ELECTRONIC SUPPLEMENTARY MATERIALS FOR:

Ksepka, Clarke, Nesbitt, Kulp, and Grande: Fossil Evidence of Wing Shape in a Stem Relative of Swifts and Hummingbirds (Aves, Pan-Apodiformes)

I. EXPANDED DIFFERENTIAL DIAGNOSIS

Eocypselus can be differentiated from other members of Pan-Apodiformes, and from more distantly related members of Strisores by a suite of characters. Diagnostic character states for *Eocypselus* (Harrison, 1984; Mayr, 2010a) are listed below, and those that can be observed directly in the holotype of *Eocypselus rowei* are marked with an asterisk. Unmarked character states are present in European specimens of *Eocypselus vincenti* but cannot be observed in the Green River specimen due to preservation. *Eocypselus* differs from crown group Apodiformes in presence of well-developed processus lateralis of the coracoid, humerus with crista deltopectoralis dorsoventrally thin rather than thick and finger-like (reversed in crown hummingbirds), distally placed processus supracondylaris dorsalis (attachment for m. extensor carpi radialis)*, weakly developed processus internus indicis of phalanx II-1*, unexpanded distal tip of phalanx II-2*, and weakly developed tuberositas musculi tibialis cranialis of the tarsometatarsus. *Eocypselus* differs from the extinct Aegialornithidae in the more strongly abbreviated humerus*, and unfenestrated digit II-1* with weakly developed processus internus indicis*. *Eocypselus* differs from other members of the clade Strisores (Podargidae, Steatornithidae, Caprimulgidae, Nyctibiidae, Aegothelidae) in the more strongly abbreviated humerus*, slender ischium which contacts the pubis at a high angle*, and presence of an ossified retinaculum extensorium of the tarsometatarsus.

II. INSTITUTIONAL ABBREVIATIONS

AMNH, American Museum of Natural History, New York, USA; **FMNH**, Field Museum of Natural History, Chicago, Illinois, USA; **NCSM**, North Carolina Museum of Natural Sciences, Raleigh, North Carolina, USA; **SMF**, Forschungsinstitut Senckenberg, Frankfurt, Germany; **SMNK**, Staatliches Museum für Naturkunde Karlsruhe, Germany; **USNM**, National Museum of Natural History, Smithsonian Institution, Washington, D.C. USA; **UWMB**, University of Washington Burke Museum, Seatlle, Washington, USA; **WDC,** Wyoming Dinosaur Center, Thermopolis, Wyoming, USA.

III. ADDITIONAL DETAILS OF PHYLOGENTIC RESULTS

Our phylogenetic results differ in several key points from previous hypotheses, provide additional resolution for key subclades, and clarify the distribution of several key characters. With regards to higher-level relationships, we recover a clade uniting Steatornithiformes and Podargiformes as the basal divergence in Strisores. This grouping was supported by the morphology-based analysis of Livezey and Zusi (2006, 2007) and the combined analysis of Nesbitt et al. (2011: see this reference for character discussion), though Livezey and Zusi (2006, 2007) recovered this clade in a more nested position within Strisores. In contrast, Steatornithiformes occupy the most basal branch within Strisores in the hypothesis of Mayr (2010) and a sister group relationship between Podargidae and Nyctibiidae was reported in the phylogenomic study of Hackett et al. (2008). We also recover the controversial Green River taxon *Fluvioviridavis* as a member of Podargiformes, based primarily on cranial synapomorphies reported by Nesbitt et al. (2011). Otherwise, relationships outside of Pan-Apodiformes are in agreement with most previous studies (Mayr, 2002, 2003, 2010; Hackett et al., 2008; Nesbitt et al., 2011).

