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## THE ENDEMIC VIREO OF FERNANDO DE NORONHA (*VIREO GRACILIROSTRIS*)

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**ABSTRACT.**—The Noronha Vireo (*Vireo gracilirostris*) is endemic to the small oceanic island of Fernando de Noronha off the easternmost tip of Brazil. Although derived from the Red-eyed Vireo (*V. olivaceus*) complex, the Noronha Vireo is differentiated strongly in coloration, plumage pattern, and morphology and fully merits recognition as a distinct species. It is a smaller bird with a much more rounded wing, longer, more slender bill and a more elongated tail and tarsus. These appear to be specializations for gleaning small insects from foliage, particularly the undersides of leaves. The birds are abundant where appropriate habitat is maintained. The few available data on reproductive and molt cycles, nesting, and vocalizations in *V. gracilirostris* are summarized. *Received 11 November 1992, accepted 24 March 1993.*

The archipelago of Fernando de Noronha is the easternmost extension of land in the Neotropics, lying 345 km east of the eastern tip of mainland Brazil (3°50'S, 32°25'W). It consists of one main island with a string of minor rocks and islets at its northeastern end and various other scattered stacks. The total land area is 18.4 km<sup>2</sup>. The island is volcanic in origin and before its discovery in 1503 probably was almost entirely forested. The avifauna consists of the usual complement of tropical seabirds, an as yet undescribed extinct flightless rail (Olson 1982), the Eared Dove (*Zenaida auriculata*), and the easternmost populations in the world of tyrant flycatcher (Tyrannidae) and vireo (Vireonidae). The flycatcher generally is considered to be an endemic subspecies of the Large Elaenia (*Elaenia spectabilis ridleyana*) (Traylor 1979), whereas the Noronha Vireo is a highly distinctive endemic species, *Vireo gracilirostris*.

Little has been written about *V. gracilirostris*, and apart from a sketch of the bill (Sharpe 1890:478), a black-and-white photograph of a live bird

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The Noronha Vireo *Vireo gracilirostris* (top) compared with its closest relative and probable direct ancestor *Vireo olivaceus chivi* (bottom) of the Red-eyed Vireo complex. Painting by William Zimmerman.

(Nacinovic and Teixeira 1989), and photographs of the skull and sternum (Barlow and Bortolotti 1989), the species has not otherwise been illustrated. I here bring together the scattered literature on this species, my own observations made on the island nearly 20 years ago, and further illustrative material.

#### HISTORY OF OBSERVATIONS AND COLLECTING

Opportunities for studying vireos on Fernando de Noronha have been limited (Table 1). The first recorded observation of the species is that of Moseley (1892:68), a naturalist on the *Challenger* Expedition who noted "a small warbler (*Sylvia*), with greenish brown plumage" when the *Challenger* visited the island in 1873. Unfortunately, the expedition was refused permission to conduct investigations on the island, and no specimens were collected.

In 1887, the biology of Fernando de Noronha was investigated comprehensively for the Royal Society by H. N. Ridley (1890a, b). Five specimens of vireos were taken at this time, upon which Sharpe (1890:478) based the original description of *V. gracilirostris*. Ridley (1888:44) noted only that the vireo was common and "frequents the cashew-nut tree and the cocoa-nut palms. It is a small green bird, like a Willow Wren [*Phylloscopus trochilus*], very active, but by no means difficult to shoot. We never succeeded in finding its nest."

The species was next encountered by Nicoll (1904:38, 1908:16), who was on the island in 1903. He noted that the species was fairly abundant, and he likened it to a Eurasian Reed Warbler (*Acrocephalus scirpaceus*) in its actions. On 15 October 1912, Murphy (1915:50) encountered "many of these greenlets . . . in the fig trees and in the thickets near the beach" and collected a pair in fresh plumage.

The *Blossom* Expedition of the Cleveland Museum of Natural History collected extensively in the South Atlantic from 1923 to 1926. Fernando de Noronha was visited in 1926, when 40 specimens of vireos were obtained, among other species. The expedition was poorly equipped, however, and experienced many difficulties with personnel and provisions. The only publication dealing specifically with the expedition is a popular account by the leader Simmons (1927), and the only scientific information now retrievable is from specimen labels and the field catalog. The bulk of the collection is at the Peabody Museum of Yale Univ., but parts of it have been rather widely dispersed.

There seems to have been no further ornithological exploration of Fernando de Noronha until my sojourn in 1973 (Olson 1982). Oren (1982, 1984) visited the island in 1980 and again in 1982. Nacinovic and Teixeira (1989) record ornithological observations made on three visits to Fernando de Noronha in the 1980s.

#### SYSTEMATICS AND MORPHOLOGY

##### *Vireo gracilirostris* Sharpe

##### NORONHA VIREO

"small warbler (*Sylvia*)" Moseley, 1892:68.

