The Condor 90:906–912

STATUS OF THE ENDEMIC ATITLAN GREBE OF GUATEMALA: IS IT EXTINCT?[1]

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Abstract. Efforts to determine the factors responsible for the long-term population decline of the Atitlan Grebe (*Podilymbus gigas*), a species restricted to Lake Atitlán in Guatemala, led to the discovery that the only *Podilymbus* species present on Lake Atitlán in 1986–1987 was the Pied-billed Grebe (*P. podiceps*). *Podilymbus gigas* is similar to *P. podiceps* in color and form but is almost twice the weight, and is reported to be flightless. All *Podilymbus* grebes at Lake Atitlán in 1986–1987 appeared to be the same size, and the body masses and bill measurements of six captured grebes were within the range of *P. podiceps,* but not that of *P. gigas.* Grebe eggs measured at both Lake Atitlán and Laguna del Pino, another Guatemalan lake, were similar to each other and to eggs of *P. podiceps* from North America. The territorial calls of male *Podilymbus* grebes recorded at Lake Atitlán, Laguna del Pino and West Toqua Lake in Minnesota did not differ significantly. It thus appears that *P. gigas* no longer occurs on Lake Atitlán and has been replaced, perhaps through competition or hybridization, by *P. podiceps.*

Key words: Atitlan Grebe; Podilymbus gigas; *Pied-billed Grebe;* Podilymbus podiceps; *Lake Atitlán; Guatemala; extinction.*

INTRODUCTION

The Atitlan Grebe (*Podilymbus gigas*) is known only from Lake Atitlán in Guatemala. First described in 1929, *P. gigas* is essentially a larger version of the Pied-billed Grebe (*P. podiceps*) with a few minor color differences, such as a darker head, neck, and belly (Griscom 1929). Although *P. gigas* is almost twice as heavy as *P. podiceps,* the two species have roughly similar wing lengths, and *P. gigas* is reported to be flightless (LaBastille 1974). Prior to 1965, the population of *P. gigas* on Lake Atitlán was estimated to be about 200 (Griscom 1932, Wetmore 1941, Bowes and Bowes 1962), but a decrease to 80 in 1965 placed the species in danger of extinction and led to vigorous conservation efforts to protect it (LaBastille 1974). In 1975, the population temporarily recovered to its historic level of 200, but then plummeted to approximately 50 grebes by 1983 (LaBastille 1984).

In 1986, I joined with the U.S. Fish and Wildlife Service, in cooperation with the Guatemalan government and the International Council for Bird Preservation-Pan American Section, as part of an international program to conserve *P. gigas* on Lake Atitlán. The objectives of my research were to assess the current status of the population and to identify the factors responsible for its decline using data on behavioral interactions, territorial calls, and morphometric measures.

METHODS

From March 1986 to June 1987, I observed *Podilymbus* grebes at two sites in Guatemala. Most of the research was conducted at Lake Atitlán, a 130-km^2 volcanic lake in the southwestern section of Guatemala. Territorial birds were located by playing recorded territorial calls of male *Podilymbus* grebes. The recordings were played from a motorboat stationed approximately 20 m from bulrush (*Scirpus californicus*) and cattail (*Typha domingensis*) stands that were 10 m long or longer and that might serve as suitable nesting habitat. If a grebe responded to the recording, I remained in the area for 1–2 hr, noting the numbers of adults, juveniles, and chicks, and any behavioral interactions. Sexes of adults were relatively easy to distinguish because of the male's larger body and more massive bill. Grebes were not marked and were identified for census purposes by their association with a particular territory. If a territory was always occupied, I assumed continuous ownership by the same birds.

I searched for nests if, on two consecutive visits, the grebes behaved as if they had one in the area: nesting pairs responded to the recording by duetting from within the reeds, but only one bird

[1] Received 1 April 1988. Final acceptance 28 June 1988.

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would leave the reeds and be visible to an observer. In some cases, nesting birds were observed carrying nest vegetation into the reeds.

If a clutch of eggs was found in a nest, the length and width of all eggs were measured. I calculated an average egg length and width for each clutch to ensure independence before performing statistical analyses on the data. Nests with eggs were checked only once to minimize disturbance. Nests with chicks were visited several times a week until all chicks were no longer fed by their parents.