Eocypselus is supported as a member of Pan-Apodiformes in our result by two unambiguous synapomorphies: an abbreviated humerus and an ossified arcus extensorius of the tarsometatarsus (Mayr, 2005). Monophyly of crown Apodiformes is supported by a sternum with weakly saddle-shaped or convex articular surfaces for the coracoids, a dorsoventrally thick and finger-like crista deltopectoralis, a well-projected tubercle or process placed well proximal to the distal end of the humerus for attachment of m. tensor propatagialis pars brevis (modified in some Apodidae), a well-developed processus internus indicis (convergently present in *Fluvioviridavis*, *Steatornis*, *Nyctibius* and

Caprimulgus), distal expansion of manual phalanx II-2, and prominent projection of the tuberositas musculi tibialis cranialis of the tarsometatarsus (see Mayr, 2010). A greatly anteriorly expanded, plate-like ectethmoid and spina externa forming a ridge that extends dorsoventrally over entire rostrum of the sternum, are a potential synapomorphies of Apodiformes, though these characters cannot be scored in *Eocypselus*. Mayr (2010) also listed a furcula with well-developed facies articularis acrocoracoidea as a synapomorphy of Pan-Apodiformes exclusive of *Eocypselus*, but this feature is also present in *Protocypselomorphus*, *Aegotheles* and *Nyctibius* and thus optimizes a synapomorphy of Cypselomorphae in our study, with a reversal in *Eocypselus*.

Relationships within Apodidae are not currently well-established. Our phylogeny includes representatives of the four recognized tribes of swifts and supports several major subclades within Apodidae. Placement of *Streptoprocne* (Cypseloidini) as part of the basal divergence in Apodidae is consistent with results of a previous likelihood analysis using the ZENK gene (Chubb, 2004). Monophyly of sampled swifts excluding *Streptoprocne* is supported by the attachment of m. tensor propatagialis pars brevis at the proximally displaced processus supracondylaris dorsalis (see Zusi and Bentz, 1982), presence of a proximally directed flange extending proximally along the shaft from the base of the plantar flange of trochlea metatarsi II (new character), and diastataxic wing feathering (see Bostwick and Brady, 2002). Holmgren (1998) proposed that *Streptoprocne* represented a more basal divergence, sister to Hemiprocnidae + all other Apodidae, but we find no evidence for that topology here. Holmgren (1998) listed two potential synapomorphies uniting Hemiprocnidae and Apodidae excluding Cypseloidini: a single carotid artery and use of saliva in nest building. We find both to show

homoplasy, and the distribution of the saliva character to be additionally complicated by the fact that some swifts (e.g., *Hirundapus*) do not build nests but instead dig a shallow scrape. Enforcing a topology in which Cypseloidini is basal requires 18 additional steps.

Our results differ from Chubb (2004) and agree with Holmgren (1998) in supporting monophyly of the Chaeturini (represented by *Chaetura* and *Hirundapus* in both studies). This clade is supported by presence of a bony canal on the plantar surface of the base of trochlea metatarsi II (new character) and presence of needle-like rectrices (Holmgren, 1998). A clade uniting *Aerodramus* (Collocaliini) and *Apus* (Apodini) was supported in our combined analysis as well as the analysis of Chubb (2004), though we identified no morphological synapomorphies of this clade, which collapses in the morphology-only analysis. The grouping of Collocaliini and Apodini to the exclusion of Chaeturini was also supported by the molecular analysis of Thomassen et al. (2005), though that study did not include any representatives of Cypseloidini. Given the lack of morphological support, more focus on this portion of the swift tree is warranted.

APPENDIX S1: MORPHOLOGICAL CHARACTER DESCRIPTIONS

1. Ossified nasal septum: absent (0); present (1). (Mayr, 2010b: character 1)

2. External naris, anterior portion, rim surrounding naris: restricted to the area immediately surrounding the external naris (0); extends anterolaterally onto the dorsal surface of the beak (1). (Nesbitt et al., 2011; character 2)

3. Beak, length and form: longer than rest of skull (0); shorter than rest of skull and very wide at its base, with narial openings large and reaching far into its tip (1); shorter than rest of skull and narrow at base (2). (Mayr, 2010b: character 2)