*Vireo gracilirostris* Sharpe 1890:478 (orig. descr., fig. of bill).—Nicoll, 1904:38.—Nicoll, 1908:16.—Hellmayr, 1935:144.—Pinto, 1944:401.—Santos, 1948:177.—Warren and Harrison, 1971:212.—Olson, 1982:482.—Oren, 1982:13.—Oren, 1984:36.—Sick, 1984:644.—Nacinovic and Teixeira, 1989:723 (photograph of live bird).—Barlow and Bortolotti, 1989:1536–1537, 1540–1545 (skull and sternum figured), 1547.—Ridgely and Tudor, 1989:150.

TABLE I  
SOURCES OF OBSERVATIONS AND SPECIMENS OF *VIREO GRACILIROSTRIS* AT FERNANDO DE NORONHA

Expedition	Duration	N <sup>1</sup>	References
<i>Challenger</i>	1–2 Sept. 1873	0	Moseley 1892
Royal Society	14 Aug.–24 Sept. 1887	5	Ridley 1888, 1890a, b
<i>Valhalla</i>	20–25 Dec. 1903	5	Nicoll 1904, 1908
<i>Daisy</i>	15 Oct. 1912	2	Murphy 1915
<i>Blossom</i>	18 March–26 April 1926	40	Simmons 1927
Smithsonian	6 July–18 Aug. 1973	22	Olson 1982
Museu Goeldi	16 Nov. 1980	17	Oren 1982, 1984
	1–13 Dec. 1982		
Museu Nacional	25 Sept.–1 Oct. 1983	7	Nacinovic and Teixeira 1989
	8–22 June 1986		
	25–30 Sept. 1988		

<sup>1</sup> N = number collected.

*Vireosylva gracilirostris*.—Murphy, 1915:50.—Murphy, 1936:148.

*Vireo olivaceus gracilirostris*.—Meyer de Schauensee, 1966:424.—Mayr and Short, 1970:72.—Orenstein and Barlow, 1981:4, 20, 32.

Local people on the island call the vireo “*sibito*.” Although Oren (1984) spelled the name “*sebito*,” Nacinovic and Teixeira (1989) use “*sibito*,” which is the spelling I was given. This name, according to Oren (1984), is used in northeastern Brazil for various nondescript birds.

As the preceding synonymy shows, the Noronha Vireo has almost always been treated as a distinct species. In his original description, Sharpe (1890) ventured that “there is no doubt that the Fernando Noronha bird comes nearest to *V. magister*,” a conclusion repeated by Sick (1984), probably on Sharpe’s authority only. *Vireo magister* is a vicariant form of the Black-whiskered Vireo (*V. altiloquus*) that occurs in Yucatan, Belize, and Grand Cayman.

In discussing *V. gracilirostris*, which they considered to stand “apart on so many counts that it amply deserves recognition as a full species,” Ridgely and Tudor (1989:150) stated erroneously that “since Hellmayr [1935] this form has been considered merely an insular race of *V. olivaceus*.” Although Hellmayr synonymized species on many occasions, this was not one of them, the deed apparently having been done first by Meyer de Schauensee (1966) but merely in a compilation with no systematic revisionary study.

What Hellmayr (1935:144, footnote) actually said is still pertinent today:

“This peculiar species is quite distinct from the continental *V. virescens* [= *olivaceus*] *chivi*, from which it differs, in addition to coloration, by proportionately much longer tail, very much slenderer as well as longer bill, and shorter first primary, the latter being either equal to, or a little longer than, the seventh. In general coloration it is indeed not unlike *V. magister*, though it may be readily distinguished from it by much shorter wings, slenderer tarsi, much smaller and slenderer bill, the absence of the dusky loreal spot and the grayish suffusion on the sides of the body, etc. I cannot believe that any genetic relationship really exists between these birds. . . .”

*Plumage.*—The subdued coloration and slender proportions of *V. gracilirostris* give it a strong superficial resemblance to an Old World warbler (Sylviidae), as noted by several early naturalists. The species has been described in some detail by Sharpe (1890) and Hellmayr (1935), and additional specimen measurements are found in Oren (1982) and Nacinovic and Teixeira (1989). I will therefore confine my remarks to direct comparisons with its presumed closest relative, *V. olivaceus chivi* (I use the term here in a collective sense to mean all of the South American populations of the complex, exclusive of *V. flavoviridis*).

Compared to *V. o. chivi* (Frontispiece), the dorsum of the Noronha Vireo is brownish anteriorly rather than green, and the gray cap is lacking, so that the crown is essentially the same color as the back. Most specimens in North American collections are from the indifferently prepared, and exceedingly worn and faded, series taken by the *Blossom* expedition. These give the appearance of a very brownish or grayish bird, whereas in fresh plumage the lower back, rump, and margins of the flight feathers are decidedly green. There is some individual variation, as one specimen in the series I obtained is much grayer above, with little brown or green in the plumage.

The black dorsal border of the superciliary stripe of *V. o. chivi* is lacking in *V. gracilirostris*, the superciliary itself is less pronounced and buffy rather than whitish, and the dark preocular spot is brownish rather than blackish. The underparts of *V. gracilirostris* are washed with buff, palest on the lower belly but not white with greenish flanks as in *V. o. chivi*. The underwing and under tail coverts are yellow in *V. o. chivi* but buffy in *V. gracilirostris*, although the crissum is yellowish buff in some individuals.

