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INTERGENERIC PHYLOGENETIC RELATIONSHIPS OF SWALLOWS ESTIMATED BY DNA-DNA HYBRIDIZATION

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ABSTRACT.—The phylogeny of the subfamily Hirundininae was estimated by hybridizing single-copy nuclear DNAs of 21 swallow species, representing 19 former and current genera, and a Tufted Titmouse (*Parus bicolor*) as outgroup. The phylogeny, which was unusually well resolved, consisted of three fundamental clades: *Hirundo* and allies, core martins, and African sawwings. The clade of *Hirundo* and allies comprised *Hirundo rustica, Ptyonoprogne fuligula, Delichon urbica, Cecropis semirufa, Petrochelidon pyrrhonota,* and *P. spilodera.* The sister-group of *Hirundo* and allies was the core martin clade, which consisted largely of endemic New World taxa (*Pygochelidon cyanoleuca, Neochelidon tibialis, Atticora fasciata, Phaeoprogne tapera, Progne chalybea, Haplochelidon andecola, Stelgidopteryx ruficollis,* and *Tachycineta bicolor*) and some basally branching Old World groups (*Riparia riparia, R. cincta, Phedina borbonica, Pseudhirundo griseopyga,* and *Cheramoeca leucosternus*). The African sawwings (represented by *Psalidoprocne holomelas*) formed the sister group of the core martins and *Hirundo* and allies. Among some interesting discoveries, we found a close relationship between the monotypic African and Australian genera *Pseudhirundo* and *Cheramoeca.* We also found that *Delichon,* which has persisted in the nomenclature as a genus separate from *Hirundo,* is monophyletic with taxa that are commonly considered to be members of *Hirundo.* On the other hand, *Haplochelidon andecola,* which is often considered to be a *Hirundo* or *Petrochelidon,* is not closely related to those genera, but instead lies among the New World members of the core martin clade. *Received 1 July 1992, accepted 25 November 1992.*

PERHAPS NO FAMILY of passerines is as uniform morphologically and diverse generically as the swallows (Hirundinidae). All swallow species conform to a fundamental body plan that includes long and pointed wings, medium length tails, short legs, and bills that are short and wide. This uniformity is the likely result of adaptation to a strictly aerial insectivorous lifestyle. Apparently because of this uniformity, systematists have been loath to attempt a phylogenetic reconstruction of the swallow family as a whole. While there have been many classifications of the Hirundinidae (e.g. Sharpe 1885, Peters 1960, Turner and Rose 1989, Sibley and Monroe 1990) and many discussions of the systematics of individual species or small groups of taxa, only one published paper has considered the familywide relationships of swallows based on evolutionary or phylogenetic logic. This is the 50-year-old study of Mayr and Bond (1943).

At the time of Mayr and Bond's (1943) study, some 30 to 35 generic names had been applied to the 75 to 80 species of swallows. This multitude of small, seemingly equally divergent genera had been defined mainly on the basis of external morphological characters (e.g. plumage color, nasal form, fusion of skin between toes, tarsal feathering, and size). To bring some order and logic to this confusing array of names, Mayr and Bond grouped swallow genera into units using what they considered to be conservative, phylogenetically informative characteristics, in particular those of nesting habits and plumage color patterns. In the process, they outlined a rough scenario of swallow evolution based on nesting strategy and to a lesser extent geography. They postulated that the most "primitive" species were those that nested in natural cavities or on ledges. These were followed in evolutionary sequence by species that excavated nest holes and finally species that built nests from mud. Old World groups were judged to be more primitive than New World taxa because Africa, as the continent with the most swallow species, was perceived as the center of their origin. In addition to behavioral and geographic criteria, some features of exter-

TABLE 1. List of commonly used generic names of swallows and examples of synonymy. Current names taken from Sibley and Monroe (1990). Synonyms from Roberts (1922), Hellmayr (1935), Peters (1960), Brooke (1974), AOU (1983), and Turner and Rose (1989).

Current name	Alternative or subsumed general names
Tachycineta	*Iridoprocne, Callichelidon, Kalochelidon, Lamprochelidon*
Phaeoprogne	—
Progne	*Phaeoprogne*
Notiochelidon	*Orochelidon, Pygochelidon*
Atticora	*Diplochelidon*
Neochelidon	—
Stelgidopteryx	*Alopochelidon*
Cheramoeca	—
Riparia	*Neophedina, Cheimonornis*
Phedina	*Phedinopsis*
Hirundo	*Pseudhirundo, Ptyonoprogne, Cecropis, Petrochelidon, Natalornis, Charitochelidon, Phoenichelidon, Baruwaia, Haplochelidon*
Delichon	—
Psalidoprocne	—

nal morphology (e.g. wing serrations of saw-wing or rough-winged swallows) were used to define evolutionary advancement.

Although openly preliminary, Mayr and Bond's (1943) treatment remains the most influential effort to date, supplying the rationale behind the linear arrangement of swallow species in most classifications. Under its logic, many of the old generic names have been subsumed (e.g. see Table 1), so that only 10 to 20 genera are commonly recognized today (Brooke 1974, Bock and Farrand 1980, AOU 1983, Turner and Rose 1989, Sibley and Monroe 1990). However, we still have no idea how these modern genera fit together phylogenetically, or whether Mayr and Bond's evolutionary logic and choice of characters have merit.

The uncertainty of relationships among hirundines could well serve as sufficient justification for further systematic research on the group. The inherent interest in their genealogy is strengthened because swallows are among the most popular subjects for behavioral and ecological research in ornithology. Every year, dozens of papers are published on the field biology of several North Temperate species, especially *Hirundo rustica, Petrochelidon pyrrhonota, Delichon urbica, Tachycineta bicolor,* and *Progne subis.* Given the growing awareness of the importance of historical components to modern behavior and ecology (e.g. Ricklefs 1987, Brooks and McLennan 1991), further understanding of the phylogeny of this group seems especially warranted.

In the present paper, we reexamine the relationships among genera of the Hirundininae using genetic information derived from DNA-DNA hybridization. This independent source of genealogical information has generated a phylogenetic hypothesis that can be used to test the scheme of Mayr and Bond (1943), as well as serve as a template for analyses of character evolution in this popular group.

METHODS

Selection of taxa.—The species used in our study and sources of tissues for DNA extraction are listed in Table 2. While the taxonomic order of this list follows Sibley and Monroe (1990), we have employed generally older generic names to clarify our discussion, particularly of taxa that are now commonly lumped in *Hirundo.* All of the species listed in Table 2 are members of the subfamily Hirundininae (true swallows). The other swallow subfamily Pseudochelidoninae (river-martins) consists of only two species, one from central Africa (*Pseudochelidon eurystomina*) and one (possibly extinct) from Thailand (*P. sirintarae*). Unfortunately, we did not have DNA from either of these species.

In choosing taxa for comparison, we tried to include representatives of as many previously recognized genera as possible, especially those whose relationships remain obscure. We also included representatives of all the groups defined by Mayr and Bond (1943). Here we summarize their groups and list the species in each that we compared. Mayr and Bond (1943) divided *Hirundo* into three subgenera: (1) subgenus *Hirundo,* cup-nesting barn swallows (*Hirundo rustica*) and crag martins (*Ptyonoprogne fuligula*); (2) subgenus *Lillia,* rufous-rumped, retort-nest builders (*Cecropis semirufa*); and (3) subgenus *Petrochelidon,* cliff swallows (*Petrochelidon pyrrhonota* and *P. spilodera*). House martins (*Delichon urbica*) were viewed as "an obvious descendant of *Petrochelidon*" (p. 335). Separate from *Hirundo* and allies, Mayr and Bond distinguished a series of hole-nesting groups: (1) bank-martins (*Riparia riparia, R. cincta*), basically an Old World group of four species that excavate their own burrows; (2) rough-winged swallow group (*Stelgidopteryx ruficollis, Neochelidon tibialis*), generally dull-colored, New World birds that nest in crevices or burrows excavated by other species; (3) the *Atticora* group (*Atticora fasciata, Pygochelidon cyanoleuca*), generally blue Neotropical taxa that nest mainly in crevices; (4) tree-swallow group (*Tachycineta bicolor*), New World tree-hole adopters; and (5) purple-martin group (*Progne subis,*

TABLE 2. List of study species, DNA preparations, and tissue sources. Order of taxa follows Sibley and Monroe (1990). Commonly used alternative generic and superspecific names noted in brackets. Sample number refers to Academy of Natural Science's tissue-catalog and DNA-extraction number. Locality/collection refers to collecting site and collector. Asterisks mark preparations radio-labeled and used as tracer DNA.

Name	Sample number	Locality/collection[a]
Tachycineta bicolor (Tree Swallow)	423*, 854, 857, 860, 861/62	USA/S&W, YPM
Phaeoprogne [*Progne*] *tapera* (Brown-chested Martin)	284, 285*	Peru/LSU
Progne [*subis*] *chalybea* (Grey-breasted Martin)	287, 288*, 290, 291	Bolivia/LSU
Pygochelidon [*Notiochelidon*] *cyanoleuca* (Blue-and-white Swallow)	296, 297, 298, 299*	Peru, Venezuela/LSU
Atticora fasciata (White-banded Swallow)	300, 3706*, 3707, 3708	Bolivia, Peru/LSU
Neochelidon tibialis (White-thighed Swallow)	302*, 303, 304, 305*	Bolivia, Venezuela/LSU
Stelgidopteryx [*ruficollis*] *serripennis* (Northern Rough-winged Swallow)	451*, 452, 453, 454*	USA/S&W, YPM
S. [*ruficollis*] *ruficollis* (Southern Rough-winged Swallow)	309, 313, 314, 464, 465	Bolivia, Peru/LSU Ecuador/WFVZ
Cheramoeca leucosternus[b] (White-backed Swallow)	2895*	Australia/MV
Riparia [*riparia*] *riparia* (Sand Martin [Bank Swallow])	413, 416*, 417, 418*, 431, 450*	USA/S&W, YPM
R. [*Neophedina*] *cincta*[c] (Banded Martin)	3025, 3026*, 3028, 3029	South Africa/S&W
Phedina borbonica[b] (Mascarene Martin)	3709*	Madagascar/FMNH
Pseudhirundo [*Hirundo*] *griseopyga* (Grey-rumped Swallow)	3075*, 3077	South Africa/S&W
Ptyonoprogne [*Hirundo*] *fuligula* (Rock Martin)	3050, 3052*, 3055	South Africa/S&W
Hirundo [*rustica*] *rustica* (Barn Swallow)	421*, 424, 425, 426, 2984, 2989	USA/YPM South Africa/S&W
Cecropis [*Hirundo*] *semirufa*[c] (Rufous-chested Swallow)	2976*, 2980, 2981	South Africa/S&W
Petrochelidon [*Hirundo*] *spilodera* (South African [Cliff-] Swallow)	2468, 2969, 2971/73, 2974/75*	South Africa/S&W, TM
Haplochelidon [*Petrochelidon*] *andecola*[b,d] (Andean Swallow)	315*	Peru/LSU
Petrochelidon [*Hirundo*] *pyrrhonota* (Cliff Swallow)	1975, 1976, 1977*, 1988, 1989	USA/YPM
Delichon [*urbica*] *urbica* (Northern House-Martin)	1008, 1009*, 2990, 2998	France/UM South Africa/S&W
Psalidoprocne [*pristoptera*] *holomelas* (Black Sawwing)	3058, 3059, 3060*, 3061/62	South Africa/S&W
Parus bicolor (Tufted Titmouse)	880, 882, 1990, 1992*, 1993, 2045*	USA/ANS

[a] Collection abbreviations: (ANS) Academy of Natural Sciences of Philadelphia; (FMNH) Field Museum of Natural History; (LSU) Museum of Natural Science, Louisiana State University; (MV) Museum of Victoria, Australia; (S&W) Sheldon and Winkler; (TM) Transvaal Museum; (YPM) Yale Peabody Museum; (UM) Université de Montpellier, France; (WFVZ) Western Foundation of Vertebrate Zoology.

[b] Radio-labeled and not included in complete 18 × 18 matrix.

[c] Roberts (1922) designated generic names *Neophedina* for *Riparia cincta*, and *Phoenichelidon* for *Hirundo semirufa*.

[d] Alternative generic names for *Haplochelidon andecola* also include *Hirundo* and, more recently, *Stelgidopteryx* (Parkes 1993, Turner and Rose 1989, Sibley and Monroe 1990).

Phaeoprogne tapera), another group of New World hole adopters. Mayr and Bond also identified several problematic taxa that did not fit well into any of these categories. Of these, we compared the Australian White-backed Swallow (*Cheramoeca leucosternus*), African Grey-rumped Swallow (*Pseudhirundo griseopyga*), African sawwings (*Psalidoprocne holomelas*), Mascarene Martin (*Phedina borbonica*), and Andean Swallow (*Haplochelidon andecola*).

As an outgroup we used Tufted Titmouse (*Parus bicolor*). This species was selected for two reasons. Preliminary DNA-DNA hybridization studies (Sibley and Ahlquist 1990:fig. 380) indicated that titmice are about as close genetically to swallows as any other group of sylvioid passerines. Second, we have been studying titmouse phylogeny using DNA-DNA hybridization (Sheldon et al. 1992).

Our selection of taxa for comparisons was constrained by the availability of tissues for DNA extraction. We did not have DNA of some particularly interesting swallows, including Blue Swallow (*Hirundo atrocaerulea*), Brazza's Martin (*Phedina* ["*Phedinopsis*"] *brazzae*), Tawny-headed Swallow (*Stelgidopteryx* ["*Alopochelidon*"] *fucata*) and, as mentioned above, river-martins. We were also limited in the number of taxa that could be compared in this study. For the most reliable results, DNA-DNA hybridization requires replicate pairwise measurements among all species (Springer and Krajewski 1989a, Bledsoe and Sheldon 1990, Lanyon 1992), but as the number of species under examination grows, the number of required comparisons increases geometrically. This is the "n^2 problem" described by Barrowclough (1992). Moreover, our DNA-hybrid fractionating machine could process only 35 hybrids at a time. Thus, to achieve an adequate number of replicates, we were limited to a matrix of 17 taxa (i.e. two replicates per machine run). In the end, we constructed a complete set of pairwise comparisons among 17 species of swallows and *Parus bicolor*. We also completed a set of one-way comparisons among these taxa and three additional species (*Cheramoeca leucosternus*, *Phedina borbonica*, and *Haplochelidon andecola*), tissues of which were received late in our study.

Biochemistry.—Our method of DNA-DNA hybridization was based on that of Sibley and Ahlquist (1990) and Sheldon et al. (1992). DNA was obtained from frozen tissues (−80°C) or erythrocytes stored in 10% EDTA, extracted with pronase/phenol/chloroform, RNAsed, and sonified to about 500-base-pair lengths. Single-copy DNA was prepared to C_0t 1000 (Werman et al. 1990) and oligo-labeled with tritium (Feinberg and Vogelstein 1983). Hybrids were formed with 20,000 to 50,000 disintegrations per minute of radio-labeled single-copy nuclear DNA tracer (i.e. about 0.002 μg) and 20 to 30 μg of nonlabeled target DNA (tracer: target about 1:10,000) and incubated at 60°C in 0.48 M phosphate buffer to C_0t of 22,000 or more. They were fractionated on 1.0-ml hydroxlapatite (HAP) columns placed in a thermal-elution device similar to those of Sibley and Ahlquist (1981) and Kirsch et al. (1990). Fractions of swallow/swallow hybrids were taken at 60°C and 72° to 94°C in 2.0°C increments by pumping 4 ml of 0.12 M sodium phosphate buffer through the HAP columns. Because of the greater genetic distances involved, fractions of swallow/*Parus* comparisons were taken over a wider range (60° and 68°–94°C), but still in 2.0°C increments.

Experimental design and data analysis.—Each fractionation "experiment" consisted of a maximum of 35 hybrids. These hybrids were of two main types: homoduplexes (i.e. control hybrids formed from labeled and unlabeled DNA of a single individual); and heteroduplexes (i.e. hybrids of DNA from two different individuals of the same or different species). To control for sample-preparation bias, we hybridized a series of different DNA preparations of each species (Table 2).

To construct a complete matrix among 17 species of swallows and *Parus bicolor*, we ran two kinds of experiments. Ingroup experiments included only swallows and comprised 2 homoduplex, 1 intraspecific heteroduplex, and 32 interspecific heteroduplex hybrids. This design permitted the measurement of two replicates of 17 species of swallow per experiment. To obtain a total of four replicates for each pairwise comparison, we labeled all 17 swallow species and ran two experiments for each labeled sample. In outgroup experiments, *P. bicolor* was hybridized with swallows. The reason for separating ingroup from outgroup experiments was that outgroup comparisons required more temperature fractions and, thus, were more expensive to run than ingroup comparisons. The three species that were not part of the complete 18 × 18 matrix (*Cheramoeca leucosternus*, *Phedina borbonica*, and *Haplochelidon andecola*) were compared with all other species, but usually only as radio labeled tracer.

