLUMAGE TYPE AND GULAR POUCH TYPE FOR EACH REGION AND TYPE OF OBSERVATION

Locality	Plumage type				Gular pouch type	
	A	B	C	D	Black	Orange
Live juveniles						
Punta Guapacho, Chile, 16 Jan 1987	5	20	13	0	29	6
Punta Guapacho, Chile, 18 Jan 1987[a]	5	13	10	0	22	4
Specimens						
Punta Guapacho, Chile, 12 Jan 1987	0	3	1	0	3	1
Other Chile	2	0	0	0	1	0
Peru	1	5	0	0	4	1
Santa Cruz Province, Argentina	0	0	0	4	0	4
Photographs						
Punta Guapacho, Chile, 16 Jan 1987	1	14	5	0	5	5
Peru	0	1	0	0	1	0
Santa Cruz Province, Argentina	0	0	0	2	0	2
Totals						
Pacific	9	43	19	0	43	13
Atlantic	0	0	0	6	0	6

[a] Recount of same area counted 16 Jan; not included in totals.

(2–5) juveniles usually walked up to the adult (one after another) and begged, giving shrill cries, spreading and waving the wings, and extending the gular pouch by depressing the hyoid, while jabbing at the adult's bill. Adults usually rejected and chased some chicks that begged before accepting and feeding a begging chick. Two juveniles of different plumage types (one pale and the other intermediate) begged from and were accepted by the same adult, suggesting plumage variation among siblings.

No fledgling Red-legged Shags attempted to return to the nesting ledges from the creches, although some (if not all) of the fledglings in the creches were flighted, and while begging they sometimes pursued adults on the wing to sea. At Isla Mazorca, Peru, juveniles were fed by adults in creches (D. C. Duffy, in litt.), as at Punta Guapacho. Fledgling Blue-eyed Shags, however, routinely flew up to their nesting colony from the creches below. Juvenile Blue-eyed Shags did not beg at the creches, even though they were continually present there with adults; the fledglings were fed only in the vicinity of the nests.

DISCUSSION

In Chile and Peru, the juvenal plumage of Red-legged Shags, while variable, appears to be consistently darker than that of juveniles from the

Argentine coast. In addition, while only 23% of the Pacific coast birds examined had largely or completely orange gular pouches, all six Atlantic birds examined had largely orange gular pouches. These data demonstrate a greater differentiation between Atlantic and Pacific populations in the juvenal plumage than in definitive plumage, and therefore support Humphrey and Bridge's (1970) treatment of the Atlantic population as subspecifically distinct (*P. g. cirriger*) from nominate *P. g. gaimardi* of the Pacific. Although more specimens are needed, particularly from the Atlantic coast, the Pacific population seems to be much more variable in juvenal plumage. The six Atlantic juveniles examined were all very similar, differing mainly in development of the white neck patch. Red-legged Shags probably colonized Santa Cruz Province, Argentina, after arriving by overland flight from the Chilean coast (Devillers and Terschuren 1978). The low variability of the juvenal plumage of the Atlantic population could be due to the bottleneck effect, while the pale plumage may reflect the action of the founder effect.

In the juvenile's begging posture, the hyoid is depressed (as in other cormorants), so gular pouch markings are displayed. These markings and plumage characters could facilitate recognition of offspring by parents, at least in the Pacific population of the Red-legged Shag. Parental recognition of older chicks is known in several cormorants (Serventy 1952; Snow 1960, 1963; Palmer 1962; Berry 1976; Derenne et al. 1976; Brown et al. 1982). Some cormorants recognize their fledglings by sight, without aid of vocalizations (Derenne et al. 1976). European Shags (*P. aristotelis*) apparently recognize each other by facial characteristics (Snow 1960). In these species, some variability is present in the juvenal plumage (Paulian 1953, Voisin 1970, Cramp and Simmons 1977, Derenne et al. 1976). Not all cormorant species, however, have variable juvenal plumages, and parental recognition abilities are unknown for most species. Present data are not sufficient to establish whether plumage variability evolved to facilitate parental recognition.

Red-legged Shag adults feed fledged juveniles in creches, probably because of the hazards of landing on the narrow nesting ledges (even adults often have difficulty landing; McNicholl and Hogan 1979, pers. obs.), and because of the lack of space there for both adults and fully grown young. In other cliff-nesting species for which this behavior is recorded, fledged juveniles abandon their nesting areas for creches, where they are fed (Snow 1960, 1963; Fenwick and Bourne 1975), as is also the case with some species that nest on flat areas (Serventy 1952, Snow 1966, Berry 1976, Carter and Hobson 1988). In tree-nesting cormorants, fledglings usually wait in the nest tree for feeding (Harley 1946, Oliver 1955, Palmer 1962, Morrison 1977, Olver and Kuyper 1978, Urban 1979, Olver 1984). The *P. atriceps* nesting colony had many suitable landing places, so juvenal

P. atriceps could land there to be fed. Their colonies are usually on flat areas (Murphy 1936, Johnson 1965, pers. obs.), and although fledged juveniles creche away from nests (Bernstein and Maxson 1984, 1985; Malacalza 1984; Shaw 1984), they usually (but not always; V. E. Malacalza, in litt.) return to their nests to be fed (Bernstein and Maxson 1984, 1985; Brothers 1985; G. F. van Tets, in litt.), as do fledged Guanay Cormorants (*P. bougainvillii,* Vogt 1942; D. C. Duffy, in litt.). In these shags, generally adapted to nesting in large colonies on flat ground, it appears advantageous for fledglings to return to the nest where parents can easily find them. In contrast, several (but not all; Berry 1976, Carter and Hobson 1988) of the species in which fledglings creche, nest in small colonies (Snow 1963, 1966; Fenwick and Bourne 1975), so fledglings do not form large groups and parents can easily find their offspring. Further comparative study of post-fledging behavior in cormorants is needed to determine whether these behavior patterns are constant within each species and are primarily determined by phylogeny or by nest-site and colony characteristics.

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