Additional observations were made at Laguna del Pino, a 10-ha lake near Guatemala City that supports a year-round population of approximately 10–20 *P. podiceps*. These birds were observed for 2–4 days at a time, for 40 days scattered throughout the study period. Grebes were censused and eggs were measured using the same techniques as at Lake Atitlán, and behavioral interactions were recorded. Data from the two populations were compared.

The territorial calls of male *Podilymbus* grebes, (referred to as the "gulping-cow" call by LaBastille 1974) were recorded at Lake Atitlán and Laguna del Pino throughout the study period, and at West Toqua Lake in southwestern Minnesota, in July 1987. The calls were recorded using a Sony TCM-5000EV recorder, a 45-cm parabolic reflector and a Sony ECM-170 omnidirectional microphone. A Uniscan II real-time sound spectrograph was used to obtain two frequency measurements (high and low) for the first descending "cow" note of all complete calls.

Three male and three female grebes from Lake Atitlán were captured using a hand-triggered nest trap. The body of the trap consisted of a circular 2-cm mesh net which was tied securely on a nest with eggs. When an incubating grebe returned to the nest, I pulled the trigger string, the net ascended a metal tripod frame which was attached to the nest, and enclosed the grebe. Captured grebes were weighed with a 1,000-g Pesola scale and the following measurements were taken using a dial caliper: bill length, entire exposed culmen from tip to beginning of feathers; bill depth, at posterior edge of nostril; and tarsus, distance from joint between tibia and metatarsus to joint at base of middle toe. The length of the flattened wing was measured using a wing board.

For all pair-wise comparisons between *P. podiceps* and the grebes at Lake Atitlán, I used one-tailed tests of significance to examine my a priori assumption that Atitlan Grebes were larger than *P. podiceps*. Two-tailed tests were used for all pair-wise comparisons between *P. gigas* and the grebes at Lake Atitlán.

TABLE 1. Dimensions of *Podilymbus* grebe eggs from Lake Atitlán and Laguna del Pino, and a mean for 102 North American Pied-billed Grebe eggs taken from Glover (1953). For Atitlán and Laguna del Pino, mean measurements for each independent clutch were used to calculate overall means for the population. Means ($\bar{x}$) and standard deviations (SD) are listed.

Site	Eggs	Clutches	Egg length (mm) $\bar{x}$ (SD)	Egg width (mm) $\bar{x}$ (SD)
Lake Atitlán	63	20	44.0 (2.0)	29.7 (0.8)
Laguna del Pino	13	4	43.6 (1.6)	30.2 (0.7)
N. America	102	—	43.5 (0.7)	30.8 (0.4)

RESULTS

From a distance, *Podilymbus* grebes at Lake Atitlán and Laguna del Pino appeared to be the same size when compared to American Coots (*Fulica americana*), which I used as a relative standard of reference. On five different occasions I saw grebes flying on Lake Atitlán, with their feet at least 1 m off the surface of the water. According to LaBastille (1974), *P. podiceps* occurs on Lake Atitlán during the winter months and leaves the lake by March. Given that all of my observations of grebes flying were after April, this indicates that either *P. gigas* was capable of flight or that *P. podiceps* was on the lake throughout the year.

I observed 27 broods of chicks at Lake Atitlán and found that the length of chick care was approximately 10–12 weeks. I measured 63 eggs from 20 different clutches found at Lake Atitlán between May 1986 and June 1987, and compared these with the measurements of 13 eggs from four different clutches found at Laguna del Pino between May 1986 and April 1987 (Madelynn Gierach, pers. comm.). The length and width of eggs from Lake Atitlán were not significantly different from those at Laguna del Pino (*t*-test: $t = 0.4$, $P = 0.15$ for length; $t = 0.8$, $P = 0.1$ for width; Table 1). The mean length and width for 102 *P. podiceps* eggs from North America (Table 1) are very similar to the measurements from Laguna del Pino.