One specimen that I obtained is still mainly in the lax, fluffy juvenile plumage, with the crown, back, and secondary coverts a rich rusty brown, rather similar to that in the *V. olivaceus* group in general but more reddish than in juveniles of *V. olivaceus* itself.

*Soft-part colors.*—My annotations indicate that the iris is brown, the

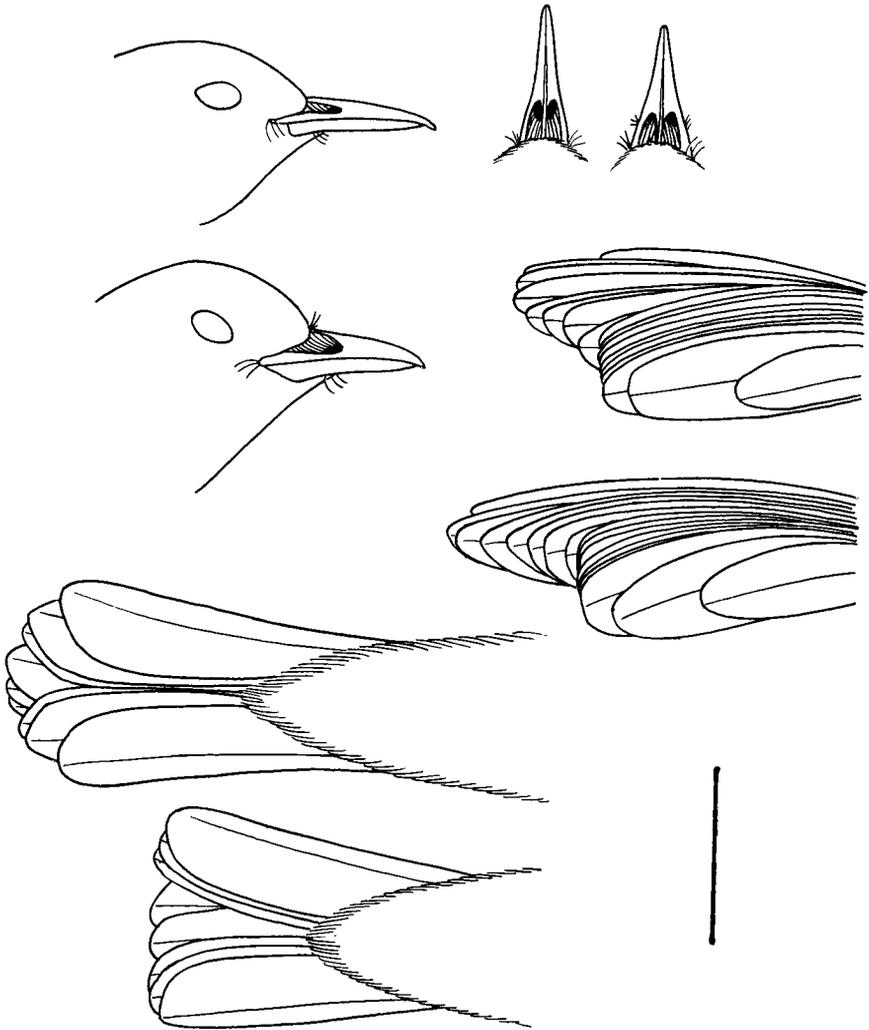


FIG. 1. Comparison of external morphology of *Vireo gracilirostris* (top in each pair, on left in dorsal view of bills) with that of *V. olivaceus chivi* (bottom in each pair, on right in dorsal view of bills) showing bills in lateral and dorsal views, wingtips in dorsal view, and tails in ventral view. Scale = 2 cm.

upper mandible brownish-horn, the lower mandible whitish, and the feet light bluish-gray.

*External morphology.*—The more obvious distinctions of *V. gracilirostris* in external morphology and proportions are shown in Figs. 1 and 3 and Table 2. The longer and obviously more slender bill (both in width