The hybrid indexes (T_m, $T_{50}H$, modified Fermi-Dirac mode, ΔT_m, $\Delta T_{50}H$, Δmode, and normalized percent reassociation [NPR]) were calculated as described in Sheldon and Bledsoe (1989). Delta values are genetic dissimilarities (distances) computed by subtracting heteroduplex values from the average homoduplex value. Uncorrected mean values for indexes and distances are provided in the Appendix. When compiling these means, we excluded data from entire experiments if we had major mechanical failure with the fractionator or if homoduplex T_ms were low (<82°C), because such low values suggest short-strandedness of labeled DNA (Springer and Kirsch 1991). We excluded individual hybrids if leakage, mechanical problems, or possible misidentification or mixing of specimens were discovered in the course of their preparation or fractionation. Because leakage during incubation caused unusually low percents of hybridization, we excluded all swallow/swallow hybrids with less than 70% NPR, even if we did not

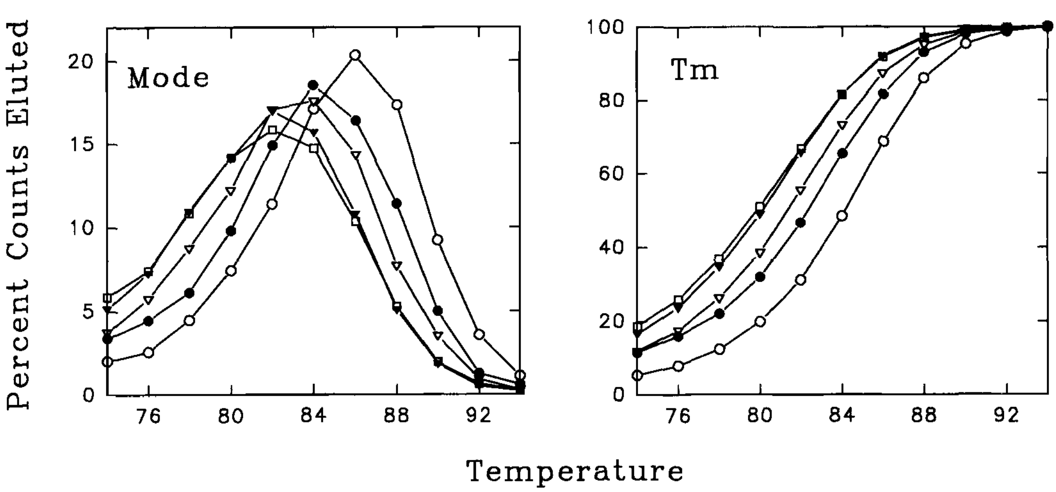

Fig. 1. Examples of differential and cumulative DNA-hybrid melting curves: (open circles) *Petrochelidon spilodera*; (closed circles) *P. pyrrhonota*; (open triangles) *Hirundo rustica*; (closed triangles) *Tachycineta bicolor*; and (open squares) *Pseudhirundo griseopyga*.

detect leakage. Similarly, we excluded all swallow/*Parus* hybrids with NPR less than 50%. We also excluded all hybrids that showed bimodality in their melting distributions such that the fraction count of the secondary peak was more than 100 disintegrations per minute larger than counts at adjacent fractionation temperatures. In the end, about 10% of the hybrids were excluded.

We used ΔT_m as the principal measure of phylogeny. ΔT_m and Δmode yield virtually identical results and are highly correlated (Figs. 1 and 2), but ΔT_m is the more robust of the two distances. It relies on data distributed over the entire melting curve, whereas Δmode is influenced most significantly by data in the immediate vicinity of the melting-distribution peak. More importantly, ΔT_m is better characterized than the mode, having been calibrated numerous times against sequences of known divergence (e.g. Caccone et al. 1988, Springer et al. 1992). While known in some cases to yield remarkably accurate estimates of long genetic distance (Goodman et al. 1990), $\Delta T_{50}H$ is generally not as reliable and conservative a measure as either ΔT_m and Δmode when applied to short genetic distances (e.g. Sheldon and Bledsoe 1989, Schmid and Marks 1990). It confounds two measures (T_m and NPR), and the latter carries a large error (see Table 3).

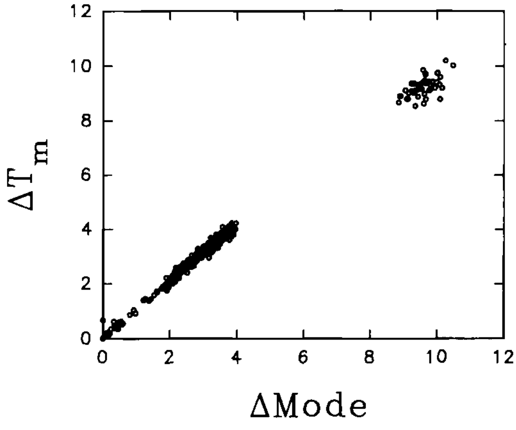

Fig. 2. Plot of Δmode versus ΔT_m. Points represent comparisons of mean values from Appendix.

To construct our final estimate of swallow phylogeny, we corrected ΔT_m to $\Delta T_m C$ in a two-step process. First, ΔT_m was converted to percent sequence divergence (d) using the factor of Springer et al. (1992):

$$d = 1.18\ (\Delta T_m/100). \qquad (1)$$

Then d was adjusted for multiple mutations at single base sites with the equation of Jukes and Cantor (1969), assuming a 60:40 AT:GC base pair ratio (Arthur and Straus 1978, Epplen et al. 1978, Swofford and Olsen 1990):

$$\Delta T_m C = (100)(-0.74)\ln(1 - 1.35[d]). \qquad (2)$$

Correction to $\Delta T_m C$ was intended to increase the additivity of the distance values, thereby improving the adherence of the data to the additivity assumption of tree-building algorithms (Springer and Krajewski 1989a, b).

To fit distances to a tree-branching pattern, we used the "Fitch" additive-distance program of PHYLIP 3.4 (Felsenstein 1989). Options were set so that trees were built by unweighted least-squares regression (Cavalli-Sforza and Edwards 1967) and the input order of the taxa was random. "Fitch" does not assume a con-

TABLE 3. Summary of matrices subjected to bootstrap analysis. Labeled *Cheramoeca leucosternus, Phedina borbonica,* and *Haplochelidon andecola* were not included in bootstrapped matrices because complete sets of pairwise comparisons were lacking for these species.

No.	Matrix size	Distance type	No. bootstraps	Description of taxa and notes
1	18 × 18	$\Delta T_m C$	1,000	See Figure 4
2	18 × 18	ΔT_m	100	
3	18 × 18	Δmode	100	
4	18 × 18	ΔT_m	1,000	Using "symboot"[a]
5	18 × 18	Δmode	1,000	As in no. 4
6	17 × 17	ΔT_m	100	*Parus* omitted
7	17 × 17	Δmode	100	As in no. 6
8	7 × 7	ΔT_m	100	Including *Hirundo, Petrochelidon* (2 species), *Cecropis, Ptyonoprogne, Delichon, Pseudhirundo*
9	7 × 7	Δmode	100	As in no. 8
10	10 × 10	ΔT_m	100	Omitting *Hirundo, Petrochelidon* (2 species), *Cecropis, Ptyonoprogne, Delichon, Psalidoprocne, Parus*
11	10 × 10	Δmode	100	As in no. 10
12	10 × 10	ΔT_m	100	As in no. 10, but with *Petrochelidon spilodera* replacing *Pseudhirundo*
13	10×10	Δmode	100	As in no. 12
14	9 × 9	ΔT_m	100	As in no. 10, but also omitting *Progne*
15	9 × 9	Δmode	100	As in no. 14

[a] "Symboot" is program of A. Dickerman (pers. comm.) that smoothes reciprocal discrepancies via method of Sarich and Cronin (1976; e.g. see Springer and Kirsch 1989).

stant or monotonic rate of evolution. Unweighted least squares is the appropriate method when variance does not increase with genetic distance, as is the case in this and most DNA-DNA hybridization data sets (e.g. Sheldon 1987a, Werman et al. 1990).

The robustness of branching patterns was tested by bootstrapping the 18 × 18 matrix and various of its subsets (see Table 3). Trees were then constructed from the bootstrap pseudomatrices with "Fitch" and, from these trees, a majority-rule phylogeny was formed with PHYLIP's "Consense" program (Krajewski and Dickerman 1990, Dickerman 1991). We also jackknifed our data by systematically removing one taxon at a time and reestimating the tree (Lanyon 1985). As noted by Krajewski and Dickerman (1990), bootstrapping and jackknifing complement one another; jackknifing tests tree stability at the level of matrix columns and rows, and bootstrapping tests at the level of matrix cells.

RESULTS

Characterization of data.—A total of 1,566 DNA hybrids consisting of 20,516 melting-curve fractions contributed to the final phylogenetic estimate. DNA of 80 individuals of swallows and 6 of *P. bicolor* were used in the comparisons. Mean values of the melting-curve indexes (T_m, mode, and $T_{50}H$), NPR, and genetic distances (ΔT_m, Δmode, and $\Delta T_{50}H$) are listed in the Appendix. Table 4 summarizes standard deviations for all indexes. As is usually the case, mode and T_m are less variable than NPR and its dependent $T_{50}H$ (Sheldon 1987a, b, Sarich et al. 1989, Sheldon and Bledsoe 1989; but see Marshall and Swift 1992). Reciprocal measurement discrep-

TABLE 4. Summary statistics of hybrid stability, reassociation, and distance values, and of matrix asymmetry.

Index	T_m	ΔT_m	Mode	Δmode	$T_{50}H$	$\Delta T_{50}H$	NPR
Mean SD	0.31	0.23	0.27	0.21	0.56	0.52	4.82
Matrix asymmetry[a]	—	4.45	—	3.62	—	12.02	—

[a] Mean percent nonreciprocity for 18 × 18 matrix (Sarich and Cronin 1976, Springer and Kirsch 1989).

TABLE 5. Reciprocal ΔT_m measurement discrepancies.

	Species																
Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1 *T. bicolor*																	
2 *P. tapera*	−0.42																
3 *P. chalybea*	0.50	0.32															
4 *N. cyanoleuca*	0.24	−0.16	−0.60														
5 *A. fasciata*	−0.02	0.48	0.04	0.20													
6 *N. tibialis*	0.38	−0.14	−0.24	0.22	−0.06												
7 *S. ruficollis*	0.13	0.24	−0.03	−0.32	−0.14	0.07											
8 *R. riparia*	−0.10	0.04	−1.03	−0.15	−0.22	−0.44	0.12										
9 *C. cincta*	−0.36	0.19	−0.66	0.38	−0.13	−0.04	−0.28	0.16									
10 *P. griseopyga*	0.09	0.15	−0.52	−0.35	−0.40	−0.55	−0.61	0.39	−0.18								
11 *P. fuligula*	−0.17	0.70	−0.47	0.46	−0.14	0.29	0.18	0.33	0.43	0.13							
12 *H. rustica*	0.05	0.03	−0.77	−0.21	0.01	0.07	−0.08	−0.11	0.21	0.10	0.11						
13 *C. semirufa*	−0.43	−0.10	−0.42	−0.15	0.07	−0.00	−0.30	0.08	−0.06	0.41	−0.32	−0.13					
14 *P. spilodera*	−0.30	−0.31	−0.79	−0.23	−0.48	−0.44	0.00	0.15	−0.29	−0.33	−0.49	−0.27	−0.30				
15 *P. pyrrhonota*	−0.44	−0.10	−0.27	−0.08	−0.15	−0.16	−1.17	−0.09	−0.37	−0.02	−0.53	−0.23	−0.11	0.04			
16 *D. urbica*	−0.01	−0.25	−0.75	−0.51	−0.32	−0.41	−0.32	0.06	−0.33	0.02	−0.45	−0.20	−0.19	0.38	−0.17		
17 *P. holomelas*	−0.09	−0.05	−0.75	−0.12	−0.57	−0.53	−0.46	0.09	−0.28	0.15	−0.52	−0.25	0.22	0.42	0.27	−0.05	
18 *Parus bicolor*	0.40	−0.13	−0.90	0.74	−0.33	−0.03	0.67	0.81	0.48	0.86	0.71	−0.21	−0.30	0.20	0.39	0.05	−0.78

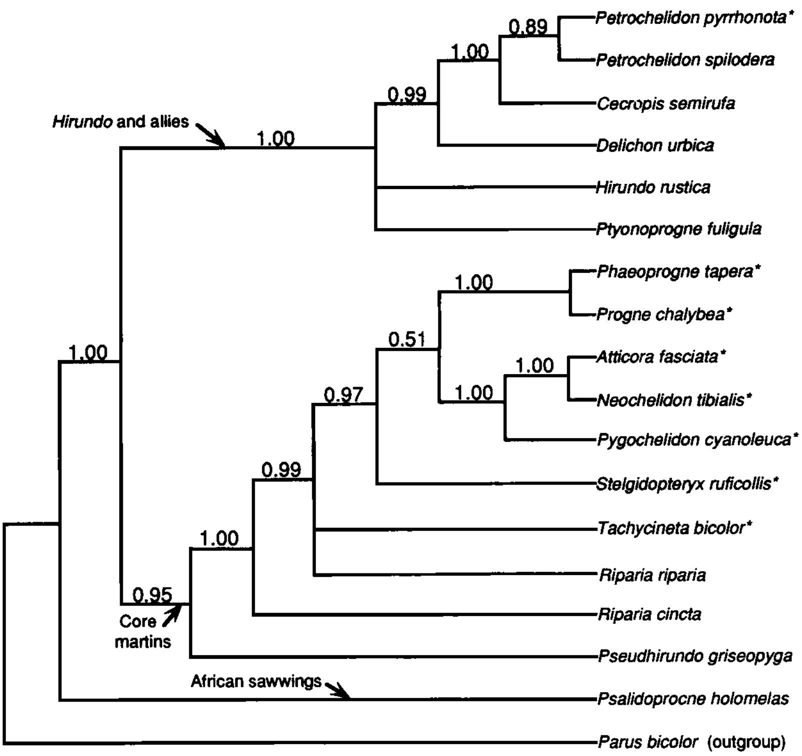

Fig. 3. Majority-rule consensus tree of 18 × 18 $\Delta T_m C$ matrix computed by "Consense" program of PHYLIP 3.4 from 1,000 bootstrap "Fitch" trees.

ancy values (Table 5) are also summarized in Table 4.

Rates of evolution.—Rates of swallow evolution were measured by the outgroup relative rate test of Sarich and Wilson (1967). Distances to and from *Parus bicolor* and the swallow species displayed significant differences (Kruskal-Wallis one-way ANOVA chi-square approximation = 37.68, $P = 0.007$), which suggests variability in rates. All rate tests of DNA hybridization data, however, suffer because of the nonindependence of the distances; that is, sets of distance measurements are linked by common homoduplex references. There is the possibility, therefore, of measurement errors causing systematic patterns that appear as rate variation.

Phylogeny.—Figure 3 is a majority-rule consensus tree built after bootstrapping the 18 × 18 $\Delta T_m C$ matrix 1,000 times. This tree is an unusually well-resolved molecular estimate of avian phylogeny (e.g. Lanyon 1985, Sheldon 1987b, Edwards et al. 1991, Sheldon et al. 1992), but its degree of resolution relates only to the taxa we sampled. If we were to compare different outgroup or ingroup species, the branching pattern might change (e.g. Lanyon 1985). To test such taxic effects given the data at hand, we built trees using subsets of the species (Table 3). In doing so, we made assumptions about monophyly of groups and designations of outgroups. For example, we assumed, based on traditional classification and their derived state of pure mud-nest building, that *Hirundo, Petrochelidon, Cecropis, Delichon,* and *Ptyonoprogne* represented a monophyletic group. We then used one of these taxa as outgroup in estimating trees for nonmud-nesting swallows, and vice versa. All such tests, as summarized in Table 3, yielded trees that were consistent with the branching of the 18 × 18 consensus tree (Fig. 3), if nodes that are supported by fewer than 89% of the bootstraps are collapsed. In addition, a strict-consensus tree produced by jackknifing the 18 × 18 matrix (Lanyon 1985) was identical to the 89% majority-rule bootstrap tree. These analyses indicate that the DNA-DNA hybridization phylogeny is remarkably insensitive to changes in outgroup and ingroup taxa. We were con-

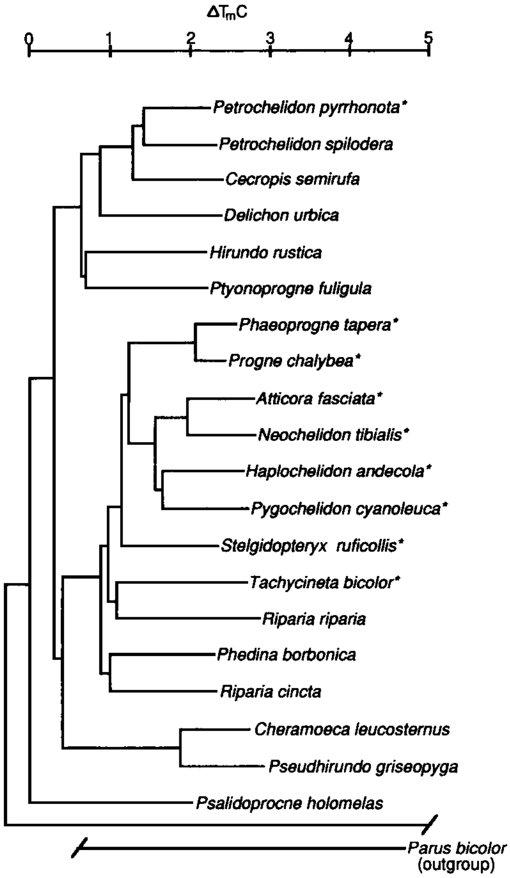

Fig. 4. Best-fit least-squares tree computed by "Fitch" program of PHYLIP 3.4 from ΔT_mC values using 21 labeled taxa. Negative branches not allowed, P set to 0, and sum of squares equal to 139.72.

cerned particularly about the selection of *Parus bicolor* as outgroup for the study. This choice, however, while possibly affecting the branching pattern of the three major clades (see below), clearly did not affect branching within lower-level clades.

Figure 4 is our best-fit 21-taxon "Fitch" tree, which includes the (mainly) one-way comparisons of *Cheramoeca, Phedina borbonica,* and *Haplochelidon.* It is consistent with Figure 3, but the robustness of the branching pattern could not be tested because of the lack of a complete set of reciprocal data.

Three fundamental groups are defined in Figures 3 and 4: (1) *Hirundo* and allies, represented by *Hirundo rustica, Petrochelidon spilodera, P. pyrrhonota, Cecropis semirufa, Delichon urbica,* and *Ptyonoprogne fuligula;* (2) the "core martins," which is the sister taxon of *Hirundo* and allies and includes all the endemic New World genera, as well as some Holarctic, African, Asian, and Australian taxa; and (3) the African sawwings (represented by *Psalidoprocne holomelas*), which appear as the sister taxon to the rest of the hirundinines.