4. Rostrum, dense neurovascular pitting: absent (0); present (1). (Nesbitt et al., 2011; character 5)

5. Maxilla, posterior termination: continuous with the jugal bar (0); extends laterally and posteriorly to the contact jugal bar (=angulus tomialis) (1). (modified from Livezey and Zusi, 2006: character 408)

6. Skull, distinct nasofrontal hinge, i.e., posterior part of beak markedly set off from anterior part of cranium by a furrow: absent (0); present (1). (Mayr and Clarke, 2003: character 5)

7. Lacrimal, descending process: present and elongate (0); poorly developed or absent (1). (modified from Mayr, 2010b: character 3)

8. "Horns" projecting posteriorly at front of orbit: absent (0); present (1). (modified from Livezey and Zusi, 2006: character 383)

9. Sclerotic ossicles: moderate size (0); greatly enlarged (1). (Nesbitt et al., 2011: character 10)

10. Ectethmoid: no anterior or lateral expansion (0); greatly expanded anteriorly, plate-like, with dorsal margin largely fused with frontals (1); greatly expanded anterolaterally, inflated, with dorsal margin largely fused with frontals (2). (modified from Mayr, 2010b: character 4)

11. Postorbital process: short (0); elongated, touching or nearly touching the jugal bar (1). (modified from Mayr, 2005: character 13)

12. Vomer, truncate anterior and bifurcate posterior end (typical of the "aegithognathous" palate): absent (0); present (1). (Mayr, 2010b: character 5)

13. Palatine, pars lateralis: unexpanded or weakly expanded (0); extremely anterolaterally expanded (1). (Mayr, 2010b: character 8)

14. Palatine, strongly protruding posterolaterally directed processes: absent (0); present (1). (Mayr, 2010b: character 7)

15. Palate, internal choana, framed by ventrally directed lamina: absent (0); present (1). (modified from Livezey and Zusi, 2006: character 442)

16. Palatine, internal choana, direction of opening: ventral (0); posterior (1). (Nesbitt et al., 2011: character 16)

17. Palatines: remain separate anterior to the internal choana (0); fused anterior to the internal choana (1). (Nesbitt et al., 2011: character 17)

18. Palatine, processus rostromedialis: short (0); long and slender (1). (Mayr, 2010b: character 6)

19. Palatine: flat (0); bears a fossa on the ventral surface that is anterior to the internal choana and is separated from its counterpart by a midline lamina (1). (modified from Livezey and Zusi, 2006: character 455)

20. Palatine and pterygoid: fused (0); separate (1). (Mayr, 2010b: character 9)

21. Pterygoid-basipterygoid contact: present at the posterior portion of or along the midshaft of the pterygoid (0); present and restricted to the anterior portion of the pterygoid (1); absent (2). (modified from Mayr, 2010b: character 10)

22. Processus paroccipitalis: projected laterally and slightly ventrally (0); strongly ventrally protruding, pointed, and at or ventral to the level of the articular surface of the quadratomandibular joint (1). (Mayr, 2010b: character 11)

23. Cone-like bony protrusion at posterior margin of foramen nervi optici: absent (0); present (1). (Mayr, 2010b: character 12)

24. Arcus jugalis, lateral view: straight or nearly straight (0); strongly bowed, so that lateral margin of skull is convex (1). (Mayr, 2005: character 18)

25. Parietal, fossa temporalis: absent or far from the midline (0); meeting or almost meeting at midline of skull (1). (modified from Mayr, 2005: character 19)

26. Quadrate, processus orbitalis: anteriorly elongated (0); reduced, short process (1); greatly reduced, essentially absent (2). Ordered. (modified from Mayr, 2010b: character 13)

27. Quadrate, deep and narrow furrow separating capitulum squamosum from capitulum oticum: absent (0); present (1). (Mayr, 2010b: character 14)

28. Quadrate, processus oticus, dorsal margin of posterior surface: with many small pneumatic foramina (0); pneumatic foramina absent (1). (modified from Mayr, 2010b: character 15)

29. Mandible, distal part of rami: moderately or very wide (0); very narrow, resulting is a short symphysis (less than a third of maximum width of rami) (1). (Mayr, 2010b: character 16)