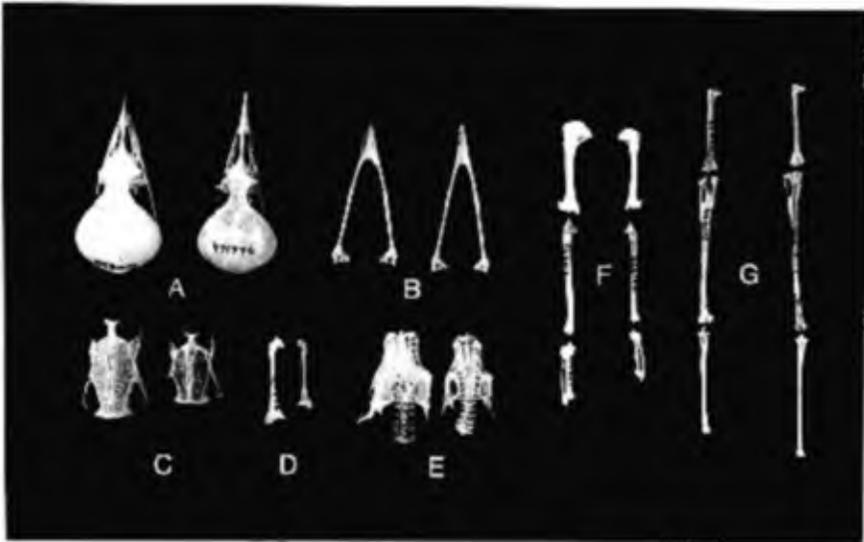


FIG. 2. Comparison of skeletal elements of *Vireo olivaceus chivi* (USNM 558010—on the left in each pair) with *V. gracilirostris* (USNM 491946—on the right in each pair). A, skulls in dorsal view; B, mandibles in dorsal view; C, sternebrae in ventral view; D, coracoids in ventral view; E, pelvises in dorsal view; F, wing elements; G, leg elements. All figures about  $\frac{3}{4}$  natural size.

and depth) give rise to the specific name, and the tail is much longer than in the *V. chivi* group. As noted above, Hellmayr (1935) remarked on the shorter first primary, to which may be added that the entire wing tip (distance between the tips of the secondaries and tips of the primaries) is shorter (Fig. 1E, F). Despite this and the fact that the pectoral girdle and wing elements are smaller in *V. gracilirostris*, the overall wing size, as indicated by the chord length, does not seem to be as correspondingly reduced, as there is considerable overlap in measurements.

The differences in wing shape are shown in Fig. 3. The wing in *V. gracilirostris* is broad and rounded, whereas in the highly migratory *V. olivaceus* the wing is long and pointed. The differences are exaggerated here by contrasting the most migratory form with perhaps the most sedentary member of the *V. olivaceus* complex. It is likely that *V. gracilirostris* does not differ as much in wing shape from the more sedentary forms of the *V. o. chivi* group. Unfortunately, no spread wings were available for any of these taxa.

By simply tracing the outline of the two specimens shown in Fig. 3 on graph paper, I found that the wing area was identical (27.0 cm<sup>2</sup>). This probably indicates that wing area cannot be reduced below a certain



FIG. 3. Comparison of wing shape in *Vireo olivaceus* (left) and *V. gracilirostris* (right). Although the wing shape is quite different in these two species, with that in the highly migratory *V. olivaceus* being very long and pointed, the surface area was identical in these two specimens. Scale = 2 cm.

amount without adversely affecting arboreal foraging, so that *V. gracilirostris* maintains the same wing area while having a much smaller pectoral girdle and associated musculature, which is advantageous in a sedentary, insular species.

*Osteology.*—Barlow and Bortolotti (1989) compared aspects of the skeleton of *V. gracilirostris* with other members of the *V. olivaceus* complex (but not *V. chivi* or *V. flavoviridis*), among which it was almost always the most divergent and in one principal component analysis (Barlow and Bortolotti 1989: fig 4) was widely separated from the other taxa. Additional data and analyses are provided here in Table 2 and Figs. 2 and 4.

Such standard indicators of overall size as cranium width and femur length show *V. gracilirostris* to be, on average, a slightly smaller bird but with considerable overlap. All elements of the wing and pectoral girdle are much smaller in *V. gracilirostris*, but so too is the pelvis. In plotting the combined lengths of sternum and coracoid versus combined lengths of the wing elements (Fig. 4b), *V. gracilirostris* falls out on the same slope as *V. olivaceus*, which seems to indicate that it is simply a smaller bird, rather than having a disproportionately reduced pectoral girdle. Barlow and Bortolotti (1989) found that relative to the total length of the wing elements, the humerus in *V. gracilirostris* is shorter and the carpometacarpus longer than in related taxa, whereas the ulna remains the same. In absolute measurements the lengths of the tail, culmen, and tarsometatarsus are greater in *V. gracilirostris*, with no overlap. Bill width in the skeleton is consistently smaller, and bill depth in skins is likewise small in *V. gracilirostris*, although with some overlap.

In sum, compared to *V. olivaceus* (including *V. o. chivi*), the Noronha Vireo is a smaller bird with a longer, more slender bill, and much longer

tail and tarsus. The wing is rounded rather than pointed, but retains the same surface area, possibly in part through relative elongation of the carpometacarpus.

*Mass.*—Unfortunately, I was unable to obtain mass data for the specimens I collected; the only such information comes from Nacinovic and Teixeira (1989), who gave the masses of seven individuals of *V. gracilirostris* as ranging from 11.5 to 20 g (mean 16.5). This seems a rather great disparity for a small non-migratory passerine, particularly as one bird at the low end of the range (12 g) was noted as being very fat. The mean mass of seven individuals of *V. o. chivi* from Peru was 13.8 g, and migratory *V. o. olivaceus* from Pennsylvania ranged from 12.0 to 25.1 g with a mean of 16.7 g (Dunning 1992).