The acoustical structure of the male territorial call was the same at all three sites where recordings were made. The call began with a short series of rapid "ca" notes (5–10 notes) followed by a

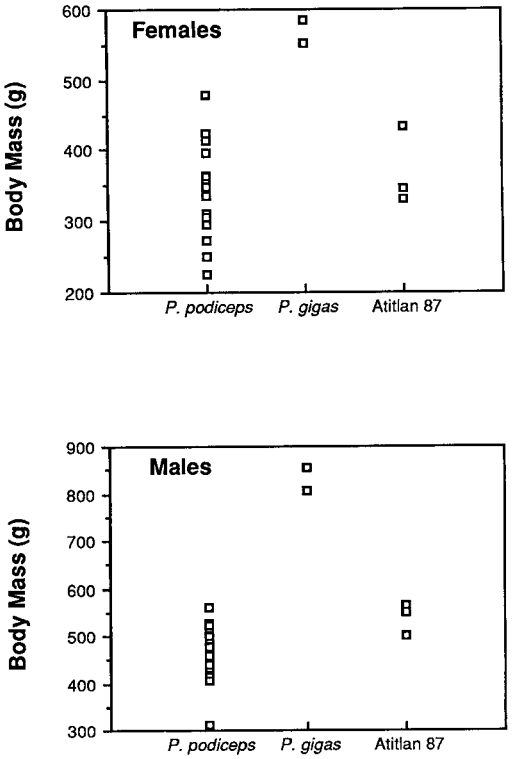

FIGURE 1. Body masses of Pied-billed Grebes (*Podilymbus podiceps*), Atitlan Grebes (*P. gigas*), and *Podilymbus* sp. captured on Lake Atitlán in 1987 (Atitlan 87). Data for *P. podiceps* are from Robert W. Storer (pers. comm.), from specimens collected in North and Central America (excluding Lake Atitlán). Data for *P. gigas* are from LaBastille (1974).

longer series of slower, descending "cow" notes (15–20 notes). No significant differences were found among the three sites for the high and low frequencies of the first "cow" note of the call (ANOVA: $F = 0.3$, $P = 0.7$ for the high; $F = 1.5$, $P = 0.2$ for the low; Table 2).

The body masses of the three male and three female grebes captured on Lake Atitlán were within the range for body masses of *P. podiceps* but not for body masses of *P. gigas* (Fig. 1 and Table 3). The body masses of the captured birds were significantly smaller than those of *P. gigas* ($t = -9.2$, $P < 0.0001$ for males; $t = -5.3$, $P < 0.0001$ for females). Interestingly, the mean body masses of the captured males were significantly greater than the body masses for male *P. podiceps* ($t = 2.3$, $P = 0.01$). However, the mean body masses of the captured females did not differ significantly from the body masses for female *P. podiceps* ($t = 0.7$, $P = 0.1$).

Bill measurements, particularly bill depth, are good discriminators between *P. gigas* and *P. podiceps* because there is little or no overlap between the two species for either sex (Robert W. Storer, pers. comm.; Table 4 and Fig. 2). The bill measurements of all six captured birds are within the range for *P. podiceps* (Fig. 2 and Table 3) and show no significant differences from that species in bill length ($t = 0.02$, $P = 0.25$ for males; $t = 0.1$, $P = 0.25$ for females) or bill depth ($t = 1.1$, $P = 0.08$ for males; $t = 0.3$, $P = 0.2$ for females).

Monthly population censuses of *Podilymbus* grebes on Lake Atitlán are shown in Table 5. The population level remained low throughout my study, with a high of 42 adults in February 1987 and a low of 23 adults in March 1986. The number of occupied territories changed each month but no territory remained open for more than 2–3 months. Fluctuations in the number of occupied territories, and therefore the number of birds, followed no pattern, such as might be caused by seasonal migration. Reasons for the changes in population sizes are unknown.

Podilymbus grebes on Lake Atitlán bred throughout the year with at least one pair of grebes

TABLE 2. Sound spectrogram data of male *Podilymbus* grebe calls from Lake Atitlán, Laguna del Pino, and West Toqua Lake in Minnesota. *n* is the number of calls (each from a different male) that were analyzed, high and low frequency measurements refer to the first "cow" note of the call. Means ($\bar{x}$) and standard deviations (SD) are listed.

Site	*n*	High (Hz) $\bar{x}$ (SD)	Low (Hz) $\bar{x}$ (SD)
Lake Atitlán	30	980 (65)	487 (47)
Laguna del Pino	13	985 (59)	457 (117)
West Toqua Lake	22	969 (87)	498 (55)

TABLE 3. Sex (M = male, F = female), weight, bill measurements, and wing and tarsus length of *Podilymbus* grebes captured at Lake Atitlán from March to June 1987.