30. Mandible, articulation with quadrate includes a "locking mechanism" formed by laterally directed peg on the quadrate fitting into a medially open concavity of the articular portion of the mandible: absent (0); present (1). (Livezey and Zusi, 2006: character 710)

31. Mandible, posterior edge of articular portion in dorsal view: mediolaterally flat (0); rounded posteriorly (1). (Nesbitt et al., 2011; character 32)

32. Mandibular rami, ventral margin, lateral view: distinctly decurved (0); virtually straight (1). (modified from Livezey and Zusi, 2006: character: 673)

33. Mandible, anterior portion of the symphysis: nearly rounded (0); distinctly pointed (1). (Nesbitt et al., 2011; character 34)

34. Mandibular rami, pronounced, monotonic curvature producing continuous lateral concavity: absent (0); present (1). (Livezey and Zusi, 2006: character 658)

35. Mandible with intraramal joint and posterior half of mandibular rami greatly widened (mediolateral width greater than dorsoventral extension) and dorsoventrally flattened: absent (0); present (1). (Mayr, 2010b: character 17)

36. Mandible, proximal end small, with short cotyla lateralis and stout processus medialis forming a narrow sulcus: no (0); yes (1). (Mayr, 2010b: character 18)

37. Number of presacral vertebrae (all vertebrae anterior to synsacrum): 19 or more (0); 18 (1); 17 (2). Ordered. Mayr (2010) considered a reduction to 17 presacral vertebrae to represent a synapomorphy of Caprimulgidae and Nyctibiidae. However, we observed 18 presacral vertebrae in all available specimens of *Nyctibius*. (Mayr, 2010b: character 24)

38. Atlas, incisura fossa: present, dorsally open (0); absent, enclosed foramen (1). (Mayr, 2010b: character: 19)

39. Axis, foramina transversaria: present (0); absent (1). (Mayr, 2010b: character: 20)

40. Third cervical vertebra, osseous bridge from processus transversus to processus articularis caudalis: absent (0); present (1). (Mayr, 2010b: character: 21)

41. Fifth cervical vertebra, osseous bridge from processus costalis to midsection of corpus: absent (0); present (1). (Mayr, 2010b: character: 22)

42. Thoracic vertebrae 1 and 2, ventral tip of processus ventralis forming large horizontal plate: no (0); yes (1). (Mayr, 2010b: character: 23)

43. Furcula, omal tip with distinct, laterally protruding facies articularis acrocoracoidea: absent (0); present (1). (Mayr, 2010b: character: 25)

44. Coracoid, facies articularis scapularis: flat (0); cup-like (1). (Mayr, 2010b: character: 26)

45. Coracoid, foramen nervi supracoracoidei: absent (0); present (1). (Mayr, 2010b: character: 27)

46. Coracoid, small foramina ventral to process acrocoracoideus: absent (0); present (1). (Nesbitt et al., 2011; character 50)

47. Coracoid, bony loop between processus procoracoideus and acrocoracoideus: absent (0); present (1). (new character)

48. Coracoid, facies articularis sternalis: narrow (0); greatly widened dorsoventrally (1). (Mayr 2003, character 1)

49. Coracoid, tip of processus acrocoracoideus: hooked (0); unhooked (1). This character cannot be scored in extant hummingbirds in which an ossified loop connects the processus procoracoideus and processus acrocoracoideus. (new character)

50. Sternum, facies articularis coracoideus: concave or flat (0); weakly saddle-shaped or convex (1). (Mayr, 2010b: character 31)

51. Sternum, spina externa forming a ridge that extends dorsoventrally over entire rostrum: absent (0); present (1). (Mayr, 2010b: character 29)

52. Sternum, spina externa: single (0); bifurcated (1). Mayr 2003, character 4)

53. Sternum, number of incisurae/fenestrae: four incisurae /fenestrae (0); two incisurae/fenestrae (1); without incisurae/fenestrae (2). Ordered. (modified from Mayr, 2010b: character 32)