Within the clade of *Hirundo* and allies, *Hirundo* and *Ptyonoprogne* are basally branching taxa; *Delichon, Cecropis,* and *Petrochelidon* are more recently derived. The precise relationships of *Hirundo* and *Ptyonoprogne* to one another and to the other members of this group have not been resolved. In about 40% of the bootstraps, *Hirundo* and *Ptyonoprogne* were linked together on a single branch; at other times they switched back and forth as the sister taxon to *Delichon, Cecropis,* and *Petrochelidon.* In contrast, the relationships of the three latter genera are clearer. The African and American cliff swallows, *P. spilodera* and *P. pyrrhonota,* are almost certainly sister taxa, despite their markedly disjunct distribution. They occur on the same branch in all of the jackknife trees and in most bootstrap trees. In the bootstrap analyses listed in Table 3, they cooccur the following percentages of the time: (analysis 1) 89%, (2) 89%, (3) 99% (4) 81%, (5) 98% (6) 87%, (7) 98%, (8) 93%, and (9) 96%.

The core martins contain a well-resolved terminal clade of New World endemics, *Pygochelidon, Neochelidon, Atticora, Haplochelidon, Phaeoprogne, Progne,* and *Stelgidopteryx.* Among these taxa, only the positions of *Stelgidopteryx* and the *Progne*/*Phaeoprogne* clade are ambivalent. In most analyses, *Stelgidopteryx* occurs as the outgroup to the other taxa (e.g. in 51% of the 18 × 18 bootstrap trees and 16 of 17 jackknife trees). The next outgroup of this terminal New World group is also unresolved. The Holarctic *Riparia riparia* and the New World endemic *Tachycineta bicolor* occur either as sister taxa to the clade of New World endemics or to one another. In all analyses, *Riparia cincta* is the sister taxon of the New World endemics (including *Tachycineta*) plus *Riparia riparia.* In the 21-taxon tree (Fig. 4), a short branch links *Riparia cincta* and *Phedina borbonica,* but the stability of this branch has not been tested. Finally, *Pseudhirundo* and *Cheramoeca* join to form a branch that is the sister to all the other core martins.

Psalidoprocne holomelas always appears as the outgroup to the other hirundinines in "Fitch" tree analyses. However, in some "Kitsch" analyses, which assume a constant rate of evolution, *P. holomelas* switches position with the clade comprising *Cheramoeca* and *Pseudhirundo.*

DISCUSSION

ASSESSMENT OF MAYR AND BOND (1943)

The groups of genera outlined by Mayr and Bond (1943) based on nesting habits and plumage patterns conform to our clades to a remarkable degree. The only discrepancy is their placement of *Neochelidon tibialis.* They grouped it with *Stelgidopteryx,* and we found it to be more closely related to *Pygochelidon* and *Atticora.* Our results even support several of Mayr and Bond's more subtle assertions or suggestions. For example, they thought that the Australian *Cheramoeca* and African *Pseudhirundo* might be distantly related to one another based on their "tunneling" behavior and color patterns. We have found just such a relationship between these highly disjunct, monotypic genera. Mayr and Bond indicated that the generic allocation of *Haplochelidon* hinged on its nesting habits; if it were found not to build a mud nest, then it would belong with the New World endemic genera rather than in *Petrochelidon.* We now know that it does not build a mud nest and that it is more closely related to *Pygochelidon, Atticora,* and *Neochelidon* than to *Hirundo* and allies (for a thorough discussion, see Parkes 1993). Mayr and Bond also remarked on the difficulty of allocating such taxa as *Phedina, Cheramoeca/Pseudhirundo,* and *Psalidoprocne* to larger groups. In light of our molecular data, it is clear that these taxa were difficult to place because they are relatively highly diverged and without close relatives. Finally, Mayr and Bond divided swallows into Old and New World groups, and our results concur; the New World endemic taxa are confined to the terminal branches of the core martin clade.

Our results do not support the rationale used by Mayr and Bond, however, to describe the relative evolutionary advancement of major swallow groups. Mayr and Bond regarded the adoption of natural hollows as the most likely primitive nesting strategy, followed by the excavation of holes and finally building of mud nests. Instead, we found hole excavators (*Psalidoprocne, Pseudhirundo,* and *Riparia*) to be the most basally branching ("primitive") swallows and that mud nesters (*Petrochelidon, Cecropis, Delichon, Hirundo,* and *Ptyonoprogne*) and hole adopters (*Pygochelidon, Neochelidon, Atticora, Phaeoprogne, Progne, Stelgidopteryx,* and probably *Tachycineta*) have arisen independently from hole excavators. See Winkler and Sheldon (1993) for a formal analysis of nest-type evolution.

Mayr and Bond also implied that mud nesting progressed evolutionarily from simple cups to more ornate structures. Our data suggest that the complexity of nests is tied to phylogeny. *Hirundo* and *Ptyonoprogne,* which build cup nests, branched earlier than *Delichon,* which builds an enclosed nest. *Delichon,* in turn, branched earlier than *Cecropis* and *Petrochelidon,* which build retort nests with entrance tunnels. By itself, our phylogeny does not indicate a progression through time; the same number of character-state changes is required to achieve the distribution of nest types on the phylogeny whether the primitive nest was cup- or retort-shaped. However, the observation in living birds that the construction of cups precedes enclosure into closed cups or retorts, provides developmental evidence in support of Mayr and Bond's view of an evolutionary progression from simple to complex nests (Winkler and Sheldon 1993).

TAXONOMIC HIGHLIGHTS

Barn Swallows and allies.—In most modern classifications, *Hirundo* encompasses the former genera *Petrochelidon, Cecropis,* and *Ptyonoprogne,* but excludes *Delichon.* Mayr and Bond (1943) and subsequent classifiers have suggested, however, that *Delichon* and *Hirundo* should be lumped. Wolters (1952) for example, like Mayr and Bond (1943), discounted the importance of tarsal feathering in *Delichon* as a distinguishing characteristic and emphasized instead the occurrence of interspecific hybridization between species of *Hirundo* and *Delichon* as evidence of their close relationship. Our results support this view, as *Delichon, Petrochelidon,* and *Cecropis* have been found to be monophyletic. Interestingly, *Delichon* replaces the two latter genera geographically (and probably adaptively) in Europe and northern Asia (Turner and Rose 1989). Wolters also suggested that *Hirundo* (sensu stricto) and *Ptyonoprogne* might be closer to one another than to *Delichon, Cecropis,* and *Petrochelidon.* Our data, unfortunately, do not indicate the precise sister-group relationships of *Hirundo rustica* and *Ptyonoprogne fuligula* vis-a-vis the other three genera. Even if nest-type data are mapped onto the phylogeny, a clearer picture of the *rustica* and *fuligula* sister relationships does not emerge, because their cup nesting is the apparent primitive state.

Endemic New World genera.—The interrelationships of *Pygochelidon, Neochelidon, Atticora, Stelgidopteryx,* and other endemic New World taxa are particularly poorly known. On the basis of plumage, Brooke (1974) grouped *Notiochelidon, Pygochelidon, Neochelidon,* and *Atticora* together in an "*Atticora*" group. Turner and Rose (1989) presented a somewhat different arrangement. They grouped the four species that had been distributed among *Notiochelidon, Orochelidon,* and *Pygochelidon* into *Notiochelidon,* citing similarities in their body proportions, plumage, and nesting. They placed the enlarged *Notiochelidon* next to *Atticora* in their linear classification and separated these two genera from *Neochelidon,* which they believed to be closely related to *Stelgidopteryx* and *Alopochelidon.* Their arrangement of taxa resembles Mayr and Bond's (1943) in that it distinguishes the nest-adopting species with marked amounts of blue in their plumages (e.g. *Pygochelidon* and *Atticora*) from the browner nest adopters (e.g. *Neochelidon* and *Stelgidopteryx*). Our results are more in accord with Brooke's (1974) arrangement. We found that there is no subdivision of these taxa based on plumage color (i.e. the dull-colored *Neochelidon* appears to be more closely related to the blue *Atticora* and *Pygochelidon* than to the dull *Stelgidopteryx*).

A species that has often been placed in *Hirundo* or *Petrochelidon* (e.g. Peters 1960, Turner and Rose 1989, Sibley and Monroe 1990), but which is clearly more closely related to the endemic New World genera, is the Andean Swallow (*Haplochelidon andecola*). This dull-colored blue-backed hole adopter is the sister taxon of *Pygochelidon* in our tree. As mentioned above, Mayr and Bond (1943) indicated that the affinities of this species would be clarified once its nesting was described. Parkes (1993) has reviewed the taxonomic issues in detail.

The genera *Progne* and *Phaeoprogne* have always been thought to be closely related. The monotypic *Phaeoprogne* was originally erected to emphasize its differences from *Progne*: similar sexes, lack of metallic blue in its plumage, a more slender bill, a less deeply forked tail with broader plumes, weaker feet, and more extensive feathering on the inner side of the upper tarsus (Zimmer 1955). Turner and Rose (1989), however, believed these characteristics to be of minor importance and merged the two genera into *Progne.* Our results indicate a close relationship between *Progne chalybea* and *Phaeoprogne tapera.* The distance between them was the shortest of any two genera we compared (ΔT_m 0.75) and typical of close congeners (e.g. *Stegidopteryx ruficollis* to *S. serripennis* is 0.64; *Petrochelidon spilodera* to *P. pyrrhonota* is 1.47; see Appendix). Given the monophyly and closeness of *Progne* and *Phaeoprogne,* we agree with Turner and Rose (1989) that these genera should probably be lumped.

Tachycineta, represented in our phylogeny by *T. bicolor,* was the only endemic New World genus that did not group unambiguously with the other New World endemics. However, if its nesting behavior (viz. hole adoption) is taken into account and treated as a synapomorphy, then *Tachycineta* becomes the sister taxon of all the other New World endemic genera (Winkler and Sheldon 1993). Further genetic work on the other *Tachycineta* species and their inter- and intrageneric relationships is underway.

Other taxa.—With the exception of *Riparia riparia,* which is Holarctic in distribution, the remaining species in our study are Old World taxa. Of the relationships found among them, the most unexpected in terms of traditional classification is the paraphyly of *Riparia riparia* and *R. cincta.* Both species excavate nest cavities in sand banks and are quite similar in plumage. However, *cincta* differs from all other *Riparia* species in overall size, bill and nostril shape, possession of sharp loral bristles, and the extent of its coloniality. On the basis of these differences, Roberts (1922) placed *cincta* in a monotypic genus, *Neophedina,* and it is for this reason we included it in our study. In addition to these morphological and behavioral differences, we have found *cincta* to be much more highly diverged from *riparia* than is another congener, the Plain Martin (*R. paludicola*): ΔT_m of 2.88 versus 1.4, respectively (unpubl. data). Given the apparent paraphyly of *riparia* and *cincta,* which is supported circumstantially by the other evidence of substantial divergence, we are inclined at this point to agree with Roberts (1922) and recognize *Neophedina* for *cincta.*

In Figure 4, *Riparia cincta* and *Phedina borbonica* appear as sister taxa. Despite the coincidental nature of their alternative generic names (*Phedina* and *Neophedina*), their relationship to one another is not well established. The robustness of the branch linking the two species was not tested because we were unable to complete a set of reciprocal comparisons of *borbonica.* In addition, *borbonica* does not resemble *cincta* in plumage or nesting behavior. Indeed, *borbonica* is a most unusual swallow in several respects. In particular, its nest is apparently unique among swallows. It is an open cup placed in a nook or crevice (e.g. on beams in buildings or among rocks by the coast) and apparently contains no mud, but instead is constructed entirely of vegetable matter (Langrand 1990; R. K. Brooke and T. Schulenberg pers. comm.). The nest does not even resemble that of *borbonica*'s sole putative congener, Brazza's Martin (*Phedina* [*"Phedinopsis"*] *brazzae*), which is placed in a (self-excavated?) tunnel (Turner and Rose 1989). Because of its unusual nest and general plainness, *borbonica* has been described as the "least specialized" or "most primitive" of all swallows (Mayr and Bond 1943, R. K. Brooke pers. comm.). Until DNA of *brazzae* becomes available and more complete comparisons can be made between it, *borbonica,* and the other basally branching core martins, the composition and phylogenetic position of *Phedina* remain uncertain.

Psalidoprocne, the genus of African sawwings, is a relatively large group of about 12 taxa. We have assumed the monophyly of *Psalidoprocne,* based on the synapomorphic serration on the outer web of the first primary and other plumage and behavioral similarities. The inclusion of more species of *Psalidoprocne* in the study, however, would undoubtedly have helped to solidify the position of this genus in the family, as well as reveal interesting phylogenetic structure among the congeners.

COMPARISON WITH SIBLEY AND AHLQUIST'S (1982) RESULTS

The only other molecular study that bears on the generic-level relationships of swallows is the DNA-DNA hybridization work of Sibley and Ahlquist (1982, 1990). They labeled two species of swallow, *Riparia riparia* and *Hirundo rustica,* and hybridized them with a series of swallow and nonswallow species in a study designed primarily to determine the extrafamilial relationships of the Hirundinidae. Their results were summarized as lists of $T_{50}H$s and a phenogram. We have extracted pertinent distances from their tables and juxtaposed them with ours in Table 6.

TABLE 6. Comparison of distances from this study and from Sibley and Ahlquist (1982).

Taxa	Sibley and Ahlquist[a] ($T_{50}H$)	This study[b] T_m	$T_{50}H$
Labeled *Riparia riparia*			
Progne subis	0.7	3.26	3.97
Hirundo rustica	2.4	3.30	3.50
Petrochelidon spilodera	2.5	3.69	4.18
Notiochelidon murina	2.5	—	—
Stelgidopteryx ruficollis	3.0	2.54	3.67
Parus atricapillus	10.8	—	—
Labeled *Hirundo rustica*			
Petrochelidon spilodera	0.5	2.53	3.00
Riparia riparia	2.1	3.41	4.36
Parus bicolor	11.2	8.78	9.33

[a] Each value represents a single hybrid measurement.

[b] Each value represents a mean distance (see Appendix).

For all swallow/swallow hybrids, Sibley and Ahlquist's $T_{50}H$ distances are shorter than ours. To some extent, this shortness may be an artifact of differences in methodology. In the case of labeled *H. rustica,* it almost certainly results from a low-homoduplex melting temperature and consequent distance compression in the Sibley and Ahlquist data (C. Sibley pers. comm.). (The causes and consequences of DNA-hybrid distance compression are described in Sheldon and Bledsoe [1989] and Springer and Kirsch [1991].) Although distracting, this compression does not change the ranking of their distances from ours (e.g. *H. rustica* is closer to *P. spilodera* than to *Riparia*). On the other hand, their labeled *Riparia* distances tell a different story. Their *Riparia/Progne* distance is much shorter than ours ($\Delta T_{50}H$ 0.7 versus 3.97), and their *Riparia/Stelgidopteryx* distance is longer than the *Riparia/Hirundo* and *Riparia/Petrochelidon* distances. The disparity in distance ranking led Sibley and Ahlquist (1982, 1990) to a branching pattern that differs markedly from ours. Their tree places *Stelgidopteryx* as the outgroup to a clade comprising *Hirundo, Petrochelidon, Riparia,* and *Progne.*

Our results are likely to be more trustworthy than Sibley and Ahlquist's for several reasons. We compared many more swallows than they and replicated pairwise measurements (usually) among several individuals of each species to achieve relatively robust estimates of distances among those species, as well as among major clades. Based as they were on nonreplicated comparisons, Sibley and Ahlquist's distances between species were not averages, but single points subject to greater perturbation or error (e.g. as caused by mismeasurement, misidentification of species, or mix-ups of DNA samples). Further, by comparing so few species, Sibley and Ahlquist did not produce replicate estimates of distances among major clades, a process that helps to fortify internodes (again by averaging). Finally, unlike Sibley and Ahlquist, we completed a matrix of pairwise comparisons. Doing so allowed us to avoid phenetic clustering methods and the consequent assumptions of a molecular clock and monophyly of taxa that they require (e.g. Bledsoe and Sheldon 1990, Lanyon 1992, Sheldon and Bledsoe 1993).

ISSUES OF GENERIC CLASSIFICATION

As mentioned at the outset, there is a multitude of poorly defined swallow genera. Even with the enthusiastic lumping of the last 50 years, 10 to 20 genera still remain in common use. This number is in marked contrast to some other sylvioid families (sensu Sibley and Monroe 1990). For example, Paridae (titmice and chickadees) consists of only a single genus, even though it exhibits essentially the same amount of genetic divergence as Hirundinidae among its most distantly related species (Sheldon et al. 1992).

It is our intention eventually to revise the classification of the Hirundinidae so that swallow taxa are monophyletic and the linear arrangement of species reflects phylogeny (e.g. Wiley 1981). A generic revision with these objectives would require, for example, that *Pseudhirundo griseopyga* and *Haplochelidon andecola* be split and separated from *Hirundo* and allies, with which they have often been associated but are not monophyletic. We also believe, in lieu of naming each bifurcation, that the family should be divided into generic groups that reflect basic biological characteristics. Thus, we are inclined to maintain the genera *Petrochelidon*, *Cecropis*, and *Delichon*, based on the characteristics of their nesting. Such splitting would simplify the description of distinct, coherent, and ecologically significant groups. However, before we can undertake this revision, we need to learn a great deal more about the phylogeny of many taxa, especially the speciose genera *Hirundo* (sensu lato) and *Psalidoprocne*, and the poorly understood complex of New World Neotropical endemics.

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APPENDIX. Hybrid indexes ($\bar{x}$ ± SD) for 21 radio-labeled taxa. "hm" and "ht" indicate homoduplex and heteroduplex values, respectively.