Sex	Weight (g)	Bill length (mm)	Bill depth (mm)	Wing (mm)	Tarsus (mm)
M	500	25.0	13.3	137	49.6
M	550	23.1	13.5	139	48.9
M	565	23.1	13.7	139	49.2
F	330	20.1	10.3	114	44.2
F	435	21.6	11.7	125	44.7
F	345	18.6	11.5	122	42.0

on eggs or with chicks in every month (Table 5). There did appear to be a peak from June until August when at least half of the breeding pairs had young. Many pairs had multiple broods. Two pairs had four broods within a 12-month period, and six pairs had two or three broods in 1 year. Mean clutch size was 4.2 eggs (range = 2–6; n = 12 complete clutches). The average brood size (at 2 weeks of age when the chicks left the reeds and were visible to observers) was 2.5 chicks (n = 27 broods). Average survival to 3 months (age of independence) was 54% and 14 broods had 100% survival. However, once the chicks molted into juvenal plumage and became independent, I no longer saw them on Lake Atitlán. It is possible that they leave the lake, are eaten, starve, or become entangled in gill nets.

As a result of frequent trips to possible capture sites for adult grebes, I discovered many nests that failed before the eggs hatched. From March to May 1987, 15 nests with eggs were abandoned or destroyed. Local reed cutters had cut reeds near or at the edge of nests, which were then abandoned in 10 cases. Local villagers stole the eggs from three nests, and nonhuman predators probably destroyed the eggs in two (large pieces of eggshell were found in the nest and the surrounding reeds appeared to be undisturbed).

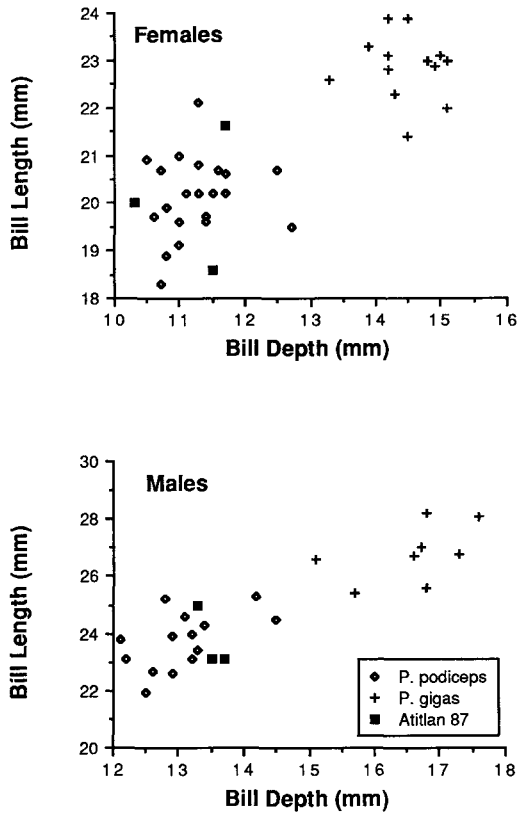

FIGURE 2. Measurements of bill length plotted against bill depth for Pied-billed Grebes (*Podilymbus podiceps*), Atitlan Grebes (*P. gigas*), and *Podilymbus* sp. captured on Lake Atitlán in 1987 (Atitlan 87). Data for *P. podiceps* and *P. gigas* are from Robert W. Storer (pers. comm.), as in Table 4, and include a factor to correct for postmortem shrinkage (×1.038 for bill length and ×1.093 for bill depth; Fjeldså 1980).

DISCUSSION

Results of my study indicate that only *P. podiceps* now exists on Lake Atitlán. If the grebes on Lake Atitlán had been *P. gigas,* several important differences should have been noted. The most obvious, that of greater body size, was not seen or indicated by measurements. The six grebes captured on Lake Atitlán represented approximately half the breeding pairs (each of the six came from a different pair and only 13 pairs were present on the lake during the capture period), and had weights and bill measurements within the range of *P. podiceps.* I was very familiar with all of the other grebes on Lake Atitlán, and none appeared to be any larger than the six captured grebes.

TABLE 4. Measurements of bill length and depth, of the Atitlan Grebe (*Podilymbus gigas*) and the Pied-billed Grebe (*P. podiceps*). Sample size (n), means ($\bar{x}$), and range are presented. Data are from Robert W. Storer (pers. comm.). The measurements were taken on specimens from Mexico and Central America (only the *P. gigas* are from Lake Atitlán), and a correction factor has been added to adjust for postmortem shrinkage (×1.038 for bill length and ×1.093 for bill depth; Fjeldså 1980).