54. Humerus, dimensions: unabbreviated (0); abbreviated, ratio of length to midshaft width less than 10.0 (1); greatly abbreviated, ratio of length to midshaft width less than 5.0 (2). Ordered. (modified from Mayr, 2010b: character 37)

55. Humerus, distal protrusion of caput humeri: absent (0); present (1). See Figure 3 of Mayr (2003). (Mayr 2003, character 13)

56. Humerus, sulcus transversus very deep, long and rectangular-shaped: no (0); yes (1). (Mayr, 2010b: character: 33)

57. Humerus, caudal prominence of tuberculum ventralis: weak or moderate (0); distinctly greater than that of head of the humerus (1). (Mayr, 2010b: character: 34)

58. Humerus, crista deltopectoralis: proximodistally elongated (0); proximodistally narrow, strongly protruding and tapering (1). (Mayr, 2003: character 7)

59. Humerus, proximal portion, distal end of facies bicipitalis: indistinct and continuous with the shaft (0); distinct and extends ventral to the shaft (1). (Nesbitt et al., 2011: character 60)

60. Humerus, rounded tubercle distal to caput humeri: absent (0); present (1). See figure 4F of Mayr (2007). Although Mayr (2007) considered this tubercle to be absent

in extant hummingbirds, we found it to be present in *Archilochus colubris*. (new character)

61. Humerus, fossa m. brachialis: absent (0); shallow (1), deep and sharply delimited (2). Ordered. (modified from Mayr, 2010b: character 36)

62. Humerus, processus supracondylaris dorsalis (origin for m. extensor radialis metacarpalis): weakly projected (0); strongly projected (1). (Mayr, 2003: character 8)

63. Humerus, processus supracondylaris dorsalis (origin for extensor radialis metacarpalis): distally placed (0); proximally placed, situated along the proximal 2/3rds of the shaft (1). Note that this character references the more proximal of the two processes present in present along the dorsal margin of the shaft in *Hemiprocne*. (Mayr, 2005: character 24)

64. Humerus, attachment of m. tensor propatagialis pars brevis: small, distally located tubercle (0); well-projected tubercle or process placed well proximal to the distal end of the humerus (1); attachment at the proximally displaced processus supracondylaris dorsalis (2). Zusi and Bentz (1982) demonstrated the arrangement of m. tensor propatagialis brevus and m. exentensor metacarpi radialis in hummingbirds and swifts. Some Apodidae and Trochilidae lack a distinct of tubercle of insertion for m. tensor propatagialis brevus due to combined insertion of the tendons of the tendons of this muscle and m. exentensor metacarpi radialis. We consider this to as a separate state from the primitive condition of a weak, distally located tubercle for m. tensor propatagialis brevus. Because the fossil

taxon *Scaniacypselus wardi* possesses a strongly projected proximally displaced processus supracondylaris dorsalis and lacks any evidence of a distal attachment for m. tensor propatagialis brevus, we scored this taxon (2). Ordered. (new character)

65. Humerus, strongly protruding process attachment site of m. pronator superficialis: absent (0); present (1). (Mayr, 2003: character 14)

66. Humerus, distal end, tuberculum supracondylare ventrale: low and rounded (0); elongated and narrow (1). (Mayr, 2010b: Character 35)

67. Radius and ulna, insertion of m. biceps brachii: inserts on both radius and ulna (0); inserts on radius (1); inserts on ulna (2). Codings were made based on the family level observations of Karhu (1988). (new character)

68. Radius, distal end with marked tubercle on ventral side of shaft, opposite to tubercle ulnare: no (0); yes (1). (Mayr, 2010b: character 38)

69. Ulna, tuberculum ligamenti collatoralis: small (0); greatly expanded (1). (new character)

70. Ulna, olecranon: blunt (0); constricted and sharp (1). (Mayr, 2003: character 18)

71. Ulna, deep fossa at proximal end: absent (0); present (1). See figure 4H of Mayr (2007). (new character)

72. Proportions of distal wing (carpometacarpus + phalanges II-1 and II-2): distal wing shorter than humerus (0); distal wing longer than humerus (1); carpometacarpus

alone is longer than humerus (2). Ordered. (modified from Mayr, 2005: character 37)