	T_m	ΔT_m	$T_{50}H$	$\Delta T_{50}H$	Mode	Δmode	NPR	*n*
			Tachycineta bicolor					
Tachycineta bicolor (hm)	83.82 ± 0.55	0.00	83.82 ± 0.55	0.00	85.81 ± 0.38	0.00	100.00	8
T. bicolor (ht)	83.23 ± 0.29	0.44 ± 0.21	82.68 ± 0.96	0.98 ± 0.88	85.37 ± 0.35	0.38 ± 0.21	91.39 ± 0.33	2
Phaeoprogne tapera	81.52 ± 0.49	2.48 ± 0.14	80.97 ± 0.30	3.03 ± 0.42	83.72 ± 0.33	2.22 ± 0.06	91.80 ± 4.60	6
Progne chalybea	81.63 ± 0.46	2.53 ± 0.13	80.78 ± 1.42	3.39 ± 1.00	83.77 ± 0.20	2.28 ± 0.22	89.58 ± 10.98	4
Pygochelidon cyanoleuca	81.05 ± 0.70	2.81 ± 0.27	79.79 ± 1.00	4.07 ± 0.87	83.26 ± 0.53	2.61 ± 0.31	84.25 ± 9.99	5
Atticora fasciata	81.30 ± 0.42	2.73 ± 0.22	80.88 ± 0.13	3.15 ± 0.51	83.48 ± 0.26	2.53 ± 0.20	93.36 ± 5.15	3
Neochelidon tibialis	81.12 ± 0.82	3.04 ± 0.35	80.59 ± 0.61	3.57 ± 0.43	83.31 ± 0.69	2.74 ± 0.43	91.94 ± 5.14	4
Stelgidopteryx ruficollis	81.79 ± 0.42	2.54 ± 0.26	81.13 ± 0.54	3.19 ± 0.48	83.89 ± 0.32	2.26 ± 0.26	90.29 ± 5.10	7
Riparia riparia	81.26 ± 0.80	2.78 ± 0.42	80.37 ± 1.23	3.66 ± 1.05	83.49 ± 0.50	2.52 ± 0.34	88.25 ± 7.43	5
R. cincta	81.21 ± 0.30	2.45 ± 0.30	80.82 ± 0.53	2.84 ± 0.53	83.48 ± 0.23	2.27 ± 0.24	93.90 ± 4.00	4
Pseudhirundo griseopyga	79.87 ± 0.10	3.81 ± 0.17	78.86 ± 0.27	4.82 ± 0.22	82.23 ± 0.05	3.56 ± 0.15	87.30 ± 4.60	3
Ptyonoprogne fuligula	80.45 ± 0.09	3.23 ± 0.15	79.76 ± 0.71	3.93 ± 0.73	82.72 ± 0.04	3.06 ± 0.15	90.56 ± 7.19	3
Hirundo rustica	80.60 ± 0.53	3.40 ± 0.23	80.12 ± 0.57	3.88 ± 0.47	82.88 ± 0.40	3.07 ± 0.22	92.85 ± 4.44	6
Cecropis semirufa	80.40 ± 0.07	3.26 ± 0.14	79.36 ± 1.26	4.31 ± 1.23	82.67 ± 0.06	3.08 ± 0.17	87.87 ± 11.68	4
Petrochelidon spilodera	80.24 ± 0.27	3.48 ± 0.27	79.72 ± 0.58	4.00 ± 0.58	82.62 ± 0.08	3.24 ± 0.08	93.12 ± 3.07	2
P. pyrrhonota	80.44 ± 0.31	3.24 ± 0.24	79.42 ± 0.19	4.26 ± 0.19	82.73 ± 0.43	3.05 ± 0.32	86.41 ± 3.51	3
Delichon urbica	80.47 ± 0.43	3.60 ± 0.24	79.69 ± 0.63	4.39 ± 0.77	82.75 ± 0.37	3.26 ± 0.23	89.34 ± 6.75	5
Psalidoprocne holomelas	79.98 ± 0.25	3.68 ± 0.23	79.87 ± 0.39	3.79 ± 0.38	82.26 ± 0.15	3.49 ± 0.15	98.53 ± 2.81	4
Parus bicolor	73.58 ± 0.26	9.73 ± 0.26	69.84 ± 1.15	13.47 ± 1.15	75.40 ± 0.23	10.01 ± 0.23	71.33 ± 3.61	2
			Phaeoprogne tapera					
Tachycineta bicolor	80.37 ± 1.12	2.89 ± 0.37	80.33 ± 1.21	2.91 ± 0.55	82.61 ± 0.94	2.74 ± 0.39	99.39 ± 3.30	4
Phaeoprogne tapera (hm)	83.33 ± 0.64	0.00	83.32 ± 0.70	0.00	85.43 ± 0.51	0.00	100.00	6
P. tapera (ht)	83.22 ± 0.87	0.04 ± 0.13	83.37 ± 0.74	−0.13 ± 0.27	85.34 ± 0.62	0.01 ± 0.15	102.84 ± 2.62	2
Progne chalybea	82.51 ± 1.08	0.89 ± 0.52	82.18 ± 1.31	1.20 ± 0.68	84.66 ± 0.89	0.80 ± 0.48	95.25 ± 7.32	5
Pygochelidon cyanoleuca	81.33 ± 0.63	1.93 ± 0.23	80.91 ± 0.64	2.33 ± 0.79	83.46 ± 0.58	1.90 ± 0.14	94.36 ± 10.57	4
Atticora fasciata	80.97 ± 0.51	2.52 ± 0.31	81.14 ± 0.39	2.34 ± 0.44	83.19 ± 0.40	2.34 ± 0.24	102.80 ± 2.29	3
Neochelidon tibialis	81.19 ± 0.90	2.07 ± 0.25	80.95 ± 0.62	2.29 ± 0.65	83.26 ± 0.86	2.09 ± 0.31	97.36 ± 12.09	4
Stelgidopteryx ruficollis	81.26 ± 0.42	2.24 ± 0.40	81.06 ± 0.14	2.42 ± 0.77	83.63 ± 0.45	1.90 ± 0.19	97.01 ± 5.66	3
Riparia riparia	80.55 ± 0.90	2.71 ± 0.29	80.35 ± 1.01	2.89 ± 0.59	82.80 ± 0.75	2.55 ± 0.23	97.15 ± 5.04	4
R. cincta	80.70 ± 0.74	2.56 ± 0.15	80.58 ± 0.53	2.66 ± 0.45	82.98 ± 0.71	2.37 ± 0.15	98.26 ± 5.04	4
Pseudhirundo griseopyga	79.34 ± 0.76	3.92 ± 0.17	79.18 ± 0.63	4.06 ± 0.28	81.64 ± 0.58	3.71 ± 0.11	97.60 ± 2.56	4
Ptyonoprogne fuligula	80.00 ± 0.52	3.49 ± 0.35	79.32 ± 0.77	4.16 ± 0.57	82.15 ± 0.50	3.39 ± 0.31	90.36 ± 4.76	3
Hirundo rustica	80.18 ± 0.70	3.32 ± 0.27	80.16 ± 0.40	3.32 ± 0.45	82.36 ± 0.51	3.17 ± 0.22	99.61 ± 4.73	3
Cecropis semirufa	80.00 ± 0.92	3.26 ± 0.21	80.05 ± 0.91	3.19 ± 0.30	82.12 ± 0.80	3.23 ± 0.24	100.82 ± 2.01	4
Petrochelidon spilodera	80.45 ± 0.47	3.04 ± 0.37	80.47 ± 0.27	3.01 ± 0.57	82.59 ± 0.47	2.94 ± 0.33	100.19 ± 3.35	3
P. pyrrhonota	80.15 ± 0.80	3.11 ± 0.13	79.59 ± 0.42	3.65 ± 0.52	82.32 ± 0.76	3.03 ± 0.17	92.21 ± 6.66	4
Delichon urbica	80.04 ± 0.58	3.22 ± 0.43	79.95 ± 0.58	3.28 ± 0.84	82.14 ± 0.51	3.21 ± 0.25	99.14 ± 7.12	4
Psalidoprocne holomelas	79.81 ± 0.88	3.45 ± 0.21	80.02 ± 0.79	3.22 ± 0.27	82.03 ± 0.71	3.32 ± 0.18	103.41 ± 1.90	4
Parus bicolor	74.60 ± 0.60	8.88 ± 0.60	68.71 ± 5.32	14.76 ± 5.32	76.07 ± 0.47	9.43 ± 0.47	68.73 ± 14.76	3

APPENDIX. Continued.

	T_m	ΔT_m	$T_{50}H$	$\Delta T_{50}H$	Mode	Δmode	NPR	*n*
			Progne chalybea					
Tachycineta bicolor	80.84 ± 0.21	2.04 ± 0.05	80.77 ± 0.75	2.08 ± 0.58	83.14 ± 0.23	1.93 ± 0.02	99.16 ± 8.93	2
Phaeoprogne tapera	82.30 ± 0.30	0.57 ± 0.34	82.61 ± 0.36	0.24 ± 0.43	84.47 ± 0.29	0.60 ± 0.33	106.29 ± 3.87	4
Progne chalybea (hm)	82.62 ± 0.47	0.00	82.54 ± 0.96	0.00	84.86 ± 0.42	0.00	100.00	7
P. chalybea (ht)	82.91 ± 0.17	−0.04 ± 0.01	83.00 ± 0.38	−0.15 ± 0.20	85.00 ± 0.18	0.07 ± 0.07	101.73 ± 4.03	2
Pygochelidon cyanoleuca	80.92 ± 0.02	1.99 ± 0.12	81.16 ± 0.39	1.73 ± 0.27	83.07 ± 0.09	2.06 ± 0.21	104.70 ± 7.12	3
Atticora fasciata	80.84 ± 0.12	2.03 ± 0.13	81.00 ± 0.26	1.84 ± 0.26	83.11 ± 0.09	1.96 ± 0.15	103.00 ± 2.78	4
Neochelidon tibialis	80.71 ± 0.25	2.16 ± 0.24	80.39 ± 1.10	2.46 ± 1.19	83.05 ± 0.37	2.01 ± 0.35	98.32 ± 15.08	4
Stelgidopteryx ruficollis	80.92 ± 0.90	1.92 ± 0.81	81.13 ± 0.87	1.67 ± 0.80	83.14 ± 0.79	1.86 ± 0.66	103.85 ± 2.30	3
Riparia riparia	80.61 ± 0.04	2.22 ± 0.15	80.52 ± 0.41	2.29 ± 0.49	82.87 ± 0.06	2.13 ± 0.20	98.91 ± 6.52	3
R. cincta	80.94 ± 0.23	1.90 ± 0.10	81.11 ± 0.34	1.69 ± 0.21	83.19 ± 0.21	1.82 ± 0.07	103.30 ± 2.76	3
Pseudhirundo griseopyga	79.52 ± 0.40	3.35 ± 0.28	79.13 ± 1.25	3.72 ± 1.15	81.82 ± 0.37	3.25 ± 0.27	96.23 ± 11.30	4
Ptyonoprogne fuligula	80.12 ± 0.20	2.75 ± 0.31	80.23 ± 0.45	2.61 ± 0.59	82.37 ± 0.22	2.70 ± 0.36	102.65 ± 6.51	4
Hirundo rustica	80.31 ± 0.04	2.60 ± 0.10	80.64 ± 0.20	2.24 ± 0.06	82.48 ± 0.11	2.64 ± 0.10	106.21 ± 3.11	3
Cecropis semirufa	80.01 ± 0.24	2.86 ± 0.34	80.31 ± 0.32	2.53 ± 0.44	82.24 ± 0.17	2.83 ± 0.35	105.42 ± 2.23	4
Petrochelidon spilodera	80.07 ± 0.09	2.80 ± 0.12	80.13 ± 0.48	2.71 ± 0.58	82.27 ± 0.13	2.80 ± 0.12	101.81 ± 7.19	4
P. pyrrhonota	79.98 ± 0.09	2.93 ± 0.09	79.92 ± 0.24	2.97 ± 0.28	82.26 ± 0.12	2.87 ± 0.09	99.18 ± 2.92	3
Delichon urbica	79.87 ± 0.30	3.04 ± 0.26	79.62 ± 0.70	3.26 ± 0.56	82.17 ± 0.27	2.96 ± 0.25	96.85 ± 8.54	3
Psalidoprocne holomelas	79.93 ± 0.42	2.94 ± 0.34	80.14 ± 0.27	2.71 ± 0.29	81.89 ± 0.20	3.18 ± 0.27	103.74 ± 7.32	4
Parus bicolor	73.74 ± 0.44	8.54 ± 0.44	72.01 ± 0.80	10.11 ± 0.80	75.24 ± 0.38	9.34 ± 0.38	82.82 ± 4.18	4
			Pygochelidon cyanoleuca					
Tachycineta bicolor	81.88 ± 0.41	2.57 ± 0.20	82.22 ± 0.24	2.23 ± 0.28	83.94 ± 0.23	2.41 ± 0.20	106.71 ± 4.11	4
Phaeoprogne tapera	82.27 ± 0.31	2.09 ± 0.27	82.65 ± 0.28	1.71 ± 0.46	83.32 ± 0.22	1.96 ± 0.32	108.29 ± 5.27	3
Progne chalybea	81.86 ± 0.59	2.59 ± 0.41	82.04 ± 0.37	2.41 ± 0.37	84.10 ± 0.21	2.25 ± 0.25	103.30 ± 6.12	4
Pygochelidon cyanoleuca (hm)	84.58 ± 0.30	0.00	84.58 ± 0.31	0.00	86.45 ± 0.24	0.00	100.00	7
P. cyanoleuca (ht)	84.07 ± 0.23	0.39 ± 0.18	84.42 ± 0.02	0.04 ± 0.40	85.94 ± 0.16	0.41 ± 0.16	108.84 ± 5.39	2
Atticora fasciata	82.34 ± 0.13	2.02 ± 0.21	82.78 ± 0.03	1.58 ± 0.37	84.34 ± 0.04	1.94 ± 0.23	109.58 ± 3.78	3
Neochelidon tibialis	82.34 ± 0.36	2.12 ± 0.31	82.75 ± 0.32	1.71 ± 0.42	84.35 ± 0.29	2.00 ± 0.28	108.58 ± 3.80	4
Stelgidopteryx ruficollis	82.34 ± 0.47	2.12 ± 0.26	82.58 ± 0.37	1.87 ± 0.20	84.30 ± 0.32	2.06 ± 0.21	104.77 ± 1.93	4
Riparia riparia	81.71 ± 0.29	2.74 ± 0.13	81.92 ± 0.25	2.54 ± 0.43	83.71 ± 0.31	2.64 ± 0.20	104.15 ± 6.30	4
R. cincta	81.63 ± 0.31	2.82 ± 0.12	81.78 ± 0.27	2.67 ± 0.28	83.64 ± 0.16	2.71 ± 0.25	102.81 ± 3.22	4
Pseudhirundo griseopyga	80.70 ± 0.19	3.75 ± 0.19	80.94 ± 0.09	3.51 ± 0.41	82.68 ± 0.12	3.67 ± 0.34	104.62 ± 4.49	4
Ptyonoprogne fuligula	80.89 ± 0.13	3.56 ± 0.33	81.02 ± 0.42	3.43 ± 0.71	82.89 ± 0.26	3.46 ± 0.44	102.54 ± 7.45	4
Hirundo rustica	81.20 ± 0.53	3.25 ± 0.28	81.51 ± 0.49	2.94 ± 0.29	83.26 ± 0.35	3.09 ± 0.30	106.33 ± 1.14	4
Cecropis semirufa	80.79 ± 0.35	3.66 ± 0.36	81.00 ± 0.38	3.46 ± 0.55	82.84 ± 0.30	3.51 ± 0.37	104.13 ± 4.74	4
Petrochelidon spilodera	80.98 ± 0.35	3.48 ± 0.22	81.20 ± 0.29	3.25 ± 0.34	83.03 ± 0.10	3.33 ± 0.21	104.38 ± 3.05	4
P. pyrrhonota	81.09 ± 0.42	3.36 ± 0.18	81.08 ± 0.39	3.37 ± 0.23	83.36 ± 0.22	2.99 ± 0.19	99.75 ± 2.15	4
Delichon urbica	81.29 ± 0.39	3.16 ± 0.20	81.31 ± 0.60	3.14 ± 0.30	83.26 ± 0.20	3.09 ± 0.27	100.93 ± 5.59	4
Psalidoprocne holomelas	80.67 ± 0.44	3.79 ± 0.17	80.94 ± 0.39	3.51 ± 0.20	82.65 ± 0.23	3.70 ± 0.11	105.65 ± 1.89	4
Parus bicolor	74.88 ± 0.27	9.86 ± 0.27	73.01 ± 0.75	11.73 ± 0.75	77.01 ± 0.15	9.58 ± 0.15	81.76 ± 5.36	4

APPENDIX. Continued.

