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# BIRDS CAUGHT IN SPIDER WEBS: A SYNTHESIS OF PATTERNS

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ABSTRACT.—Results of queries through public avian list-servers and a thorough literature search formed a data base to synthesize patterns of birds trapped in spider webs. Sixty-nine cases of birds, representing 54 species in 23 families, were reported trapped in webs. Hummingbirds were the most diverse family (nine species) and had the most cases of entrapment ($n = 20$). *Archilochus colubris* represented the species with the most cases of entrapment ($n = 6$). Mean mass and wing chord length of all species trapped were 11 g and 61 mm, respectively. Eighty-seven percent of all individuals had mass ≤15 g and 88% had a wing chord <90 mm. *Phaethornis longuemareus* and *Mellisuga minima* represented the smallest species (mass = 2 g, wing chord = 37 mm), and *Streptopelia senegalensis* was the largest (mass = 80 g, wing chord = 138 mm). Thirty cases of birds were entrapped without human intervention: 22 died and eight not wrapped in silk freed themselves. Those wrapped in silk invariably died unless freed by a human observer. One-half of all reported spider webs were of the genus *Nephila*, and all were orb weavers except for a single *Latrodectus*. *Nephila clavipes* entrapped nine species representing 14 cases, ranging from *Mellisuga minima* (mass = 2 g, wing chord = 37 mm) to *Catharus ustulatus* (mass = 23 g, wing chord = 93 mm). Patterns, causes, and consequences of birds entrapped in spider webs are discussed, including orb weavers as opportunistic predators of birds trapped in webs, and spider webs as a natural environmental hazard to birds. *Received 31 August 2011. Accepted 7 December 2011.*

Birds have a wide variety of predators. Top predators to birds include humans, who have a long history of harvesting birds for sport, protein, and ritual (Brooks 1999). Other predators of birds include fish (Lockwood 1922), reptiles (Dove et al. 2011), amphibians (Norris-Elye 1944), mammals (Bisbal 1986), and a variety of avian species ranging from raptors (Mayr 1966) to certain passerines (Graves 1978). Hymenopterans (Grant 1959), odonates (Hofslund 1977), and mantids (Carignan 1988) have also been reported to attack birds, especially smaller species such as hummingbirds (Trochilidae).

Other cases involving invertebrates include birds trapped in webs of orb weaver spiders, of which there are numerous accounts in regional journals (e.g., Coale 1912, Lockwood 1922, Kirkham 1925, Abbot 1931, Bent 1953, Grant 1959, Morris 1963, Doberski 1973, Pratt 1974, Vernon 1976, Hofslund 1977, Donnelly 1980, Dean 1984, Gosling 1984, Levy 1987, Carignan 1988, McKenzie 1991, Shaw 1994, Cheke and Mann 2001, Heck and Heck 2001, Riddell 2001, Engel 2006, Cox and Nesmith 2007, Peloso and de Sousa 2007, Brooks et al. 2008). The pattern of birds trapped in spider webs has not been properly synthesized to date despite extensive documentation because these observations are largely considered incidental and often dismissed by scientists as unremarkable (Graham 1997). For example, Lima (1993) broadly synthesized patterns of predator escape by North American birds but did not include fates of birds trapped in spider webs. Miller and Gass (1985) examined patterns of predation of hummingbirds and concluded the majority of the incidents were unusual and inconsistent. All cases they examined were of vertebrate predators except one, and that single case was not a spider.

Two colleagues and I found a web-entrapped Swainson's Thrush (*Catharus ustulatus*) in September 2007 while inspecting damage to wildlife sanctuaries on High Island (Galveston County, Texas) following Hurricane Humberto (Brooks et al. 2008). Subsequent literature review revealed a plethora of short published and unpublished reports of birds entrapped in spider webs with extensive variation in species and their respective fates. The objective of this synthesis is to examine patterns and fates of birds trapped in spider webs. This topic warrants investigation because birds trapped in spider webs have been reported in the literature on multiple occasions and may represent more than a series of trivial incidents. Even the most detailed reports to date (e.g., Graham 1997, Cox and Nesmith 2007, Peloso and de Sousa 2007, Sakai 2007) only examined a single or limited number of cases and lacked a thorough synthesis of multiple cases.

## METHODS

Data were obtained from an exhaustive literature search and replies to queries to several avian list-servers (NEOORN-L, ORNITH-L, African-Birding-L) on 17 September 2007. Some recipients of the initial posting forwarded the message

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to numerous individuals as well as to an Australian list-server (BirdingAus-L) on 19 September. All replies were tabularized into a data set. A follow-up e-mail posted to the same list-servers on 25 September resulted in additional information which expanded the data set. A literature search occurred during mid September 2007-mid November 2011 with most references from before 2008.

Only cases of birds trapped in a single spider web were included for consistency of comparisons. Reports of birds found encumbered with silk strands attached to the body were not included because the circumstances prior to the observation were undocumented. The bird may have simply picked up strands of an abandoned, broken spider web during flight.

Wing chord data were collected from study specimens at the Houston Museum of Natural Science (HMNS), the Field Museum (FMNH), and the American Museum of Natural History (AMNH). Measurements were collected using standard dial calipers and measured to the nearest mm. Mass (g) data were gleaned from specimen tags at HMNS and FMNH, and from Dunning (2008) for AMNH specimens where mass data were lacking from tags.