#### ECOLOGY AND BEHAVIOR

*Distribution and abundance.*—*Vireo gracilirostris* is confined to the main island of Fernando de Noronha and does not occur on any of the adjacent islets, the largest of which is Ilha Rata, where the elaeenia exists but not the vireo. The birds are generally distributed throughout the island wherever there is forest, or at least scrub, but are absent from large areas in the center of the island that have been cleared for airport runways, fields, etc. The greatest numbers occurred in the forest around the famous phonolitic plug known as Morro do Pico, and in the forest that covered the western quarter of the island, where birds were truly abundant.

My only attempt to census vireos took place on the morning of 18 July 1973 from about 08:30 to 10:30 h while walking along the woodland trail at the western end of the island from the base of Morro Dois Abraços to the lighthouse at Alto da Bandeira, a distance of 2 km. During this time, I saw 31 vireos and counted 93 singing males. Although the birds are a favorite target of children who kill them to eat or purely for recreation (Nacinovic and Teixeira 1989), this is probably a minor source of mortality, and the species should not be in any danger as long as existing forested areas of the island are preserved.

*Feeding and general behavior.*—The Noronha Vireo is a curious and tame bird that allows close approach by humans and is generally quite tolerant of the presence of conspecifics. Birds that seemed to work too close to each other would sometimes snap their bills audibly at one another and move apart. I twice observed chases followed by weak singing by the “victor,” but usually there was little aggressive behavior between birds, which often foraged in proximity to one another in considerable numbers. Birds in pairs, presumably mates, scold human intruders with great frequency while approaching closely.

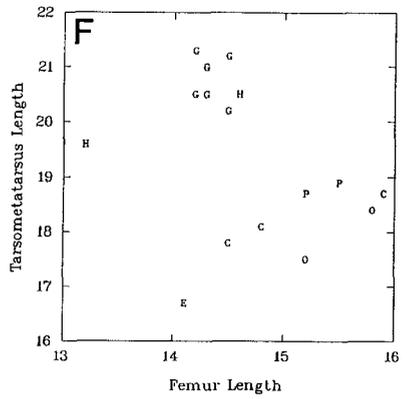
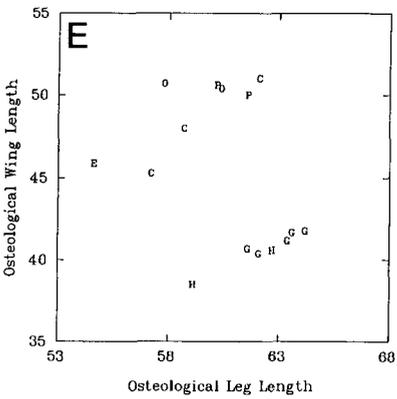
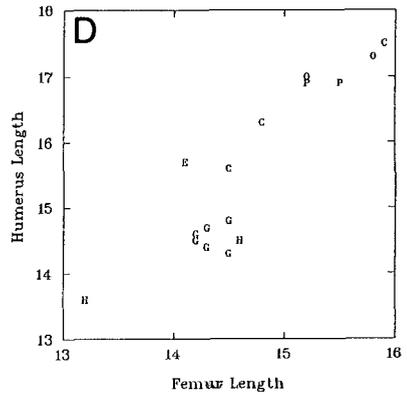
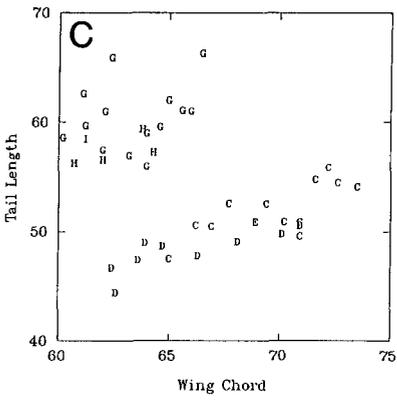
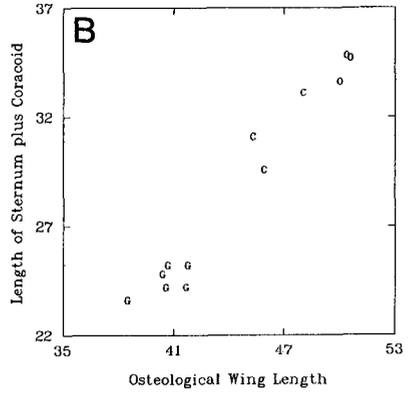
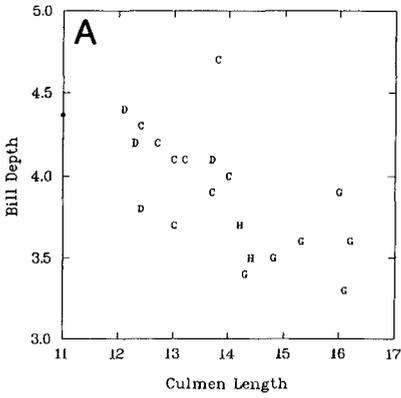
TABLE 2  
SKIN AND SKELETAL MEASUREMENTS (MM) OF *VIREO GRACILIROSTRIS* AND *V. OLIVACEUS*