	T_m	ΔT_m	$T_{50}H$	$\Delta T_{50}H$	Mode	Δmode	NPR	*n*
			Atticora fasciata					
Tachycineta bicolor	81.50 ± 0.10	2.75 ± 0.18	79.88 ± 2.96	4.37 ± 2.91	83.69 ± 0.12	2.54 ± 0.13	88.08 ± 18.67	4
Phaeoprogne tapera	82.21 ± 0.29	2.04 ± 0.40	82.15 ± 0.41	2.10 ± 0.53	84.25 ± 0.20	1.98 ± 0.22	99.31 ± 2.31	4
Progne chalybea	82.22 ± 0.19	1.99 ± 0.29	81.96 ± 0.53	2.25 ± 0.65	84.13 ± 0.13	2.09 ± 0.13	96.07 ± 5.42	3
Pygochelidon cyanoleuca	82.43 ± 0.23	1.82 ± 0.32	82.15 ± 0.55	2.10 ± 0.61	84.45 ± 0.15	1.77 ± 0.16	95.67 ± 5.96	4
Atticora fasciata (hm)	84.36 ± 0.22	0.00	84.35 ± 0.23	0.00	86.35 ± 0.22	0.00	100.00	6
A. fasciata (ht)	84.11 ± 0.15	0.13 ± 0.00	84.13 ± 0.08	0.12 ± 0.06	86.06 ± 0.06	0.17 ± 0.04	100.45 ± 1.56	2
Neochelidon tibialis	82.86 ± 0.11	1.39 ± 0.19	82.88 ± 0.29	1.37 ± 0.39	84.83 ± 0.15	1.39 ± 0.14	100.63 ± 4.24	4
Stelgidopteryx ruficollis	82.10 ± 0.19	2.15 ± 0.29	81.75 ± 0.17	2.50 ± 0.27	84.13 ± 0.09	2.10 ± 0.11	94.63 ± 3.29	4
Riparia riparia	81.47 ± 0.13	2.78 ± 0.24	81.08 ± 0.51	3.17 ± 0.62	83.63 ± 0.09	2.59 ± 0.10	94.42 ± 5.51	4
R. cincta	81.44 ± 0.19	2.84 ± 0.30	80.91 ± 0.27	3.37 ± 0.38	83.65 ± 0.14	2.58 ± 0.15	91.98 ± 1.14	3
Pseudhirundo griseopyga	80.54 ± 0.25	3.71 ± 0.34	80.40 ± 0.42	3.85 ± 0.52	82.63 ± 0.19	3.59 ± 0.19	97.69 ± 3.12	4
Ptyonoprogne fuligula	80.88 ± 0.17	3.34 ± 0.24	80.67 ± 0.26	3.55 ± 0.37	83.06 ± 0.15	3.16 ± 0.13	96.71 ± 2.93	3
Hirundo rustica	80.73 ± 0.18	3.48 ± 0.25	80.62 ± 0.23	3.60 ± 0.31	82.96 ± 0.13	3.26 ± 0.12	98.04 ± 1.08	3
Cecropis semirufa	80.45 ± 0.07	3.83 ± 0.06	80.22 ± 0.16	4.06 ± 0.28	82.68 ± 0.09	3.55 ± 0.09	96.43 ± 3.65	3
Petrochelidon spilodera	80.98 ± 0.21	3.27 ± 0.31	80.75 ± 0.41	3.50 ± 0.52	83.07 ± 0.08	3.16 ± 0.09	96.32 ± 3.26	4
P. pyrrhonota	80.77 ± 0.25	3.48 ± 0.35	80.43 ± 0.41	3.82 ± 0.52	82.89 ± 0.13	3.34 ± 0.14	94.79 ± 2.56	4
Delichon urbica	80.82 ± 0.34	3.43 ± 0.43	80.47 ± 0.64	3.78 ± 0.67	82.86 ± 0.21	3.37 ± 0.22	94.95 ± 6.80	4
Psalidoprocne holomelas	80.64 ± 0.07	3.61 ± 0.17	80.66 ± 0.18	3.59 ± 0.29	82.70 ± 0.05	3.53 ± 0.04	100.39 ± 2.23	4
Parus bicolor	75.17 ± 0.20	9.41 ± 0.20	73.21 ± 0.55	11.36 ± 0.55	76.60 ± 0.33	9.98 ± 0.33	79.31 ± 3.39	4
			Neochelidon tibialis					
Tachycineta bicolor	80.62 ± 0.20	2.66 ± 0.19	79.89 ± 0.66	3.38 ± 0.64	82.77 ± 0.19	2.60 ± 0.19	90.02 ± 7.34	4
Phaeoprogne tapera	81.07 ± 0.10	2.21 ± 0.09	80.69 ± 0.25	2.58 ± 0.25	83.25 ± 0.10	2.12 ± 0.12	94.29 ± 2.72	4
Progne chalybea	80.78 ± 0.20	2.40 ± 0.11	80.14 ± 0.32	3.03 ± 0.16	82.95 ± 0.16	2.32 ± 0.15	90.39 ± 3.38	4
Pygochelidon cyanoleuca	81.28 ± 0.18	1.90 ± 0.31	80.24 ± 0.45	2.92 ± 0.38	83.48 ± 0.13	1.80 ± 0.28	86.01 ± 7.22	4
Atticora fasciata	81.62 ± 0.23	1.45 ± 0.17	81.50 ± 0.66	1.53 ± 0.91	83.73 ± 0.15	1.45 ± 0.18	99.46 ± 12.98	4
Neochelidon tibialis (hm)	83.33 ± 0.42	0.00	83.34 ± 0.40	0.00	85.42 ± 0.40	0.00	100.00	8
N. tibialis (ht)	83.52 ± 0.21	−0.24 ± 0.17	82.75 ± 0.50	0.52 ± 0.54	85.69 ± 0.27	−0.32 ± 0.24	88.41 ± 9.98	2
Stelgidopteryx ruficollis	81.02 ± 0.21	2.26 ± 0.24	80.20 ± 0.64	3.08 ± 0.66	83.14 ± 0.22	2.23 ± 0.24	88.71 ± 6.28	4
Riparia riparia	80.44 ± 0.32	2.76 ± 0.36	79.76 ± 0.78	3.42 ± 0.94	82.58 ± 0.44	2.71 ± 0.48	91.70 ± 10.06	5
R. cincta	80.55 ± 0.12	2.72 ± 0.15	79.99 ± 0.09	3.29 ± 0.12	82.68 ± 0.08	2.69 ± 0.09	91.25 ± 1.26	4
Pseudhirundo griseopyga	79.51 ± 0.18	3.67 ± 0.19	79.04 ± 0.41	4.12 ± 0.65	81.74 ± 0.27	3.53 ± 0.23	93.69 ± 6.97	4
Ptyonoprogne fuligula	79.66 ± 0.19	3.50 ± 0.08	78.99 ± 0.73	4.16 ± 0.90	81.90 ± 0.24	3.37 ± 0.16	92.01 ± 10.88	4
Hirundo rustica	79.74 ± 0.33	3.53 ± 0.30	79.37 ± 0.31	3.90 ± 0.31	81.98 ± 0.17	3.38 ± 0.16	94.81 ± 3.18	4
Cecropis semirufa	79.49 ± 0.21	3.70 ± 0.22	79.11 ± 0.58	4.05 ± 0.81	81.72 ± 0.18	3.55 ± 0.24	95.60 ± 10.02	4
Petrochelidon spilodera	79.81 ± 0.23	3.47 ± 0.24	79.19 ± 0.26	4.08 ± 0.27	82.06 ± 0.18	3.31 ± 0.20	91.77 ± 1.94	4
P. pyrrhonota	79.92 ± 0.28	3.26 ± 0.32	78.76 ± 0.16	4.40 ± 0.16	82.03 ± 0.18	3.25 ± 0.25	84.82 ± 3.59	4
Delichon urbica	79.95 ± 0.28	3.32 ± 0.28	78.86 ± 0.50	4.41 ± 0.53	82.12 ± 0.27	3.24 ± 0.28	86.12 ± 7.72	3
Psalidoprocne holomelas	79.57 ± 0.06	3.71 ± 0.04	79.28 ± 0.18	4.00 ± 0.17	81.55 ± 0.11	3.81 ± 0.12	95.68 ± 2.18	4
Parus bicolor	74.59 ± 0.23	9.30 ± 0.23	72.38 ± 1.06	11.51 ± 1.06	75.86 ± 0.04	10.08 ± 0.04	78.33 ± 8.56	4

APPENDIX. Continued.

	T_m	ΔT_m	$T_{50}H$	$\Delta T_{50}H$	Mode	Δmode	NPR	n
			Stelgidopteryx serripennis					
Tachycineta bicolor	82.01 ± 0.16	2.40 ± 0.23	81.50 ± 0.16	2.92 ± 0.20	84.43 ± 0.20	2.23 ± 0.25	92.34 ± 1.04	4
T. albiventer	81.49	3.00	80.97	3.52	83.8	2.92	91.65	1
Phaeoprogne tapera	82.42 ± 0.20	2.00 ± 0.25	81.87 ± 0.63	2.55 ± 0.64	84.77 ± 0.09	1.88 ± 0.14	92.15 ± 5.77	4
Progne chalybea	82.23 ± 0.23	1.95 ± 0.21	82.14 ± 0.27	2.05 ± 0.67	84.46 ± 0.46	1.90 ± 0.09	99.42 ± 9.02	3
Pygochelidon cyanoleuca	82.00 ± 0.16	2.44 ± 0.15	80.76 ± 0.83	3.68 ± 0.77	84.52 ± 0.12	2.15 ± 0.19	84.42 ± 7.57	3
Atticora fasciata	82.13 ± 0.15	2.29 ± 0.13	81.72 ± 0.34	2.70 ± 0.30	84.56 ± 0.21	2.09 ± 0.14	93.90 ± 2.67	4
Neochelidon tibialis	82.23 ± 0.16	2.18 ± 0.24	81.77 ± 0.40	2.64 ± 0.47	84.55 ± 0.16	2.10 ± 0.24	93.14 ± 3.79	4
Stelgidopteryx r. serrip. (hm)	84.26 ± 0.44	0.00	84.27 ± 0.43	0.00	86.21 ± 0.38	0.00	100.00	6
S. r. serrip. (ht)	83.82	0.67	83.43	1.06	86.7	0.00	93.17	1
S. r. ruficollis	83.64 ± 0.22	0.64 ± 0.32	83.24 ± 0.58	1.04 ± 0.83	85.93 ± 0.35	0.55 ± 0.28	93.79 ± 9.31	5
Riparia riparia	81.76 ± 0.25	2.66 ± 0.32	79.99 ± 1.21	4.43 ± 1.20	84.29 ± 0.22	2.37 ± 0.29	80.42 ± 8.88	4
R. cincta	81.52 ± 0.34	2.20 ± 0.34	81.73 ± 0.34	2.01 ± 0.34	83.51 ± 0.26	2.29 ± 0.26	104.17 ± 1.00	4
Pseudhirundo griseopyga	80.36 ± 0.24	3.35 ± 0.24	80.69 ± 0.22	3.04 ± 0.22	82.42 ± 0.22	3.38 ± 0.22	106.33 ± 1.08	4
Ptyonoprogne fuligula	80.59 ± 0.22	3.13 ± 0.22	80.73 ± 0.39	3.01 ± 0.39	82.77 ± 0.22	3.03 ± 0.22	102.75 ± 3.75	4
Hirundo rustica	81.25 ± 0.01	3.16 ± 0.11	80.91 ± 0.05	3.50 ± 0.15	83.61 ± 0.01	3.05 ± 0.11	94.37 ± 0.50	2
Cecropis semirufa	80.56 ± 0.16	3.16 ± 0.16	80.99 ± 0.14	2.75 ± 0.14	82.62 ± 0.14	3.18 ± 0.14	108.22 ± 1.66	4
Petrochelidon spilodera	80.66 ± 0.32	3.05 ± 0.32	80.83 ± 0.43	2.90 ± 0.43	82.76 ± 0.22	3.04 ± 0.22	103.46 ± 5.90	4
Haplochelidon andecola	82.07 ± 0.19	2.37 ± 0.15	81.24 ± 0.25	3.20 ± 0.19	84.45 ± 0.12	2.22 ± 0.10	88.68 ± 0.98	3
P. pyrrhonota	81.67 ± 0.62	2.40 ± 0.26	81.48 ± 0.30	2.60 ± 0.50	83.70 ± 0.60	2.52 ± 0.14	97.24 ± 10.18	4
Delichon urbica	81.10 ± 0.19	3.32 ± 0.25	80.78 ± 0.49	3.64 ± 0.54	83.45 ± 0.21	3.21 ± 0.28	94.82 ± 4.60	4
Psalidoprocne holomelas	80.56 ± 0.07	3.16 ± 0.07	81.02 ± 0.11	2.71 ± 0.11	82.55 ± 0.07	3.24 ± 0.07	109.43 ± 1.47	4
Parus bicolor	75.02 ± 0.89	9.48 ± 0.76	72.03 ± 0.31	12.46 ± 0.30	76.99 ± 0.54	9.63 ± 0.61	74.02 ± 5.72	3
			Cheramoeca leucosternus					
Tachycineta bicolor	78.30 ± 0.60	3.95 ± 0.36	78.16 ± 0.72	4.05 ± 0.45	81.39 ± 0.11	3.62 ± 0.29	98.50 ± 4.89	3
Phaeoprogne tapera	78.62 ± 0.59	3.70 ± 0.43	78.25 ± 0.59	4.05 ± 0.29	81.55 ± 0.48	3.54 ± 0.42	95.49 ± 5.06	4
Progne chalybea	78.90 ± 0.63	3.43 ± 0.44	78.56 ± 0.61	3.74 ± 0.31	81.66 ± 0.35	3.42 ± 0.29	95.71 ± 5.12	4
Pygochelidon cyanoleuca	78.81 ± 0.37	3.60 ± 0.25	78.71 ± 0.80	3.68 ± 0.86	81.41 ± 0.29	3.76 ± 0.43	100.53 ± 13.65	3
Atticora fasciata	78.47 ± 0.47	3.86 ± 0.14	78.01 ± 0.00	4.28 ± 0.37	81.24 ± 0.04	3.84 ± 0.37	93.95 ± 6.16	2
Neochelidon tibialis	78.47 ± 0.54	3.86 ± 0.38	78.36 ± 0.48	3.94 ± 0.38	81.25 ± 0.46	3.84 ± 0.40	98.61 ± 1.57	4
Stelgidopteryx ruficollis	78.61 ± 0.35	3.71 ± 0.36	77.88 ± 0.96	4.42 ± 1.18	81.41 ± 0.50	3.67 ± 0.60	91.90 ± 8.76	4
Cheramoeca leucosternus (hm)	83.13 ± 0.93	0.00	83.12 ± 0.98	0.00	85.48 ± 0.55	0.00	100.00	8
Riparia riparia	78.52 ± 0.69	3.81 ± 0.46	77.65 ± 0.80	4.64 ± 0.60	81.20 ± 0.72	3.89 ± 0.48	89.94 ± 4.95	4
R. cincta	78.92 ± 0.42	3.41 ± 0.20	77.91 ± 0.45	4.39 ± 0.53	81.64 ± 0.26	3.45 ± 0.12	88.26 ± 4.61	4
Phedina borbonica	80.18 ± 0.09	3.39 ± 0.09	80.13 ± 0.10	3.43 ± 0.10	82.31 ± 0.10	3.16 ± 0.10	99.21 ± 0.62	4
Pseudhirundo griseopyga	80.72 ± 0.58	1.61 ± 0.32	80.88 ± 0.52	1.41 ± 0.25	83.55 ± 0.31	1.54 ± 0.12	102.45 ± 2.88	4
Ptyonoprogne fuligula	78.35 ± 0.62	3.97 ± 0.36	77.56 ± 1.29	4.73 ± 1.03	81.20 ± 0.34	3.89 ± 0.10	91.50 ± 7.51	4
Hirundo rustica	78.77 ± 0.46	3.56 ± 0.21	78.72 ± 0.34	3.58 ± 0.43	81.56 ± 0.26	3.53 ± 0.15	99.54 ± 6.29	4

APPENDIX. Continued.