73. Carpometacarpus, processus dentiformis: absent (0); present (1). (new character)

74. Carpometacarpus, processus intermetacarpalis: absent or small (0); well-developed, reaching metacarpal III (1); absent, but tendon of musculus extensor carpi ulnaris inserts on metacarpal III as it does in taxa with a intermetacarpal process (2). Our scoring for *Eurotrochilus* follows Mayr and Micklich (2010b) who demonstrate the presence of this structure (contra Bocheński and Bocheński, 2008). (Mayr, 2005: character 50)

75. Carpometacarpus, projection of distal end of metacarpal III: shorter than or subequal to metacarpal II (0); longer than metacarpal II (1). (Mayr, 2010b: character 40)

76. Manual phalanx II-1, cranial face: narrow (0); dorsoventrally widened, giving phalanx a T-shaped cross section (1). (Nesbitt et al., 2011: character 71)

77. Manual phalanx II-1, processus internus indicis: poorly developed (0); well-developed (1). (Mayr, 2010b: character 44)

78. Manual phalanx II-1, processus internus indicis: placed near caudal margin of the distal end of the phalanx (0); placed near midpoint of the distal end of the phalanx (1). (new character)

79. Manual phalanx II-1, dorsal fossa: single depression (0); divided into two depressions or fenestrae separated by a distinct oblique bulge (1). (Mayr, 2010b: character 43)

80. Manual phalanx II-1: solid (0); fenestrated (1). (new character)

81. Manual phalanx II-2, distal end: straight or slight posterior expansion (0); posterior expansion well-developed (1). (Nesbitt et al., 2011: character 75)

82. Pelvis, foramen ilioischiadicum: open (0); closed (1). (Mayr, 2010b: character 45)

83. Pelvis wide in mediolateral direction, width across antitrochanters: less than length of synsacrum (0); greater than length of synsacrum (1). (Mayr, 2010b: character 46)

84. Pelvis, well-developed tuberculum preacetabularis: present (0); absent (1). (Mayr, 2010b: character 47)

85. Pelvis, terminal portion of the ischium slender, touching pubis at an angle of 45° - 90°, thus creating a very wide fenestra ischiopubica: no (0); yes (1). (Mayr, 2005: character 63)

86. Tibiotarsus, length: distinctly longer than carpometacarpus (0); shorter or about equal length to the carpometacarpus (1). (Mayr, 2005: 65)

87. Tibiotarsus, distal end, pons supratendineus: ossified (0); unossified (1). (Mayr, 2010b: character 48)

88. Tibiotarsus, distal sulcus of trochlea cartilaginis tibialis: shallow (0); deep (1). (Mayr, 2010b: character 49)

89. Intertarsal sesamoid: absent (0); present (1). (Mayr, 2010b: character 50)

90. Tarsometatarsus, length: at least half as long as carpometacarpus (0); greatly abbreviated, less than half as long as carpometacarpus (1). (Mayr, 2010b: character 51)

91. Tarsometatarsus, hypotarsus, enclosure of tendons of musculus flexor digitorum longus and musculus flexor hallucis longus: no bony canals present (0); single canal present (1); two canals present (2). Ordered. (modified from Mayr, 2010b: character 53)

92. Tarsometatarsus, arcus extensorius (ossified retinaculum extensorium): absent (0); present (1). (Mayr, 2010b: character 54)

93. Tarsometatarsus, tuberculum m. tibialis cranialis: modestly developed (0); extremely prominent (1). (Mayr, 2010b: character 52)

94. Tarsometatarsus, tuberculum m. tibialis cranialis: placed near midline of dorsal face of tarsometatarsus (0); placed near medial margin of dorsal face of tarsometatarsus (1). (new character)

95. Tarsometatarsus, crista medianoplantaris: absent (0); present (1). (new character)

96. Tarsometatarsus, medial and lateral margins of trochlea metatarsi II with pronounced plantarly directed flanges: absent (0); present (1). (new character)