Measurement	<i>V. gracilirostris</i>		<i>V. olivaceus</i>	
	Range	Mean	Range	Mean
1. Wing chord	60.2-66.5	62.9	62.4-73.5	68.1
2. Tail length	56.3-66.3	60.1	44.4-55.9	50.4
3. Culmen length	14.3-16.2	15.1	11.7-14.0	12.9
4. Bill depth	3.3-3.9	3.5	3.7-4.7	4.1
5. Cranium length	16.1-17.3	16.8	16.9-18.6	17.8
6. Cranium width	13.3-14.2	13.7	13.6-14.8	14.2
7. Bill length	16.2-17.7	16.7	14.0-16.6	15.6
8. Bill width	5.4-5.9	5.6	6.2-7.2	6.7
9. Pelvis width	8.0-9.0	8.6	9.1-10.5	10.1
10. Sternum length	11.3-12.3	12.0	14.9-18.0	16.9
11. Carina depth	3.4-4.6	4.0	5.3-6.4	5.9
12. Coracoid length	12.3-13.1	12.7	14.9-16.8	16.0
13. Humerus length	13.6-14.8	14.5	15.6-17.5	16.6
14. Ulna length	16.4-17.9	17.4	19.5-22.0	21.0
15. Carpometacarpus length	8.5-9.2	9.0	10.2-11.9	11.3
16. Femur length	13.2-14.5	14.2	14.1-15.9	15.1
17. Tibiotarsus length	26.3-28.5	27.6	23.8-27.5	25.8
18. Tarsometatarsus length	19.6-21.3	20.6	16.7-18.9	18.1

Notes: Measurements 1-4 are from skins, the specimens of *V. olivaceus* being of South American *chivi* group. For measurements 1 and 2, N = 22; for measurements 3 and 4, N = 9 for *V. gracilirostris* and N = 13 for *V. o. chiva*. Measurements 5-18 are from skeletons, N = 8 for each taxon. The skeletons of *V. olivaceus* include four *V. o. olivaceus* from North America and 4 from South America that are labelled as being of the *chivi* group, although one is probably a misidentified northern migrant. When not a standard measurement or self-evident, the manner of taking each measurement is specified as follows: 4. At anterior margin of external nostril. 5. From nasofrontal hinge to posteriormost extent of braincase. 6. Greatest width. 7. From nasofrontal hinge to tip. 8. At posterior margin of bony nostril. 9. Across antitrochanters. 10. From midline of manubrial fork to posterior margin. 11. From the ventral sternal plate to tip of carina. 12. From head to external distal angle. 17. Including cnemial crest.

Oren (1984) wrote that the vireo was flexible in procuring food, which is always small arthropods, and may forage from the tops of the trees to the ground and in leaves, on trunks, or in inflorescences. He also noted that it habitually hangs head down. Analysis of stomach contents reported by Nacinovic and Teixeira (1989) revealed a variety of insect remains (Coleoptera, Hymenoptera, Orthoptera, and Trichoptera) and a few small fruits of Ulmaceae.

In my experience, although the birds did show some variability in feeding behavior, most individuals spent more time foraging on the undersides of leaves than in any other feeding activity. In their most characteristic pose, the birds would grasp the edge of a leaf in their feet and bend over upside-down to feed from the undersurface. One bird stayed in this position for 15-16 sec, gleaning insects the entire time. Another



bird was observed feeding upside-down from the flowers of an *Erythrina* tree. Three representative feeding bouts on the underside of leaves involved 32 gleaning movements in 2 min, 54 in 2 min, and 22 in 65 sec, for rates averaging between 16 and 27 capture movements per min. The main food appeared to be tiny "whiteflies" (probably Homoptera, Aleyroididae) that were often present in myriads. The long, slender bill, and especially the very long tail of *V. gracilirostris*, which would act as a counterbalance, appear to be specializations that facilitate feeding in this distinctive manner.

Foraging by hanging from leaves has been reported in several other species of *Vireo* and *Hylophilus* (Remsen and Robinson 1990:148). In a study of foraging behavior of forest birds in the eastern United States, Robinson and Holmes (1982:1924) found that Red-eyed Vireos (*V. olivaceus*) occasionally would forage by hanging from a leaf or twig (7.1% of observed prey capturing maneuvers vs 0.4–2.4% in all other species except Black-capped Chickadees, [*Parus atricapillus*], which used this technique in 28.7% of observed captures). Thus, the Noronha Vireo appears to have capitalized on a foraging technique that is present in its ancestral stock, but is used much less frequently.

Twice I saw birds make long hawking flights after insects, once a bird hovered over a leaf and gleaned from the upper surface, and only occasionally would a bird forage on trunks or limbs or capture larger insects. Birds were seen to hold prey, or once a piece of a leaf, under one foot while feeding on it. In one instance where several birds were seen feeding among roadside weeds, the majority seemed to be juveniles.