	T_m	ΔT_m	$T_{50}H$	$\Delta T_{50}H$	Mode	Δmode	NPR	n
Cecropis semirufa	78.30 ± 1.20	4.02 ± 1.00	77.92 ± 1.69	4.38 ± 1.49	81.14 ± 0.93	3.94 ± 0.79	96.05 ± 6.70	4
Petrochelidon spilodera	79.23 ± 0.64	3.17 ± 0.38	78.72 ± 0.39	3.67 ± 0.11	81.91 ± 0.35	3.25 ± 0.10	93.48 ± 3.71	3
Haplochelidon andecola	79.78 ± 0.14	3.79 ± 0.14	77.53 ± 0.38	6.04 ± 0.38	81.87 ± 0.24	3.60 ± 0.24	74.02 ± 2.46	4
P. pyrrhonota	79.06 ± 0.66	3.27 ± 0.39	78.46 ± 0.24	3.84 ± 0.08	81.77 ± 0.41	3.31 ± 0.40	92.52 ± 5.21	4
Delichon urbica	79.15 ± 0.57	3.18 ± 0.37	78.63 ± 0.77	3.67 ± 0.90	81.83 ± 0.29	3.26 ± 0.16	94.86 ± 11.01	4
Psalidoprocne holomelas	78.37 ± 0.42	3.95 ± 0.16	78.37 ± 0.32	3.93 ± 0.17	81.21 ± 0.16	3.88 ± 0.11	99.93 ± 3.27	4
Parus bicolor	75.18 ± 0.29	9.14 ± 0.29	73.08 ± 0.86	11.24 ± 0.86	76.48 ± 0.40	9.79 ± 0.40	78.35 ± 4.81	4
			Riparia riparia					
Tachycineta bicolor	81.02 ± 0.27	2.88 ± 0.28	80.75 ± 0.41	3.15 ± 0.44	83.49 ± 0.12	2.65 ± 0.14	96.15 ± 2.73	4
Phaeoprogne tapera	81.26 ± 0.28	2.66 ± 0.36	80.64 ± 1.18	3.28 ± 1.23	83.66 ± 0.25	2.49 ± 0.28	93.27 ± 11.37	3
Progne chalybea	80.70 ± 0.05	3.26 ± 0.05	79.99 ± 0.39	3.97 ± 0.39	83.34 ± 0.28	2.83 ± 0.28	90.65 ± 5.03	2
Pygochelidon cyanoleuca	81.00 ± 0.14	2.89 ± 0.13	80.52 ± 0.49	3.38 ± 0.48	83.52 ± 0.11	2.62 ± 0.13	93.69 ± 6.96	4
Atticora fasciata	80.89 ± 0.11	3.01 ± 0.16	80.78 ± 0.11	3.11 ± 0.18	83.41 ± 0.22	2.73 ± 0.24	98.39 ± 1.67	4
Neochelidon tibialis	80.72 ± 0.16	3.20 ± 0.23	80.00 ± 0.41	3.92 ± 0.48	83.26 ± 0.19	2.89 ± 0.22	90.46 ± 2.78	3
Stelgidopteryx ruficollis	81.34 ± 0.36	2.54 ± 0.41	80.20 ± 1.65	3.67 ± 1.62	83.90 ± 0.34	2.23 ± 0.36	88.81 ± 12.77	3
Cheramoeca leucosternus	79.89	4.08	79.65	4.31	82.37	3.79	96.77	1
Riparia riparia (hm)	83.76 ± 0.33	0.00	83.67 ± 0.51	0.00	86.03 ± 0.25	0.00	100.0	5
R. riparia (ht)	83.34	0.50	83.30	0.53	85.63	0.49	99.41	1
R. cincta	81.02 ± 0.33	2.88 ± 0.40	80.45 ± 0.65	3.45 ± 0.72	83.43 ± 0.31	2.71 ± 0.34	92.41 ± 4.28	4
Phedina borbonica	81.28 ± 0.15	2.62 ± 0.12	81.24 ± 0.18	2.66 ± 0.16	83.64 ± 0.15	2.50 ± 0.17	99.35 ± 0.74	4
Pseudhirundo griseopyga	79.85	4.11	79.29	4.67	82.33	3.83	92.26	1
Ptyonoprogne fuligula	80.16 ± 0.07	3.74 ± 0.02	79.89 ± 0.03	4.01 ± 0.12	82.62 ± 0.05	3.52 ± 0.08	96.22 ± 1.41	2
Hirundo rustica	80.59 ± 0.09	3.30 ± 0.18	80.40 ± 0.17	3.50 ± 0.26	82.94 ± 0.11	3.20 ± 0.15	97.01 ± 1.25	2
Cecropis semirufa	80.22 ± 0.06	3.68 ± 0.03	80.06 ± 0.09	3.84 ± 0.18	82.60 ± 0.06	3.54 ± 0.02	97.63 ± 2.07	2
Petrochelidon spilodera	80.21 ± 0.08	3.69 ± 0.17	79.72 ± 0.30	4.18 ± 0.39	82.74 ± 0.14	3.40 ± 0.18	93.64 ± 2.64	2
Haplochelidon andecola	80.62 ± 0.16	3.27 ± 0.07	79.12 ± 0.08	4.78 ± 0.01	83.33 ± 0.08	2.82 ± 0.04	83.04 ± 0.37	2
P. pyrrhonota	80.41 ± 0.10	3.48 ± 0.01	79.98 ± 0.15	3.91 ± 0.06	82.87 ± 0.01	3.27 ± 0.02	94.18 ± 0.50	2
Delichon urbica	80.26	3.70	79.90	4.07	82.55	3.61	94.79	1
Psalidoprocne holomelas	79.93 ± 0.23	3.97 ± 0.24	79.88 ± 0.30	4.02 ± 0.31	82.36 ± 0.12	3.78 ± 0.14	99.34 ± 1.14	4
Parus bicolor	73.71 ± 0.00	10.19 ± 0.09	70.11 ± 0.48	13.79 ± 0.39	75.88 ± 0.48	10.26 ± 0.45	72.50 ± 3.36	2
			Riparia cincta					
Tachycineta bicolor	80.87 ± 0.17	2.81 ± 0.21	80.95 ± 0.41	2.73 ± 0.47	83.17 ± 0.16	2.58 ± 0.16	101.39 ± 4.72	4
Phaeoprogne tapera	81.31 ± 0.19	2.37 ± 0.25	81.66 ± 0.30	2.02 ± 0.36	83.55 ± 0.07	2.20 ± 0.07	106.06 ± 2.57	4
Progne chalybea	81.12 ± 0.24	2.56 ± 0.29	81.02 ± 0.59	2.66 ± 0.65	83.39 ± 0.12	2.36 ± 0.13	98.67 ± 6.97	4
Pygochelidon cyanoleuca	81.25 ± 0.23	2.44 ± 0.28	80.81 ± 0.74	2.87 ± 0.78	83.51 ± 0.10	2.24 ± 0.10	94.45 ± 11.08	4
Atticora fasciata	80.71 ± 0.00	2.97 ± 0.08	81.04 ± 0.04	2.64 ± 0.12	82.99 ± 0.08	2.76 ± 0.05	105.69 ± 0.65	2
Neochelidon tibialis	80.93 ± 0.22	2.76 ± 0.23	81.09 ± 0.23	2.59 ± 0.29	83.17 ± 0.23	2.58 ± 0.22	102.96 ± 3.83	4
Stelgidopteryx ruficollis	81.20 ± 0.35	2.48 ± 0.32	80.81 ± 0.87	2.87 ± 0.85	83.29 ± 0.39	2.46 ± 0.38	94.87 ± 9.57	4

APPENDIX. Continued.

	T_m	ΔT_m	$T_{50}H$	$\Delta T_{50}H$	Mode	Δmode	NPR	*n*
				Riparia cincta (continued)				
Cheramoeca leucosternus	80.36 ± 0.22	3.32 ± 0.14	80.60 ± 0.21	3.08 ± 0.13	82.57 ± 0.20	3.18 ± 0.17	104.08 ± 0.04	2
Riparia riparia	80.96 ± 0.32	2.72 ± 0.33	80.92 ± 0.53	2.76 ± 0.57	83.20 ± 0.21	2.54 ± 0.21	99.42 ± 4.59	4
R. cincta (hm)	83.39 ± 0.38	0.00	83.39 ± 0.42	0.00	85.56 ± 0.25	0.00	100.00	7
R. cincta (ht)	83.34 ± 0.18	0.35 ± 0.26	83.42 ± 0.44	0.26 ± 0.52	85.52 ± 0.13	0.23 ± 0.17	101.82 ± 4.99	2
Pseudhirundo griseopyga	80.19 ± 0.14	3.49 ± 0.17	80.29 ± 0.28	3.39 ± 0.33	82.41 ± 0.10	3.34 ± 0.12	101.68 ± 2.76	4
Ptyonoprogne fuligula	80.53 ± 0.16	3.16 ± 0.20	80.49 ± 0.56	3.19 ± 0.61	82.79 ± 0.09	2.96 ± 0.09	99.85 ± 7.03	4
Hirundo rustica	80.58 ± 0.28	3.11 ± 0.33	80.85 ± 0.24	2.83 ± 0.30	82.76 ± 0.28	2.99 ± 0.30	104.79 ± 2.38	4
Cecropis semirufa	80.45 ± 0.17	3.24 ± 0.17	80.62 ± 0.16	3.06 ± 0.21	82.62 ± 0.24	3.13 ± 0.23	102.98 ± 2.33	4
Petrochelidon spilodera	80.56 ± 0.06	3.13 ± 0.12	80.58 ± 0.35	3.10 ± 0.41	82.85 ± 0.06	2.90 ± 0.05	100.63 ± 5.16	4
P. pyrrhonota	80.71 ± 0.11	2.98 ± 0.09	80.57 ± 0.19	3.11 ± 0.19	82.95 ± 0.16	2.80 ± 0.13	97.81 ± 2.12	4
Delichon urbica	80.62 ± 0.10	3.06 ± 0.12	80.43 ± 0.68	3.25 ± 0.65	82.81 ± 0.13	2.94 ± 0.14	97.80 ± 8.41	4
Psalidoprocne holomelas	80.20 ± 0.03	3.48 ± 0.07	80.19 ± 0.72	3.49 ± 0.76	82.36 ± 0.11	3.39 ± 0.09	101.10 ± 10.09	4
Parus bicolor	73.42 ± 0.17	9.58 ± 0.17	69.20 ± 0.87	13.80 ± 0.87	75.22 ± 0.21	10.10 ± 0.21	69.22 ± 3.26	4
				Phedina borbonica				
Tachycineta bicolor	81.27 ± 0.09	2.54 ± 0.06	80.43 ± 0.97	3.38 ± 1.01	83.43 ± 0.12	2.43 ± 0.08	89.31 ± 11.82	3
Phaeoprogne tapera	81.35 ± 0.26	2.41 ± 0.34	81.12 ± 0.34	2.64 ± 0.41	83.60 ± 0.05	2.20 ± 0.15	95.99 ± 1.33	3
Progne chalybea	81.16 ± 0.52	2.62 ± 0.48	80.54 ± 0.40	3.24 ± 0.33	83.41 ± 0.51	2.42 ± 0.48	90.96 ± 4.98	4
Pygochelidon cyanoleuca	81.42 ± 0.44	2.36 ± 0.47	80.70 ± 0.47	3.08 ± 0.51	83.57 ± 0.35	2.26 ± 0.40	89.94 ± 7.07	4
Atticora fasciata	80.96 ± 0.19	2.82 ± 0.16	80.69 ± 0.25	3.10 ± 0.21	83.24 ± 0.11	2.60 ± 0.03	95.38 ± 1.19	4
Neochelidon tibialis	81.17 ± 0.12	2.61 ± 0.16	80.49 ± 0.24	3.29 ± 0.29	83.37 ± 0.22	2.47 ± 0.23	89.45 ± 1.71	4
Stelgidopteryx ruficollis	81.19 ± 0.19	2.59 ± 0.16	80.45 ± 0.44	3.34 ± 0.44	83.64 ± 0.15	2.19 ± 0.07	88.93 ± 3.73	4
Cheramoeca leucosternus	80.17 ± 0.08	3.63 ± 0.02	79.68 ± 0.12	4.13 ± 0.16	82.49 ± 0.05	3.37 ± 0.07	93.01 ± 1.85	3
Riparia riparia	81.11 ± 0.23	2.70 ± 0.24	80.73 ± 0.38	3.07 ± 0.36	83.37 ± 0.12	2.49 ± 0.18	94.10 ± 2.47	3
R. cincta	81.56 ± 0.25	2.22 ± 0.26	80.80 ± 0.40	2.98 ± 0.48	83.83 ± 0.25	2.01 ± 0.23	89.41 ± 5.90	4
Phedina borbonica (hm)	84.01 ± 0.38	0.00	84.01 ± 0.38	0.00	86.02 ± 0.32	0.00	100.00	6
Pseudhirundo griseopyga	80.38 ± 0.10	3.42 ± 0.14	80.07 ± 0.11	3.74 ± 0.16	82.54 ± 0.05	3.32 ± 0.11	94.88 ± 0.34	3
Ptyonoprogne fuligula	80.40 ± 0.14	3.36 ± 0.19	79.92 ± 0.22	3.84 ± 0.29	82.73 ± 0.17	3.07 ± 0.20	92.54 ± 2.55	3
Hirundo rustica	80.61 ± 0.48	3.20 ± 0.40	80.28 ± 0.56	3.52 ± 0.49	82.83 ± 0.47	3.03 ± 0.37	94.87 ± 0.87	3
Cecropis semirufa	80.48 ± 0.16	3.28 ± 0.10	80.31 ± 0.17	3.45 ± 0.13	82.84 ± 0.19	2.96 ± 0.09	97.13 ± 0.87	3
Petrochelidon spilodera	80.67 ± 0.15	3.11 ± 0.13	80.26 ± 0.13	3.52 ± 0.17	83.03 ± 0.15	2.80 ± 0.08	93.43 ± 1.88	4
Haplochelidon andecola	81.18 ± 0.15	2.58 ± 0.09	78.90 ± 0.28	4.86 ± 0.21	83.43 ± 0.02	2.37 ± 0.09	74.76 ± 1.00	3
P. pyrrhonota	80.73 ± 0.15	3.03 ± 0.08	80.15 ± 0.05	3.61 ± 0.11	83.16 ± 0.18	2.64 ± 0.08	91.07 ± 2.55	3
Delichon urbica	80.43 ± 0.31	3.33 ± 0.27	79.49 ± 0.83	4.28 ± 0.90	82.69 ± 0.24	3.11 ± 0.18	88.37 ± 10.80	3
Psalidoprocne holomelas	80.17 ± 0.07	3.61 ± 0.05	79.99 ± 0.11	3.79 ± 0.12	82.50 ± 0.22	3.33 ± 0.14	96.97 ± 2.18	4
Parus bicolor	75.34 ± 0.42	9.12 ± 0.42	72.77 ± 0.57	11.68 ± 0.57	76.64 ± 0.47	9.76 ± 0.47	75.10 ± 4.86	4
				Pseudhirundo griseopyga				
Tachycineta bicolor	80.40 ± 0.03	3.72 ± 0.11	80.42 ± 0.26	3.70 ± 0.40	82.60 ± 0.02	3.45 ± 0.04	100.38 ± 4.85	4
Phaeoprogne tapera	80.35 ± 0.13	3.77 ± 0.09	80.36 ± 0.26	3.75 ± 0.36	82.62 ± 0.11	3.43 ± 0.07	100.52 ± 6.44	4
Progne chalybea	80.21 ± 0.22	3.87 ± 0.28	79.96 ± 0.47	4.11 ± 0.50	82.52 ± 0.20	3.52 ± 0.22	96.29 ± 3.45	3

APPENDIX. Continued.

	T_m	ΔT_m	$T_{50}H$	$\Delta T_{50}H$	Mode	Δmode	NPR	*n*
Pygochelidon cyanoleuca	80.06 ± 0.24	4.10 ± 0.21	79.09 ± 0.22	5.06 ± 0.12	82.32 ± 0.09	3.74 ± 0.09	86.90 ± 1.59	3
Atticora fasciata	80.02 ± 0.17	4.11 ± 0.15	79.87 ± 0.29	4.24 ± 0.24	82.30 ± 0.24	3.75 ± 0.23	97.85 ± 1.88	4
Neochelidon tibialis	79.86 ± 0.26	4.22 ± 0.38	79.70 ± 0.49	4.37 ± 0.62	82.21 ± 0.32	3.83 ± 0.35	97.74 ± 3.46	3
Stelgidopteryx ruficollis	80.12 ± 0.55	3.96 ± 0.43	79.54 ± 0.95	4.52 ± 0.89	82.35 ± 0.41	3.69 ± 0.38	91.96 ± 8.17	3
Riparia riparia	80.28 ± 0.34	3.72 ± 0.34	78.15 ± 0.15	5.84 ± 0.15	82.58 ± 0.32	3.45 ± 0.32	75.77 ± 1.48	2
R. cincta	80.45 ± 0.34	3.67 ± 0.21	80.09 ± 0.50	4.02 ± 0.37	82.75 ± 0.21	3.31 ± 0.17	94.62 ± 2.16	4
Pseudhirundo griseopyga (hm)	84.10 ± 0.11	0.00	84.09 ± 0.16	0.00	86.05 ± 0.05	0.00	100.00	7
P. griseopyga (ht)	83.52 ± 0.15	0.60 ± 0.32	83.49 ± 0.24	0.63 ± 0.42	85.60 ± 0.23	0.45 ± 0.27	99.34 ± 1.63	2
Ptyonoprogne fuligula	80.42 ± 0.29	3.71 ± 0.31	79.62 ± 0.87	4.49 ± 0.92	82.69 ± 0.20	3.37 ± 0.21	89.54 ± 6.85	4
Hirundo rustica	80.49 ± 0.25	3.63 ± 0.13	80.28 ± 0.82	3.83 ± 0.70	82.79 ± 0.11	3.26 ± 0.10	97.65 ± 7.82	4
Cecropis semirufa	80.05 ± 0.31	4.07 ± 0.22	79.45 ± 0.70	4.66 ± 0.58	82.49 ± 0.12	3.56 ± 0.12	92.06 ± 4.80	4
Petrochelidon spilodera	80.55 ± 0.26	3.57 ± 0.14	80.39 ± 0.24	3.72 ± 0.13	82.79 ± 0.16	3.26 ± 0.13	97.49 ± 0.83	4
P. pyrrhonota	80.32 ± 0.20	3.81 ± 0.07	79.98 ± 0.54	4.13 ± 0.45	82.69 ± 0.11	3.36 ± 0.08	95.40 ± 5.95	4
Delichon urbica	80.34 ± 0.66	3.82 ± 0.54	79.86 ± 1.37	4.29 ± 1.22	82.52 ± 0.51	3.54 ± 0.48	93.84 ± 9.34	3
Psalidoprocne holomelas	80.00 ± 0.20	4.12 ± 0.19	79.96 ± 0.28	4.15 ± 0.20	82.27 ± 0.14	3.78 ± 0.14	99.44 ± 1.90	4
Parus bicolor	74.03 ± 0.49	10.03 ± 0.49	70.88 ± 2.40	13.19 ± 2.40	75.57 ± 0.54	10.48 ± 0.54	74.52 ± 9.73	4
			Ptyonoprogne fuligula					
Tachycineta bicolor	79.87 ± 0.38	3.40 ± 0.32	79.62 ± 0.43	3.65 ± 0.37	82.00 ± 0.18	3.31 ± 0.14	96.21 ± 0.92	4
Phaeoprogne tapera	80.48 ± 0.15	2.79 ± 0.10	80.32 ± 0.15	2.95 ± 0.14	82.57 ± 0.10	2.75 ± 0.10	97.13 ± 1.69	4
Progne chalybea	80.05 ± 0.26	3.22 ± 0.24	79.41 ± 0.24	3.86 ± 0.23	82.30 ± 0.22	3.01 ± 0.20	91.19 ± 3.84	4
Pygochelidon cyanoleuca	80.17 ± 0.24	3.10 ± 0.28	79.58 ± 0.44	3.69 ± 0.47	82.37 ± 0.18	2.95 ± 0.20	92.15 ± 6.60	4
Atticora fasciata	79.79 ± 0.11	3.48 ± 0.03	79.68 ± 0.02	3.60 ± 0.06	81.96 ± 0.02	3.36 ± 0.04	98.25 ± 1.35	2
Neochelidon tibialis	80.06 ± 0.30	3.21 ± 0.32	79.92 ± 0.33	3.35 ± 0.35	82.06 ± 0.18	3.25 ± 0.21	97.75 ± 1.19	4
Stelgidopteryx ruficollis	80.33 ± 0.32	2.94 ± 0.26	80.10 ± 0.48	3.17 ± 0.42	82.36 ± 0.19	2.95 ± 0.14	96.53 ± 2.93	4
Cheramoeca leucosternus	80.00 ± 0.09	3.27 ± 0.01	79.82 ± 0.04	3.46 ± 0.13	82.08 ± 0.11	3.23 ± 0.17	97.14 ± 2.15	2
Riparia riparia	79.87 ± 0.28	3.41 ± 0.29	79.43 ± 0.41	3.84 ± 0.44	82.13 ± 0.23	3.18 ± 0.24	94.02 ± 3.24	4
R. cincta	80.54 ± 0.17	2.73 ± 0.11	80.12 ± 0.18	3.16 ± 0.13	82.63 ± 0.11	2.69 ± 0.07	93.03 ± 0.82	4
Pseudhirundo griseopyga	79.69 ± 0.09	3.58 ± 0.03	79.44 ± 0.10	3.83 ± 0.07	81.93 ± 0.09	3.38 ± 0.05	96.33 ± 0.84	4
Ptyonoprogne fuligula (hm)	83.27 ± 0.23	0.00	83.27 ± 0.27	0.00	85.34 ± 0.20	0.00	100.00	7
P. fuligula (ht)	83.05 ± 0.50	0.22 ± 0.58	82.86 ± 0.83	0.42 ± 0.92	85.20 ± 0.30	0.11 ± 0.35	96.77 ± 5.77	2
Hirundo rustica	80.69 ± 0.62	2.59 ± 0.55	80.51 ± 0.94	2.76 ± 0.87	82.98 ± 0.48	2.34 ± 0.44	97.81 ± 4.58	4
Cecropis semirufa	80.65 ± 0.13	2.60 ± 0.07	80.56 ± 0.12	2.70 ± 0.06	82.75 ± 0.22	2.55 ± 0.18	98.45 ± 1.34	3
Petrochelidon spilodera	80.92 ± 0.21	2.35 ± 0.20	80.76 ± 0.19	2.51 ± 0.16	83.11 ± 0.13	2.21 ± 0.12	97.39 ± 1.20	4
P. pyrrhonota	80.95 ± 0.13	2.32 ± 0.12	80.61 ± 0.27	2.66 ± 0.26	83.20 ± 0.16	2.12 ± 0.18	94.59 ± 2.58	4
Delichon urbica	80.83 ± 0.15	2.44 ± 0.19	80.27 ± 0.70	3.00 ± 0.72	82.93 ± 0.15	2.38 ± 0.19	91.83 ± 7.84	4
Psalidoprocne holomelas	80.12 ± 0.22	3.15 ± 0.19	80.23 ± 0.18	3.04 ± 0.15	82.23 ± 0.17	3.09 ± 0.17	101.84 ± 0.68	4
Parus bicolor	73.59 ± 0.12	9.73 ± 0.12	66.42 ± 2.07	16.91 ± 2.07	75.74 ± 0.30	9.64 ± 0.30	61.01 ± 4.83	4

APPENDIX. Continued.