97. Tarsometatarsus, proximally directed flange extending proximally along the shaft from the base of the plantar flange of trochlea metatarsi II: absent (0); present (1). (new character)

98. Tarsometatarsus, bony canal on the plantar surface of the base of trochlea metatarsi II: absent (0); present (1). (new character)

99. Tarsometatarsus, canalis interosseus distalis: present (0); absent (1). (Mayr, 2010b: character 55)

100. Second and third phalanx of fourth toe: subequal in length to fourth phalanx (0); greatly abbreviated, measuring less than half the length of the fourth phalanx (1). (Mayr, 2010b: character 56)

101. Cerebellum with reduced anterior lobe, particularly small folia II and III, and relatively large posterior lobe: no (0); yes (1). (Mayr, 2010b: character 69; scorings after Iwaniuk, 2006)

102. Caeca: absent (0); present (1). (Mayr, 2010b: character 68)

103. Rictal bristles: absent (0); present (1). (Mayr, 2010b: character 67)

104. Villi at the bases of the basal-most downy barbules of breast feathers: absent (0); present (1). (Mayr, 2005: 98)

105. Wing feathering, ratio of longest primary to longest secondary: <2.0 times longer (0); greatly extended, >2.5 times longer (2). We supplemented scorings from specimens with scorings from online images from the Slater Museum Wing Image Collection Database.

106. Wing feathering: diastataxic (0); eutaxic (1). (Mayr, 2010b: character 66)

107. M. splenius capitis with cruciform origin: no (0); yes (1). (Mayr, 2010b: character 57)

108. M. ambiens: present (0); absent (1). (Mayr, 2010b: character 58)

109. M. iliofemoralis externus: present (0); absent (1). (Mayr, 2010b: character 59)

110. M. flexor cruris lateralis, pars accessoria: present (0); absent (1). (Mayr, 2010b: character 60)

111. M. caudofemoralis, pars pelvica: present (0); absent (1). (Mayr, 2010b: character 61)

112. M. fibularis longus: present (0); absent (1). (Mayr, 2010b: character 62)

113. M. popliteus: present (0); absent (1). (Mayr, 2010b: character 63)

114. Vinculum between tendons of musculus flexor perforans et perforatus digiti III and musculus perforatus digiti III: present (0); absent (1). (Mayr, 2010b: character 64)

115. Cranial carotid arteries: left and right artery present (0); only left artery present (1). Scorings follow Glenny (1953) and Chantler (1999).

116. Saliva used nest building: no (0); yes (1). Scorings follow Chantler (1999). Because *Hirundapus caudacutus* scrapes a depression instead of constructing a nest, we coded this species "?" for this character. After Holmgren (1998).

117. Needle-like rectrices, with rachi extending distally well beyond the barbed region of the feather: absent (0); present (1). After Holmgren (1998).

APPENDIX S2: SKELETAL SPECIMENS AND LITERATURE CONSULTED FOR SCORINGS

Aegotheles cristatus: USNM 632141

Aerodramus vanikorensis: USNM 557188

Amazilia tzacatl: USNM 613414

Apus apus: USNM 621285, USNM 621341, UWMB 32988**,** UWMB 56587

Archilochus colubris: NCSM 8365, NCSM 10040, NCSM 22313

Batrachostomus auritus: USNM 430279

Caprimulgus carolinensis: NCSM 18510, NCSM 18528, NCSM 18529, UWBM 32812

Chaetura pelagica: NCSM 8702, NCSM 8930, UWBM 32434, UWBM 32435

Crypturellus undulatus: AMNH 6480

Eocypselus vincenti: Harrison, 1984; Dyke et al. 2004; Mayr 2010

Eocypselus rowei: WDC CGR-109

Hemiprocne mystacea: USNM 572397, USNM 560829, UWBM 58752, UWBM 63244

Hirundapus caudacutus: USNM 632245, USNM 500800, UWBM 47128, UWBM 47231

Fluvioviridavis platyrhamphus: SMNK.PAL.2368a+b holotype, FMNH PA 607

Masillapodargus longipes: SMNK.PAL.1083 (holotype), SMF-ME 1415a+b, SMNK.PAL.552a+b, SMNK.PAL.557, SMF-ME 3404a+b, SMF-ME 3405a+b., SMF-ME 3406, Mayr 1999; Mayr 2003