			Bill length (mm)		Bill depth (mm)	
Species	Sex	n	$\bar{x}$	(Range)	$\bar{x}$	(Range)
gigas	M	8	27.2	(25.4–28.9)	16.6	(15.1–17.6)
gigas	F	14	23.1	(21.4–27.8)	14.4	(13.3–15.1)
podiceps	M	14	23.9	(19.7–27.7)	13.2	(10.2–15.2)
podiceps	F	21	20.2	(17.4–22.9)	11.3	(9.6–13.0)

TABLE 5. Monthly censuses of adult *Podilymbus* grebes at Lake Atitlán, March 1986 to June 1987.

Date	Pairs without young	Pairs with young	Solitary males	Total adults
1986 Mar	5	3	7	23
Apr	9	4	10	36
May	12	5	5	39
June	7	8	2	32
July	7	9	1	33
Aug	8	8	2	34
Sept	13	3	4	36
Oct	8	6	7	35
Nov	11	4	6	36
Dec	13	2	8	38
1987 Jan	16	0	9	41
Feb	14	2	10	42
Mar	14	1	10	40
Apr	11	2	6	32
May	6	6	1	25
June	7	6	1	27

Another expected difference is that the larger species, i.e., *P. gigas,* would have larger eggs (Lack 1968, Grant 1982). However, I found that the dimensions of the grebe eggs on Lake Atitlán were similar to those of *P. podiceps* in Guatemala and North America. One would also predict that because *P. gigas* is larger, it would have a lower-frequency call than *P. podiceps* (Lanyon 1978, Bowman 1979). Again, I found no differences in call frequencies for grebes on Lake Atitlán, Laguna del Pino, and West Toqua in Minnesota.

One reported difference between *P. gigas* and *P. podiceps* is the length of time that the adults care for their chicks; *P. gigas* spends 10–12 weeks and *P. podiceps* spends 3–6 weeks caring for their chicks (LaBastille 1974). In an unpublished study of parental care by *P. podiceps* at Laguna del Pino, Madelynn Gierach (pers. comm.) found that for eight broods of chicks studied, parental care lasted approximately 10–14 weeks. Previous data on chick care in *P. podiceps* had come from studies conducted in temperate climates (LaBastille 1974, Kirby 1976). Gierach's data indicate that *P. podiceps* in tropical climates may spend a longer period of time in chick care. The data obtained at Lake Atitlán and Laguna del Pino demonstrate no difference in the length of chick care for the *Podilymbus* grebes at both sites.

My observations, and those of Madelynn Gierach on the behavior of *Podilymbus* grebes on Lake Atitlán and Laguna del Pino, failed to reveal any differences between the two populations. Therefore, on the basis of the behavioral data and physical measurements, I conclude that the *Podilymbus* grebes present on Lake Atitlán in 1986–1987 were not the "truly huge" *P. gigas,* as described by Wetmore (1941), but instead were the more common *P. podiceps.*

Unfortunately, it is difficult to determine when and why *P. gigas* disappeared from Lake Atitlán and was replaced by *P. podiceps.* There are no published accounts on the history of *P. podiceps* in Guatemala and it is not known when the first one appeared on Lake Atitlán. Wetmore (1941), in his report on the birds of the Guatemalan highlands, does not mention observing *P. podiceps* on Lake Atitlán in November of 1936. The Museo de Historia Natural in Guatemala City has a specimen of *P. podiceps* that was collected on Lake Atitlán in 1964. LaBastille (1974) studied several breeding pairs of *P. podiceps* on Lake Atitlán in the winter months in the late 1960s. Although there are no reported sightings of *P. podiceps* on Lake Atitlán before the early 1960s, nevertheless, one cannot conclude that only *P. gigas* was on the lake at this time.

In addition, it is not known when the last *P. gigas* disappeared from Lake Atitlán. In 1963, LaBastille collected four adult *P. gigas*; and she measured a clutch of five very large eggs ($\bar{x}$ = 51 mm long × 33 mm wide, vs. $\bar{x}$ = 43 mm × 30 mm for *P. podiceps*), that probably belonged to a pair of *P. gigas* (LaBastille 1974). However, between 1960 and 1987 it is unclear how many of the grebes on Lake Atitlán were *P. gigas* and how many were *P. podiceps.*