	T_m	ΔT_m	$T_{50}H$	$\Delta T_{50}H$	Mode	Δmode	NPR	*n*
				Hirundo rustica				
Tachycineta bicolor	80.06 ± 0.80	3.34 ± 0.27	79.08 ± 1.05	4.32 ± 0.63	82.69 ± 0.40	3.11 ± 0.26	88.33 ± 5.50	8
Phaeoprogne tapera	80.12 ± 1.11	3.29 ± 0.46	79.03 ± 1.52	4.37 ± 0.90	82.75 ± 0.78	3.05 ± 0.49	87.59 ± 5.65	8
Progne chalybea	80.18 ± 0.77	3.37 ± 0.37	79.27 ± 0.86	4.29 ± 0.43	82.70 ± 0.55	3.14 ± 0.39	88.46 ± 2.78	6
Pygochelidon cyanoleuca	80.08 ± 0.99	3.46 ± 0.44	78.37 ± 1.69	5.17 ± 1.11	82.71 ± 0.64	3.15 ± 0.38	82.38 ± 8.35	7
Atticora fasciata	79.91 ± 1.46	3.47 ± 0.44	78.93 ± 1.78	4.44 ± 0.86	82.42 ± 0.88	3.30 ± 0.49	87.66 ± 3.81	4
Neochelidon tibialis	80.36 ± 0.63	3.46 ± 0.42	79.72 ± 0.36	4.09 ± 0.65	82.56 ± 0.44	3.25 ± 0.35	91.07 ± 6.05	4
Stelgidopteryx ruficollis	80.18 ± 0.69	3.24 ± 0.16	79.19 ± 0.69	4.23 ± 0.30	82.82 ± 0.37	3.03 ± 0.21	88.05 ± 3.36	11
Riparia riparia	79.98 ± 0.88	3.41 ± 0.24	79.03 ± 1.01	4.36 ± 0.63	82.55 ± 0.53	3.22 ± 0.22	88.29 ± 5.62	7
R. cincta	80.39 ± 0.18	2.90 ± 0.18	79.94 ± 0.36	3.34 ± 0.36	82.76 ± 0.18	2.77 ± 0.18	93.77 ± 2.71	4
Pseudhirundo griseopyga	80.29 ± 0.72	3.53 ± 0.21	79.51 ± 0.54	4.30 ± 0.18	82.60 ± 0.41	3.21 ± 0.11	89.45 ± 3.64	4
Ptyonoprogne fuligula	81.13 ± 0.66	2.48 ± 0.19	80.67 ± 0.72	2.93 ± 0.39	83.35 ± 0.52	2.32 ± 0.22	93.08 ± 3.90	6
Hirundo rustica (hm)	84.16 ± 1.39	0.00	84.15 ± 1.39	0.00	86.38 ± 1.16	0.00	100.00	19
H. rustica (ht)	85.11 ± 1.41	0.38 ± 0.34	85.09 ± 1.36	0.40 ± 0.30	87.13 ± 1.35	0.36 ± 0.39	99.71 ± 2.90	20
Cecropis semirufa	80.68 ± 0.54	2.75 ± 0.36	80.19 ± 0.50	3.24 ± 0.75	82.95 ± 0.36	2.62 ± 0.27	93.25 ± 7.00	6
Petrochelidon spilodera	81.14 ± 0.71	2.53 ± 0.15	80.67 ± 0.77	3.00 ± 0.29	83.36 ± 0.63	2.35 ± 0.28	92.65 ± 2.43	5
Haplochelidon andecola	80.06 ± 0.10	3.14 ± 0.10	77.93 ± 0.25	5.27 ± 0.25	82.32 ± 0.36	3.08 ± 0.36	76.94 ± 1.82	3
Petrochelidon pyrrhonota	80.79 ± 0.14	2.47 ± 0.15	80.25 ± 0.12	3.00 ± 0.13	83.14 ± 0.10	2.34 ± 0.11	92.09 ± 1.48	6
Delichon urbica	80.74 ± 0.82	2.63 ± 0.33	80.49 ± 1.68	2.88 ± 1.57	83.14 ± 0.56	2.63 ± 0.28	105.21 ± 38.11	12
Psalidoprocne holomelas	80.54 ± 0.45	3.28 ± 0.16	80.33 ± 0.24	3.49 ± 0.41	82.63 ± 0.26	3.19 ± 0.14	96.81 ± 4.51	4
Parus bicolor	74.32 ± 1.06	8.78 ± 0.73	73.76 ± 4.82	9.33 ± 4.44	75.71 ± 0.86	10.08 ± 0.53	115.83 ± 50.01	6
				Cecropis semirufa				
Tachycineta bicolor	79.45 ± 0.25	3.69 ± 0.38	78.87 ± 0.29	4.27 ± 0.12	81.84 ± 0.26	3.64 ± 0.29	92.25 ± 4.90	3
Phaeoprogne tapera	79.71 ± 0.21	3.36 ± 0.19	79.49 ± 0.24	3.59 ± 0.19	82.14 ± 0.22	3.29 ± 0.23	97.00 ± 0.70	4
Progne chalybea	79.85 ± 0.10	3.29 ± 0.29	78.39 ± 1.17	4.75 ± 0.96	82.42 ± 0.19	3.06 ± 0.35	85.08 ± 10.73	3
Pygochelidon cyanoleuca	79.33 ± 0.13	3.81 ± 0.09	77.42 ± 1.56	5.71 ± 1.42	81.81 ± 0.13	3.68 ± 0.08	81.85 ± 12.84	3
Atticora fasciata	79.31 ± 0.14	3.76 ± 0.22	79.06 ± 0.22	4.01 ± 0.29	81.84 ± 0.17	3.59 ± 0.28	96.59 ± 1.29	4
Neochelidon tibialis	79.37 ± 0.27	3.70 ± 0.27	78.44 ± 1.30	4.63 ± 1.17	81.78 ± 0.26	3.65 ± 0.32	90.65 ± 12.91	4
Stelgidopteryx ruficollis	79.68 ± 0.19	3.46 ± 0.05	79.07 ± 0.55	4.06 ± 0.48	82.01 ± 0.14	3.48 ± 0.05	92.48 ± 5.30	3
Riparia riparia	79.65 ± 0.01	3.60 ± 0.01	79.44 ± 0.04	3.81 ± 0.04	82.13 ± 0.11	3.47 ± 0.11	97.20 ± 0.65	2
R. cincta	79.84 ± 0.36	3.30 ± 0.15	79.28 ± 0.46	3.85 ± 0.34	82.06 ± 0.65	3.42 ± 0.47	92.68 ± 4.87	3
Pseudhirundo griseopyga	79.40 ± 0.07	3.67 ± 0.24	78.92 ± 0.19	4.15 ± 0.38	81.97 ± 0.06	3.46 ± 0.17	93.67 ± 1.92	4
Ptyonoprogne fuligula	80.15 ± 0.51	2.92 ± 0.31	79.25 ± 0.97	3.82 ± 0.80	82.61 ± 0.47	2.82 ± 0.30	88.82 ± 9.23	4
Hirundo rustica	80.25 ± 0.17	2.89 ± 0.27	79.59 ± 0.71	3.54 ± 0.71	82.71 ± 0.17	2.77 ± 0.13	91.94 ± 6.30	3
Cecropis semirufa (hm)	82.77 ± 0.41	0.00	82.77 ± 0.44	0.00	85.12 ± 0.42	0.00	100.00	7
C. semirufa (ht)	82.51 ± 0.06	0.56 ± 0.20	82.61 ± 0.08	0.46 ± 0.18	84.95 ± 0.11	0.48 ± 0.12	101.93 ± 0.58	2
Petrochelidon spilodera	81.45 ± 0.11	1.69 ± 0.17	81.23 ± 0.26	1.90 ± 0.38	83.86 ± 0.13	1.63 ± 0.11	96.82 ± 2.95	3
P. pyrrhonota	81.27 ± 0.14	1.75 ± 0.20	79.94 ± 1.13	3.07 ± 1.02	83.75 ± 0.18	1.62 ± 0.18	85.04 ± 8.84	3

APPENDIX. Continued.

	T_m	ΔT_m	$T_{50}H$	$\Delta T_{50}H$	Mode	Δmode	NPR	*n*
Delichon urbica	80.65 ± 0.45	2.36 ± 0.33	80.59 ± 0.56	2.42 ± 0.48	83.05 ± 0.34	2.32 ± 0.30	99.09 ± 2.62	3
Psalidoprocne holomelas	79.42 ± 0.27	3.71 ± 0.18	79.32 ± 0.48	3.81 ± 0.50	81.76 ± 0.22	3.73 ± 0.14	98.69 ± 4.43	3
Parus bicolor	73.58 ± 0.37	8.79 ± 0.37	66.57 ± 5.21	15.80 ± 5.21	75.05 ± 0.55	9.66 ± 0.55	64.23 ± 13.17	3
Petrochelidon spilodera								
Tachycineta bicolor	80.24 ± 0.14	3.78 ± 0.14	79.56 ± 0.12	4.46 ± 0.12	82.54 ± 0.08	3.43 ± 0.08	90.85 ± 3.18	2
Phaeoprogne tapera	80.67 ± 0.21	3.35 ± 0.21	80.30 ± 0.35	3.72 ± 0.35	82.84 ± 0.07	3.13 ± 0.07	94.38 ± 1.74	2
Progne chalybea	80.43	3.59	79.95	4.07	82.48	3.49	92.51	1
Pygochelidon cyanoleuca	80.31 ± 0.17	3.71 ± 0.17	79.89 ± 1.01	4.12 ± 1.01	82.43 ± 0.01	3.55 ± 0.01	94.99 ± 11.47	2
Atticora fasciata	80.28 ± 0.11	3.74 ± 0.11	79.94 ± 0.17	4.08 ± 0.17	82.59 ± 0.00	3.38 ± 0.00	94.94 ± 0.72	2
Neochelidon tibialis	83.39	3.91	79.74	4.27	82.31	3.66	94.84	1
Stelgidopteryx ruficollis	80.97	3.05	80.30	3.72	82.92	3.05	90.09	1
Riparia riparia	80.48	3.54	78.84	5.18	82.72	3.25	81.01	1
R. cincta	80.61 ± 0.41	3.41 ± 0.41	80.13 ± 0.70	3.89 ± 0.70	82.72 ± 0.28	3.26 ± 0.28	93.21 ± 3.43	2
Pseudhirundo griseopyga	80.12 ± 0.37	3.90 ± 0.37	79.49 ± 0.67	4.52 ± 0.67	82.42 ± 0.08	3.55 ± 0.08	91.57 ± 3.15	2
Ptyonoprogne fuligula	81.18 ± 0.37	2.84 ± 0.37	80.39 ± 1.20	3.63 ± 1.20	83.35 ± 0.31	2.62 ± 0.31	89.75 ± 10.27	2
Hirundo rustica	81.22 ± 0.26	2.80 ± 0.26	81.22 ± 0.45	2.80 ± 0.45	83.38 ± 0.20	2.59 ± 0.20	100.11 ± 2.86	2
Cecropis semirufa	82.03 ± 0.48	1.99 ± 0.48	81.85 ± 0.50	2.17 ± 0.50	84.08 ± 0.36	1.90 ± 0.36	96.96 ± 0.19	2
Petrochelidon spilodera (hm)	84.07 ± 0.13	0.00	84.03 ± 0.38	0.00	86.05 ± 0.13	0.00	100.00	4
P. spilodera (ht)	83.39	0.63	83.18	0.84	85.65	0.32	96.34	1
P. pyrrhonota	82.55 ± 0.17	1.47 ± 0.17	81.20 ± 0.91	2.82 ± 0.91	84.70 ± 0.12	1.28 ± 0.12	82.66 ± 6.71	2
Delichon urbica	81.22 ± 0.21	2.80 ± 0.21	80.97 ± 0.14	3.05 ± 0.14	83.35 ± 0.11	2.63 ± 0.11	96.14 ± 1.12	2
Psalidoprocne holomelas	80.34 ± 0.13	3.68 ± 0.13	80.29 ± 0.14	3.73 ± 0.14	82.77 ± 0.16	3.21 ± 0.16	99.07 ± 0.12	2
Parus bicolor	74.69 ± 0.33	9.43 ± 0.33	72.08 ± 1.80	11.97 ± 1.80	76.26 ± 0.49	9.87 ± 0.49	76.93 ± 10.39	3
Haplochelidon andecola								
Tachycineta bicolor	80.85 ± 0.41	2.75 ± 0.27	81.77 ± 0.70	1.83 ± 0.74	83.48 ± 0.36	2.72 ± 0.27	118.45 ± 16.53	4
Phaeoprogne tapera	81.41 ± 0.21	2.20 ± 0.12	82.72 ± 0.33	0.88 ± 0.23	83.91 ± 0.24	2.28 ± 0.25	126.93 ± 4.39	4
Progne chalybea	81.38 ± 0.50	2.22 ± 0.35	82.61 ± 0.73	0.99 ± 0.62	83.98 ± 0.29	2.21 ± 0.19	125.05 ± 8.61	4
Pygochelidon cyanoleuca	81.85 ± 0.11	1.76 ± 0.17	82.96 ± 0.33	0.64 ± 0.23	84.27 ± 0.22	1.92 ± 0.25	122.38 ± 6.62	4
Atticora fasciata	81.72 ± 0.08	1.84 ± 0.22	82.87 ± 0.12	0.68 ± 0.25	84.20 ± 0.11	1.97 ± 0.22	123.26 ± 1.61	3
Neochelidon tibialis	81.54 ± 0.31	2.06 ± 0.33	82.84 ± 0.19	0.76 ± 0.18	84.02 ± 0.27	2.17 ± 0.27	126.73 ± 2.03	4
Stelgidopteryx ruficollis	81.09 ± 0.22	2.52 ± 0.36	81.76 ± 0.35	1.83 ± 0.39	83.81 ± 0.13	2.39 ± 0.17	111.15 ± 8.07	4
Cheramoeca leucosternus	80.16 ± 0.04	3.44 ± 0.14	81.38 ± 0.04	2.22 ± 0.14	82.82 ± 0.08	3.37 ± 0.22	123.93 ± 0.50	2
Riparia riparia	81.10 ± 0.13	2.64 ± 0.13	82.36 ± 0.49	1.37 ± 0.49	83.57 ± 0.03	2.72 ± 0.03	125.20 ± 9.02	2
R. cincta	81.39 ± 0.33	2.22 ± 0.26	81.84 ± 0.55	1.76 ± 0.41	83.99 ± 0.43	2.21 ± 0.40	108.11 ± 6.37	4
Phedina borbonica	81.01 ± 0.11	2.60 ± 0.30	82.50 ± 0.09	1.10 ± 0.27	83.63 ± 0.16	2.56 ± 0.03	129.06 ± 1.07	2
Pseudhirundo griseopyga	80.03 ± 0.30	3.62 ± 0.37	81.39 ± 0.31	2.26 ± 0.41	82.70 ± 0.21	3.52 ± 0.29	125.13 ± 2.30	3
Ptyonoprogne fuligula	80.00 ± 0.08	3.60 ± 0.26	80.40 ± 0.68	3.20 ± 0.50	82.86 ± 0.01	3.33 ± 0.12	106.73 ± 12.22	2

APPENDIX. Continued.