Noronha Vireos are probably very sedentary. One followed for 20 min did not move more than 15–18 m. A color-banded bird was seen several days after release only about 500 m from the original banding site.

*Vocalizations.*—The first description of the voice of the Noronha Vireo was by Nicoll, (1904:38) who noted that "it has a loud call-note, resembling the "chizzick" of a Wagtail," and also that "their loud, but by no

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FIG. 4. Bivariate plots of various skin and skeletal measurements (mm) of *Vireo gracilirostris* (G = males, H = females), *V. o. olivaceus* (O = males, P = females), *V. olivaceus chivi* (C = males, D = females, E = unsexed). In all cases, *V. gracilirostris* clusters separately from the other taxa, although there is overlap in some individual measurements. A. Skin measurements of bill depth versus culmen length. B. Combined lengths of sternum and coracoid versus combined length of humerus, ulna, and carpometacarpus. C. Skin measurements of tail length versus wing chord. D. Humerus length versus femur length. E. Combined length of humerus, ulna, and carpometacarpus versus combined length of femur, tibiotarsus, and tarsometatarsus. F. Length of tarsometatarsus versus length of femur.

means unpleasant, song somewhat resembled that of a pied wagtail [*Motacilla alba*]” (Nicoll, 1908:16).

Oren (1984:37) found the voice to be considerably variable, including simple notes reminiscent of a House Sparrow (*Passer domesticus*), a four-note song “typical of vireonids,” and a high, thin whistle. Nacinovic and Teixeira (1989:723–724) noted only that the birds were loquacious, with a characteristic alarm “tschrrr, tschrrr.”

The birds are generally quite vocal and possibly sing throughout the year, although by 8 August I noted that fewer individuals were inclined to sing than in July. At dawn on 16 July 1973, I was standing on the beach at the base of Morro do Pico when the entire forest around the peak burst into twittering like some giant seabird colony. This was caused by dozens of vireos singing—so many that individual songs could not be distinguished, and all melded into a chorus of vireos audible even over the roar of the surf.

On the basis of a poor-quality tape that I supplied, Barlow and Bortolotti (1989:1545, sonogram in fig. 5) were somewhat misled as to the nature of the song in this species. “*Vireo gracilirostris* was represented by only 20 songs of either one syllable (18 times) or two syllables (1 time). Sixteen of 20 were downslurred, and three different syllables occurred in the sample of 20.” From this they concluded that *V. gracilirostris* fits a pattern shown by other insular vireos that have a simpler song repertoire compared to mainland taxa. Reanalysis of the original tape with a more modern spectrograph (Barlow, in litt.), has revealed that the song of *V. gracilirostris* is more complex than had been interpreted previously. The results of this reanalysis will be published separately by Barlow.

To my ear, the full song of *V. gracilirostris* was reminiscent of that others of the Red-eyed Vireo group. I transcribed it as “*weet weet, chew-eyoo, whut whit*,” with the last note higher pitched. Songs could be quite variable, however, some being noticeably abbreviated. One bird that was watched for 2 min, during which it did not feed, gave a different call—“*seet, seet*” and “*seep-seep seedle seet*.”

The Noronha Vireo employs a variety of other vocalizations in different contexts. They frequently scold with a harsh “*skeeur*” or “*scree*” note (recordings indicate this has a buzzy quality and a 0.5 sec duration, Barlow in litt.). The response of a singing male to a playback of its song was a strident, harsher “*shree*.” One bird was seen to chase another, giving a short rattle, after which it moved through the trees singing feebly. Young peeped vociferously when fed. A nearly full-grown juvenile attended by two adults gave a “*tseep tseep*” call. One solitary, otherwise silent bird gave a little “*peep*” note just before defecating.

*Reproduction and molt.*—The breeding season of *Vireo gracilirostris* is

difficult to determine from the available data and is possibly correlated with local conditions rather than being on a strictly annual cycle. Apart from the gonad data with the specimens from the *Blossom* Expedition (which are often difficult to interpret), no information is available for the period from January through May (Table 1).

Although Oren (1984) speculated that breeding was tied to the rainy season, Nacinovic and Teixeira (1989:724) surmised from field data and specimens in the Museu Nacional that the reproductive period coincides with the beginning of the dry season (September–October), a conclusion reached partly on the basis of their June specimens having small gonads. During my visit, however, I found a few adults still attending young at the end of July, and numerous individuals in the evanescent rusty juvenile plumage were present. There was no evidence of egg-laying at that time. Although some males had relatively enlarged testes, others did not, and no females had enlarged ovaries. The birds clearly were not breeding during my visit but must surely have been actively nesting in May and June of 1973.

Some males taken by the *Blossom* expedition in March and April were noted as “breeding” or had otherwise enlarged testes. Likewise, Murphy (1915) remarked that the pair he obtained in October was breeding. Oren (1984) noted the presence of many juveniles in December. Thus it seems that egg-laying either takes place twice a year or is irregular, although it is certainly not continuous.