I suggest two possible explanations for the replacement of *P. gigas* by *P. podiceps* on Lake Atitlán. *P. gigas* may have evolved from *P. podiceps* during a period of geographic isolation but, if reproductive barriers were not complete and *P. podiceps* reinvaded Lake Atitlán sometime in the 20th century, the two groups may have hybridized. The species status of *P. gigas* has never been unanimously supported, and a few researchers have believed it to be a subspecies of *P. podiceps* (Ogilvie-Grant 1898; Salvin and Godman 1904; Hellmayer and Conover 1948; Storrs L. Olson, pers. comm.). If hybridization had occurred recently, one might expect to see grebes with intermediate measurements between *P. gigas* and *P. podiceps.* Bill measurements of the six grebes that I captured were well within the range for *P. podiceps,* although the mean

weights for the three males were higher than that for *P. podiceps,* and several had very long bills. Although the data are suggestive, a much larger sample size would be required to document if there are intermediates.

Another possibility is that when *P. gigas* were at very low numbers, *P. podiceps* reinvaded Lake Atitlán and entered all available breeding habitat. *Podilymbus podiceps* may have been more adaptable to changes in the environment because of its ability to fly and thus migrate. The introduction of largemouth bass (*Micropterus salmoides*) to Lake Atitlán in 1960, greatly decreased the crab and fish populations and depleted the food resource available to grebes on the lake (LaBastille 1974, 1984). The loss of crabs may have been particularly important because it is believed that crabs were the mainstay of the diet of *P. gigas* before the introduction of fish into Lake Atitlán (Zusi and Storer 1969). If *P. podiceps* had invaded the lake at this time it may have been more successful at surviving the drastic decrease in crab and fish numbers, and gradually replaced the *P. gigas* on the lake.

The population of *P. gigas* on Lake Atitlán may have plummeted in the 1960s for a variety of reasons, some of which may be indicated by studying the factors that are adversely affecting the number of grebes on the lake today. In 1986–1987, fecundity of *P. podiceps* appeared to be good; the breeding season was year-round, and many pairs succeeded in rearing multiple broods. Chick survival was high between the ages of 2 and 12 weeks, with a mortality rate of less than 50%. The eggs and independent juveniles are probably at the greatest risk and may represent the most vulnerable stages. The destruction of nests by reed cutters and nest robbers is not a recent phenomenon and may have severely affected the grebes in earlier decades. The disappearance of juveniles following independence may reflect a shortage of available breeding habitat. The water level at Lake Atitlán has been dropping precipitously over the last several decades and is now 6 m lower than it was in 1965 (Anne LaBastille, pers. comm.). As the water level drops, the reed beds dry out and become unsuitable for grebes. Reed cutting also eliminates areas that could be inhabitated by nesting grebes. As a result, juvenile grebes may not be able to find unoccupied habitat and are forced to leave the lake. If young *P. gigas* had faced territory shortages they would not have had the option of flying from the lake in search of suitable habitat and could have been subject to high mortality.

Dropping water levels with consequent habitat loss, interference by reed cutters and nest robbers, and reduction in food resources after introduction of largemouth bass, all may have contributed to the decline of *P. gigas* on Lake Atitlán and accounted for the drop from 200 birds before 1960 to 80 birds in 1965. In addition, the possible lethal effects of gill nets (Carter and Sealy 1984; Gary L. Nuechterlein, pers. comm.; Theunis Piersma, pers. comm.), which were introduced to the lake in 1970–1971, may have prevented *P. gigas* from making a comeback once the numbers of fish were restored. *Podilymbus podiceps* may have been more adaptable to these adverse conditions because of its ability to fly, and may have swamped the population by hybridizing with the few remaining *P. gigas,* or completely replaced the *P. gigas* on the lake.

ACKNOWLEDGMENTS

I would like to thank the following people for their help in the field: D. Buitron, F. Chiyal, R. Escobar, M. Gierach, A. LaBastille, S. MacVean, P. Mendoza, and G. L. Nuechterlein. H. A. Raffaele provided excellent logistical support while I was in Guatemala. R. W. Storer kindly supplied me with his unpublished data on *Podilymbus* grebes. D. Buitron, M. S. Foster, G. R. Graves, B. C. Livezey, R. L. Mumme, G. L. Nuechterlein, H. A. Raffaele, J. T. Ratti, and R. W. Storer made constructive comments on earlier versions of the manuscript. My research was supported by a grant from the U.S. Fish and Wildlife Service, Office of International Affairs, in cooperation with the International Council for Bird Preservation-Pan American Section.

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