	T_m	ΔT_m	$T_{50}H$	$\Delta T_{50}H$	Mode	Δmode	NPR	n
***Haplochelidon andecola* (continued)**								
Hirundo rustica	80.33 ± 0.14	3.32 ± 0.07	81.15 ± 0.79	2.49 ± 0.88	83.01 ± 0.41	3.21 ± 0.41	115.89 ± 17.06	3
Cecropis semirufa	79.91 ± 0.14	3.65 ± 0.14	80.77 ± 0.16	2.78 ± 0.14	82.52 ± 0.06	3.64 ± 0.17	115.12 ± 1.09	3
Petrochelidon spilodera	80.10 ± 0.40	3.51 ± 0.47	81.12 ± 0.39	2.48 ± 0.42	82.69 ± 0.40	3.51 ± 0.49	118.96 ± 3.53	4
Haplochelidon andecola (hm)	83.65 ± 0.30	0.00	83.64 ± 0.20	0.00	86.23 ± 0.36	0.00	100.00	3
P. pyrrhonota	80.29 ± 0.16	3.31 ± 0.26	81.11 ± 0.14	2.49 ± 0.24	82.79 ± 0.16	3.40 ± 0.25	114.18 ± 1.77	4
Delichon urbica	80.25 ± 0.15	3.31 ± 0.30	81.01 ± 0.89	2.55 ± 1.04	82.82 ± 0.28	3.35 ± 0.39	115.14 ± 14.34	3
Psalidoprocne holomelas	79.97 ± 0.32	3.63 ± 0.22	81.28 ± 0.51	2.32 ± 0.46	82.55 ± 0.23	3.64 ± 0.15	125.80 ± 7.79	4
Petrochelidon pyrrhonota								
Tachycineta bicolor	79.87 ± 0.22	3.68 ± 0.17	80.09 ± 0.09	3.46 ± 0.06	82.14 ± 0.14	3.42 ± 0.12	103.57 ± 2.22	4
Phaeoprogne tapera	80.35 ± 0.22	3.21 ± 0.15	80.36 ± 0.40	3.19 ± 0.33	82.48 ± 0.35	3.07 ± 0.30	100.43 ± 4.42	4
Progne chalybea	80.35 ± 0.36	3.20 ± 0.31	80.04 ± 0.27	3.51 ± 0.26	82.55 ± 0.52	3.01 ± 0.48	95.84 ± 6.72	4
Pygochelidon cyanoleuca	80.11 ± 0.14	3.44 ± 0.16	79.74 ± 0.63	3.81 ± 0.67	82.28 ± 0.17	3.27 ± 0.15	95.77 ± 10.27	4
Atticora fasciata	79.93 ± 0.24	3.63 ± 0.19	80.14 ± 0.25	3.41 ± 0.20	81.97 ± 0.21	3.59 ± 0.14	103.62 ± 0.79	4
Neochelidon tibialis	80.13 ± 0.22	3.42 ± 0.20	80.12 ± 0.57	3.43 ± 0.52	82.22 ± 0.28	3.34 ± 0.23	100.71 ± 10.70	4
Stelgidopteryx ruficollis	79.98 ± 0.06	3.57 ± 0.03	79.70 ± 0.57	3.86 ± 0.48	82.22 ± 0.16	3.34 ± 0.06	95.89 ± 7.46	2
Riparia riparia	79.98 ± 0.25	3.57 ± 0.22	79.81 ± 0.62	3.75 ± 0.64	82.19 ± 0.28	3.37 ± 0.26	98.23 ± 7.26	4
R. cincta	80.21 ± 0.13	3.35 ± 0.12	80.38 ± 0.20	3.17 ± 0.14	82.43 ± 0.32	3.13 ± 0.28	103.06 ± 3.14	4
Pseudhirundo griseopyga	79.73 ± 0.30	3.82 ± 0.25	79.83 ± 0.35	3.73 ± 0.32	81.97 ± 0.34	3.59 ± 0.28	101.52 ± 1.71	4
Ptyonoprogne fuligula	80.70 ± 0.09	2.85 ± 0.10	80.83 ± 0.46	2.72 ± 0.50	82.98 ± 0.10	2.57 ± 0.06	102.62 ± 7.22	4
Hirundo rustica	80.87 ± 0.20	2.70 ± 0.14	81.31 ± 0.39	2.26 ± 0.33	83.03 ± 0.22	2.55 ± 0.14	107.98 ± 6.25	3
Cecropis semirufa	81.69 ± 0.24	1.86 ± 0.27	82.08 ± 0.19	1.48 ± 0.21	83.79 ± 0.19	1.77 ± 0.24	106.92 ± 0.67	4
Petrochelidon spilodera	82.11 ± 0.25	1.44 ± 0.28	82.44 ± 0.27	1.11 ± 0.32	84.26 ± 0.18	1.30 ± 0.21	106.14 ± 2.35	4
P. pyrrhonota (hm)	83.21 ± 0.46	0.00	83.21 ± 0.49	0.00	85.33 ± 0.32	0.00	100.00	7
P. pyrrhonota (ht)	83.08 ± 0.02	0.47 ± 0.11	82.52 ± 0.66	1.03 ± 0.75	85.21 ± 0.01	0.35 ± 0.11	91.55 ± 9.41	2
Delichon urbica	81.32 ± 0.13	2.25 ± 0.20	81.80 ± 0.09	1.77 ± 0.16	83.53 ± 0.11	2.05 ± 0.19	108.54 ± 0.61	3
Psalidoprocne holomelas	79.99 ± 0.34	3.57 ± 0.27	80.47 ± 0.35	3.08 ± 0.28	82.11 ± 0.35	3.45 ± 0.29	108.98 ± 1.02	4
Parus bicolor	73.55 ± 0.50	9.19 ± 0.50	70.26 ± 2.35	12.48 ± 2.35	74.87 ± 0.53	10.15 ± 0.53	75.75 ± 13.36	4
Delichon urbica								
Tachycineta bicolor	80.08 ± 0.20	3.61 ± 0.13	80.04 ± 0.17	3.63 ± 0.23	82.47 ± 0.20	3.48 ± 0.19	99.31 ± 3.12	3
Phaeoprogne tapera	80.13 ± 0.22	3.47 ± 0.15	80.05 ± 0.13	3.54 ± 0.20	82.62 ± 0.21	3.30 ± 0.22	98.59 ± 1.87	4
Progne chalybea	79.81 ± 0.46	3.79 ± 0.15	78.55 ± 1.26	5.04 ± 0.98	82.45 ± 0.10	3.47 ± 0.09	86.08 ± 7.35	4
Pygochelidon cyanoleuca	79.93 ± 0.60	3.67 ± 0.37	79.50 ± 0.65	4.08 ± 0.66	82.39 ± 0.57	3.53 ± 0.50	94.87 ± 8.29	4
Atticora fasciata	79.85 ± 0.27	3.75 ± 0.42	79.75 ± 0.35	3.83 ± 0.48	82.28 ± 0.29	3.64 ± 0.31	98.62 ± 1.11	4
Neochelidon tibialis	79.97 ± 0.26	3.72 ± 0.10	79.90 ± 0.41	3.77 ± 0.56	82.45 ± 0.09	3.50 ± 0.03	99.29 ± 6.33	3
Stelgidopteryx ruficollis	80.05 ± 0.20	3.64 ± 0.48	79.73 ± 0.28	3.94 ± 0.57	82.49 ± 0.25	3.46 ± 0.34	95.55 ± 3.71	3
Riparia riparia	80.05 ± 0.31	3.64 ± 0.03	80.15 ± 0.16	3.52 ± 0.44	82.47 ± 0.23	3.48 ± 0.14	101.74 ± 6.83	3
R. cincta	80.13 ± 0.36	3.39 ± 0.05	80.05 ± 0.45	3.44 ± 0.16	82.63 ± 0.28	3.26 ± 0.20	98.99 ± 1.87	3

APPENDIX. Continued.

	T_m	ΔT_m	$T_{50}H$	$\Delta T_{50}H$	Mode	Δmode	NPR	n
Pseudhirundo griseopyga	79.72 ± 0.38	3.80 ± 0.09	79.83 ± 0.07	3.66 ± 0.27	82.34 ± 0.20	3.55 ± 0.18	101.55 ± 4.78	3
Ptyonoprogne fuligula	80.71 ± 0.05	2.89 ± 0.33	80.57 ± 0.40	3.01 ± 0.46	83.16 ± 0.16	2.76 ± 0.26	98.18 ± 5.02	4
Hirundo rustica	80.85 ± 0.29	2.84 ± 0.03	81.10 ± 0.23	2.57 ± 0.53	83.30 ± 0.22	2.64 ± 0.12	104.75 ± 9.54	3
Cecropis semirufa	80.97 ± 0.15	2.55 ± 0.36	80.93 ± 0.71	2.56 ± 0.73	83.41 ± 0.07	2.47 ± 0.17	100.15 ± 8.49	3
Petrochelidon spilodera	81.19 ± 0.12	2.42 ± 0.20	81.21 ± 0.10	2.37 ± 0.38	83.65 ± 0.10	2.27 ± 0.12	100.39 ± 3.07	4
P. pyrrhonota	81.18 ± 0.33	2.42 ± 0.07	80.51 ± 0.62	3.07 ± 0.35	83.61 ± 0.19	2.31 ± 0.14	90.44 ± 3.36	4
Delichon urbica (hm)	83.37 ± 0.38	0.00	83.36 ± 0.49	0.00	85.70 ± 0.29	0.00	100.00	7
D. urbica (ht)	83.02 ± 0.26	0.58 ± 0.12	82.65 ± 0.83	0.93 ± 1.20	85.35 ± 0.28	0.57 ± 0.15	95.71 ± 16.36	2
Psalidoprocne holomelas	80.01 ± 0.22	3.59 ± 0.14	80.21 ± 0.15	3.37 ± 0.41	82.40 ± 0.17	3.51 ± 0.10	103.24 ± 5.82	4
Parus bicolor	73.84 ± 0.35	9.21 ± 0.35	69.65 ± 3.75	13.41 ± 3.75	75.46 ± 0.33	9.94 ± 0.33	73.30 ± 14.75	4
Psalidoprocne holomelas								
Tachycineta bicolor	77.99 ± 0.26	3.78 ± 0.52	76.42 ± 0.13	5.34 ± 0.28	80.65 ± 0.35	3.40 ± 0.56	83.40 ± 2.05	3
Phaeoprogne tapera	78.44 ± 0.16	3.50 ± 0.24	77.45 ± 0.16	4.48 ± 0.28	81.07 ± 0.22	3.15 ± 0.40	88.16 ± 0.53	3
Progne chalybea	78.24 ± 0.28	3.69 ± 0.41	76.87 ± 0.39	5.06 ± 0.68	80.85 ± 0.15	3.37 ± 0.41	85.12 ± 4.05	3
Pygochelidon cyanoleuca	78.36 ± 0.19	3.90 ± 0.16	76.85 ± 1.43	5.41 ± 1.28	80.69 ± 0.03	3.76 ± 0.12	84.09 ± 9.21	3
Atticora fasciata	77.75 ± 0.15	4.18 ± 0.16	76.80 ± 0.08	5.13 ± 0.25	80.39 ± 0.17	3.83 ± 0.16	88.74 ± 1.22	3
Neochelidon tibialis	77.70 ± 0.26	4.24 ± 0.18	76.70 ± 0.12	5.23 ± 0.42	80.26 ± 0.26	3.96 ± 0.32	88.24 ± 3.71	3
Stelgidopteryx ruficollis	78.32 ± 0.17	3.62 ± 0.43	76.91 ± 0.43	5.02 ± 0.57	80.87 ± 0.06	3.35 ± 0.34	84.56 ± 5.50	3
Riparia riparia	78.45 ± 0.48	3.88 ± 0.21	77.26 ± 0.71	5.07 ± 0.47	80.91 ± 0.32	3.57 ± 0.21	85.67 ± 2.80	4
R. cincta	78.17 ± 0.07	3.76 ± 0.27	76.61 ± 0.51	5.32 ± 0.76	80.83 ± 0.06	3.39 ± 0.24	82.99 ± 4.30	3
Pseudhirundo griseopyga	77.79 ± 0.01	3.97 ± 0.30	76.08 ± 0.16	5.68 ± 0.46	80.44 ± 0.14	3.61 ± 0.32	82.17 ± 1.38	3
Ptyonoprogne fuligula	78.26 ± 0.30	3.67 ± 0.36	77.09 ± 0.77	4.84 ± 0.83	80.77 ± 0.35	3.45 ± 0.52	86.28 ± 4.84	3
Hirundo rustica	78.32 ± 0.12	3.53 ± 0.27	77.80 ± 0.52	4.04 ± 0.80	80.91 ± 0.18	3.23 ± 0.27	93.74 ± 6.67	4
Cecropis semirufa	78.35 ± 0.30	3.49 ± 0.16	77.36 ± 0.69	4.48 ± 0.44	80.93 ± 0.17	3.21 ± 0.32	88.34 ± 4.19	4
Petrochelidon spilodera	78.67 ± 0.13	3.26 ± 0.31	77.12 ± 0.69	4.81 ± 0.47	81.09 ± 0.31	3.13 ± 0.58	82.95 ± 4.85	3
P. pyrrhonota	78.92 ± 0.58	3.29 ± 0.29	77.40 ± 1.25	4.80 ± 0.82	81.30 ± 0.48	3.06 ± 0.26	82.65 ± 5.58	4
Delichon urbica	78.78 ± 0.31	3.64 ± 0.05	78.08 ± 0.56	4.33 ± 0.30	81.08 ± 0.17	3.43 ± 0.07	90.41 ± 2.29	3
Psalidoprocne holomelas (hm)	82.15 ± 0.68	0.00	82.15 ± 0.69	0.00	84.28 ± 0.59	0.00	100.00	10
P. holomelas (ht)	81.66 ± 0.27	0.19 ± 0.09	81.78 ± 0.11	0.07 ± 0.26	83.94 ± 0.25	0.20 ± 0.10	101.83 ± 2.60	2
Parus bicolor	73.78 ± 0.87	8.64 ± 0.35	69.24 ± 2.76	13.17 ± 1.96	74.81 ± 0.86	9.60 ± 0.26	67.46 ± 6.57	5
Parus bicolor								
Tachycineta bicolor	74.71 ± 0.24	9.33 ± 0.37	74.14 ± 0.47	9.89 ± 0.65	76.21 ± 0.33	9.79 ± 0.17	93.54 ± 2.68	4
Phaeoprogne tapera	75.02 ± 0.48	9.01 ± 0.35	74.41 ± 0.50	9.62 ± 0.40	76.84 ± 0.59	9.15 ± 0.45	92.57 ± 3.70	4
Progne chalybea	74.61 ± 0.02	9.44 ± 0.31	72.15 ± 0.66	11.91 ± 0.32	76.26 ± 0.09	9.76 ± 0.14	76.61 ± 4.42	2
Pygochelidon cyanoleuca	74.99 ± 0.27	9.12 ± 0.05	73.98 ± 0.58	10.13 ± 0.76	76.68 ± 0.38	9.36 ± 0.30	89.20 ± 7.40	3
Atticora fasciata	74.32 ± 0.13	9.74 ± 0.20	73.19 ± 0.05	10.87 ± 0.28	75.99 ± 0.46	10.02 ± 0.23	87.69 ± 0.80	2
Neochelidon tibialis	74.71 ± 0.22	9.33 ± 0.07	74.26 ± 0.22	9.78 ± 0.13	76.55 ± 0.35	9.44 ± 0.26	94.47 ± 0.72	4
Stelgidopteryx ruficollis	75.30 ± 0.30	8.81 ± 0.21	74.11 ± 0.74	9.99 ± 0.65	76.95 ± 0.29	9.09 ± 0.18	86.68 ± 4.49	3

APPENDIX. Continued.

	T_m	ΔT_m	$T_{50}H$	$\Delta T_{50}H$	Mode	Δmode	NPR	n
			Parus bicolor (continued)					
Cheramoeca leucosternus	74.89 ± 0.03	9.36 ± 0.09	74.15 ± 0.07	10.10 ± 0.13	76.91 ± 0.05	9.23 ± 0.10	91.49 ± 0.55	2
Riparia riparia	74.73 ± 0.20	9.38 ± 0.32	73.63 ± 0.42	10.48 ± 0.22	76.39 ± 0.27	9.65 ± 0.16	87.67 ± 3.42	3
R. cincta	74.94 ± 0.20	9.10 ± 0.27	73.53 ± 0.55	10.50 ± 0.51	76.68 ± 0.34	9.32 ± 0.18	84.30 ± 3.77	4
Phedina borbonica	74.90 ± 0.18	9.37 ± 0.13	74.41 ± 0.15	9.86 ± 0.11	76.86 ± 0.29	9.29 ± 0.25	93.97 ± 1.04	3
Pseudhirundo griseopyga	74.86 ± 0.30	9.18 ± 0.49	74.12 ± 0.58	9.92 ± 0.74	76.46 ± 0.22	9.53 ± 0.15	91.46 ± 3.05	4
Ptyonoprogne fuligula	75.01 ± 0.22	9.02 ± 0.20	73.61 ± 0.46	10.42 ± 0.63	76.70 ± 0.38	9.29 ± 0.24	84.39 ± 3.81	4
Hirundo rustica	75.11 ± 0.47	8.99 ± 0.40	73.18 ± 1.29	10.92 ± 1.36	76.68 ± 0.49	9.62 ± 0.40	81.78 ± 13.48	6
Cecropis semirufa	74.94 ± 0.35	9.09 ± 0.12	74.25 ± 0.36	9.78 ± 0.16	76.76 ± 0.48	9.24 ± 0.33	91.76 ± 2.22	4
Petrochelidon spilodera	74.80 ± 0.39	9.23 ± 0.22	73.74 ± 0.46	10.29 ± 0.22	76.52 ± 0.53	9.47 ± 0.37	88.20 ± 2.82	4
Haplochelidon andecola	75.58 ± 0.07	8.67 ± 0.01	71.48 ± 0.72	12.77 ± 0.78	77.30 ± 0.03	8.84 ± 0.08	68.14 ± 3.48	2
P. pyrrhonota	75.23 ± 0.29	8.80 ± 0.26	73.14 ± 1.35	10.89 ± 1.16	76.88 ± 0.34	9.12 ± 0.29	80.41 ± 9.21	4
Delichon urbica	74.87 ± 0.35	9.16 ± 0.34	73.50 ± 1.60	10.53 ± 1.48	76.52 ± 0.48	9.47 ± 0.38	86.53 ± 11.40	4
Psalidoprocne holomelas	74.62 ± 0.20	9.42 ± 0.20	74.29 ± 0.44	9.74 ± 0.24	76.43 ± 0.31	9.57 ± 0.21	95.96 ± 3.40	4
Parus bicolor (hm)	84.16 ± 0.20	0.00	84.16 ± 0.22	0.00	86.25 ± 0.40	0.00	100.00	9