The eggs of *V. gracilirostris* have never been observed or obtained by scientific collectors, although I was told by a resident of the island that the “*sibito*” may lay from two to five eggs. Higher numbers may be doubted, however, as virtually all tropical vireos have a clutch of only two (Barlow, in litt.).

An abandoned nest I found on 28 July was at the end of a limb about 5 m high in the lower story of a leafy tree on a steep hillside. It was suspended in a fork in typical vireo fashion and is composed of partially macerated leaves, fibers, rootlets, and spider webs. The outside diameter and depth are ca 64–72 mm by 52 mm, and the inside diameter and depth are ca 42 × 40 mm. This is similar to a nest described and illustrated by Nacinovic and Teixeira (1989), that was found 2.5 m up in a tree. Another old nest that I found was at the end of a small branch about 0.6 m long and 5 mm in diameter, about 6 m high in the middle of a tree.

Molt appears to take place mainly in July and August. The *Blossom* specimens taken in March and April are in worn or very worn plumage. Those that I obtained in July and August were usually in active molt, with fresh body plumage, and remiges and rectrices either new or in the process of being replaced. Numerous nearly tailless birds were seen during

this period. Murphy (1915) noted that his October pair was in fresh plumage with some body feathers still in sheath, yet by December Oren (1984) remarked that the plumage of adults was already very worn (“*muito gasta*”).

#### DISCUSSION

The two largest genera of Vireonidae, *Vireo* and *Hylophilus*, have different centers of origin and diversity. *Hylophilus* would seem to be of purely South American derivation, with all 14 species occurring there, only four of which have entered Middle America and only two of which extend beyond Costa Rica. Conversely, the genus *Vireo* is most diverse in North and Middle America and the West Indies and hardly reaches South America at all. There are no endemic species of *Vireo* in continental South America, where the only breeding taxa are the Black-whiskered Vireo (*V. altiloquus*) along the northern coast, an extension of the *leucophrys* group of the Warbling Vireo (*V. gilvus*) into the Andes, and the *V. olivaceus chivi* complex. Because the last comprises the only resident populations of *Vireo* in the interior lowlands of South America, it is the only likely progenitor of *V. gracilirostris* on geographic grounds alone.

On the basis of genetic data from starch-gel electrophoresis, Johnson and Zink (1985) considered that the *Vireo olivaceus/chivi* group was specifically very distinct from the Yellow-green Vireo (*V. flavoviridis*) and that the *chivi* group diverged much more recently from *olivaceus*, possibly from northern migrants that failed to return to the north in the Pleistocene. They estimated the time of divergence between *olivaceus* and *chivi* at about 370,000 years ago, although this figure is based on a calibration that I regard as at best only a crude approximation and possibly erroneous. This does not affect the overall assessment that *olivaceus* and *chivi* are only weakly differentiated and that this differentiation took place in the geologically recent past, however.

Given the history of *V. o. chivi* hypothesized by Johnson and Zink, it naturally follows that *Vireo gracilirostris*, presumed to be derived from *V. o. chivi*, is likewise recent in origin. Despite this, not only is it a morphologically distinct species, but it is one of the more specialized members of the family, having diverged farther from its ancestral stock than any other member of the Red-eyed Vireo complex.

The long, slender bill and tarsus and the elongated tail appear to be warbler-like specializations for gleaning small insects from foliage. The long tail may function as a counterbalance during the upside-down posture commonly assumed when feeding on the undersides of leaves.

This relatively extreme specialization for a vireo has taken place in

isolation, without any serious competition from other species of birds. The only other arboreal land bird on Fernando de Noronha is the fly-catcher *Elaenia spectabilis ridleyana*, which probably overlaps relatively little with the vireo in feeding habits. Although I saw elaenias feeding on "whiteflies" on the undersides of leaves by hovering, they were far less proficient than the vireos at using this food source and spent much less time so engaged. They also feed rather extensively on fruits, such as berries of *Lantana*, which the vireos apparently do not. The elaenia is only slightly, if at all, differentiated from its mainland relatives and appears to be a more recent arrival to the island.

Thus the Noronha Vireo evolved its specialized adaptations in the absence of interspecific competition. If competition actually affects morphological differentiation and subsequent speciation, in this case only *intraspecific* competition could have been involved. The founding population of vireos, upon colonizing an island in which all niches for arboreal insectivores were vacant, did not become more generalized so as to occupy a greater diversity of feeding opportunities, but instead appears to have evolved specializations for a more active, warbler-like lifestyle in order to feed on what is probably the most abundant or nutritious food source.

A similar evolutionary history was envisioned by Gill (1971) for the white-eyes (*Zosterops*) of the Mascarenes, where there are two sympatric species. Gill hypothesized that the first species to colonize became specialized for the richest food source (in this case nectar), from which the second colonizer, which is more of a generalist, was then excluded. The Noronha Vireo provides evidence that such an evolutionary history is possible and that a single species in isolation may become a specialist rather than a generalist.

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