Nyctibius grandis: FMNH 378824USNM 615095

Paraprefica kelleri: SMF-ME 3376 (holotype), SMF-ME 1635a+b, SMF-ME 1926, SMF-ME 2553, SMF-ME 3377a+b, SMNK.PAL.938, SMF-ME 3578, SMF-ME 3727a+b, SMF-ME 1760 Mayr 1999, Mayr 2005b

Podargus strigoides: USNM 612707, UWBM 57500

Prefica nivea: USNM 336278 (holotype)

Protocypselomorphus manfredkelleri: SMF-ME 11043 (holotype), Mayr, 2005

Scaniacypselus wardi: Harrison, 1984

Scaniacypselus szarskii: Peters 1985; Mayr and Peters, 1999

Steatornis caripensis: FMNH 318679, USNM 560206, USNM560152

Streptoprocne zonaris: USNM 614120, USNM 622306

APPENDIX S3: GENBANK ACCESSION NUMBERS AND CITATIONS FOR SEQUENCE DATA

	cytochrome b	c-myc ex3	RAG	myoglobin exon 2
Aegotheles cristatus	X95775 (Mariaux and Braun, 1996)	FJ588483 (Braun and Huddleston, 2009)	-	-
Aerodramus vanikorensis	FJ588453 (Braun and Huddleston, 2009)	EU738244 (Hackett et al. 2008)	-	EU739913 (Hackett et al. 2008)
Amazilia tzacatl	FJ588452 (Braun and Huddleston, 2009)	FJ588479 (Braun and Huddleston, 2009)	-	-
Apus apus	AY135633 (Thomassen et al. 2003)	-	AF294664 (Johansson et al. 2001)	-
Archilochus colubris	EF532935 (Morgan-Richards et al. 2008)	-	-	-
Batrachostomus septimus	EF100673 (Cleere et al. 2007)	EU738255 (Hackett et al. 2008)	DQ482613 (Barrowclough et al. 2006)	EU739925 (Hackett et al. 2008)
Caprimulgus carolinensis	FJ588442 (Braun and Huddleston, 2009)	FJ588461 (Braun and Huddleston, 2009)	DQ482627 (Barrowclough et al. 2006)	-
Chaetura pelagica	AF168105 (Hughes and Baker, 1999)	-	EF373495 (Pereira et al. 2007)	-
Crypturellus undulatus	AY139629 (Garcia-Moreno et al. 2003)	-	-	-
Hemiprocne	AY150655	EU738306	DQ482637	EU739976

mystacea	(Bleiweiss et al. 2003)	(Hackett et al. 2008)	(Barrowclough et al. 2006)	(Hackett et al. 2008)
Hirundapus caudacutus	AY294474 (Price et al. 2004)	-	EF373494 (Pereira et al. 2007)	-
Nyctibius grandis	EU344977 (Pratt et al. 2009)	EU738328 (Hackett et al. 2009)	DQ482612 (Barrowclough et al. 2006)	EU739997 (Hackett et al. 2008)
Podargus strigoides	EF100672 (Cleere et al. 2007)	EU738354 (Hackett et al. 2008)	EF373496 (Pereira et al. 2007)	EU740023 (Hackett et al. 2008)
Steatornis caripensis	EF100675 (Cleere et al. 2007)	FJ588476 (Braun and Huddleston, 2009)	DQ482611 (Barrowclough et al. 2006)	EU740042 (Hackett et al. 2008)
Streptoprocne zonaris	AY294481 (Price et al. 2004)	EU738374 (Hackett et al. 2008)	-	EU740043 (Hackett et al. 2008)

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