Birds could be trapped in a web strictly due to entanglement in the sticky threading. Those wrapped in silk by the spider did not survive and this was noted when the data were compiled. Additional bird fates examined included whether entrapped birds were: (1) able to free themselves or released with human intervention (and if they subsequently survived), (2) killed or consumed by a spider, or (3) found dead in the web. Chi-square tests were used to test probabilities ($P \leq 0.05$) with the exception of a Pearson product-moment correlation used to test the relationship between avian mass and wing chord.

## RESULTS

*Patterns of Diversity and Size of Trapped Birds.*—Sixty-nine cases of birds representing 54 species in 23 families were reported trapped in spider webs (Table 1). The Ruby-throated Hummingbird (*Archilochus colubris*) represented the species with the most cases of entrapment ($n = 6$). Hummingbirds (Trochilidae) represented the most diverse family with nine species, as well as the family with the most cases of entrapment ($n = 20$).

Avian mass ($\xi = 11$ g) was significantly correlated with wing chord ($\xi = 61$ mm) ($r = 0.7851$, $P < 0.0001$, $n = 67$). Sixty (87%) of the 69 cases of entrapped birds have a mass $\leq$15 g and 61 (88%) have a wing chord $<$90 mm (Fig. 1). The Little Hermit (*Phaethornis longuemareus*) and Vervain Hummingbird (*Mellisuga minima*) represent the smallest species with a mass of 2 g and wing chord of 37 mm, whereas the largest species was the Laughing Dove (*Streptopelia senegalensis*) with mass of 80 g and wing chord of 138 mm.

*Patterns of Bird Fates.*—Sixty-six cases of avian fates were reported. Sixty-two included information detailing whether birds were wrapped in spider silk: 18 cases (29%) involved birds wrapped in silk and 44 (71%) did not ($X^2 = 10.08$, $P < 0.001$, $n = 62$). Both wrapped (range = 2–34 g) and unwrapped (range = 2–80 g) birds have a mean mass of 11 g and differences were not significant, as were differences in wing chord for wrapped (58 mm, range = 41–96 mm) versus unwrapped (64 mm, range = 37–138 mm) birds.

Twelve (66%) birds wrapped in silk were found dead in the web and six (33%) were assisted by human intervention (5 released unharmed, 1 died). Eight (18%) of the birds not wrapped in silk freed themselves and three (7%) were dead. Thirty-three (75%) were assisted by human intervention (31 released unharmed, 2 died). Only eight birds were able to free themselves without intervention, whereas the number surviving due to human intervention was 31 ($X^2 = 12.42$, $P < 0.0003$, $n = 39$).

Twenty-two (73%) birds in the natural and unbiased cases died as a result of spider web entrapment. This excluded biased situations where humans intervened and released trapped birds unharmed but added four additional cases with no data on silk wrapping to bring the total number of cases of entrapped birds to 30. All eight cases of birds that freed themselves from webs were not wrapped in silk; those wrapped in silk invariably died unless freed by a human observer. Mean mass of the eight birds that were able to free themselves was 11 g (range = 5–34 g) and wing chord was 66 mm (range = 56–129 mm), whereas the 22 that died had a mean mass of 9 g (range = 2–34 g) and wing chord of 53 mm (range = 37–96 mm). The mass and wing chord of birds that freed themselves without intervention was slightly greater than those that died, but the results are not statistically significant for both measurements.

*Patterns of Spider Taxonomy and Pervasiveness.*—All of the 46 records that included a description of the spider associated with the web were orb weavers except for a single case, an

TABLE 1. Species of birds entrapped in spider webs and their respective fates and sizes.

| Common name | Latin name | Spider sp. | Fate | Mass (gm) | Wing (mm) | Source |
|---|---|---|---|---|---|---|
| Doves | Columbidae | | | | | |
| Laughing Dove | *Streptopelia senegalensis* | *Nephila* sp. | NW, RU | 80 | 138 | D. Forsman in litt. |
| Hummingbirds | Trochilidae | | | | | |
| Long-billed Hermit | *Phaethornis longirostris* | *Nephila clavipes* | NW, RU | 5 | 56 | Sakai 2007 |
| Long-billed Hermit | *P.longirostris* | *N.clavipes* | NW, F | 5 | 56 | Graham 1997 |
| Long-billed Hermit | *P.longirostris* | *N.clavipes* | NW, F | 5 | 56 | Graham 1997 |
| Long-billed Hermit | *P.longirostris* | *N.clavipes* | W, RU | 5 | 56 | Graham 1997 |
| Little Hermit | *P.longuemareus* | *N.clavipes* | W, RU | 2 | 37 | Graham 1997 |
| Vervain Hummingbird | *Mellisuga minima* | *N.clavipes* | NW, K | 2 | 37 | Levy 1987 |
| Vervain Hummingbird | *M.minima* | *N.clavipes* | NW, K | 2 | 37 | Levy 1987 |
| White-chinned Sapphire | *Hylocharis cyanus* | Orb Weaver (*Mastophora*) | NW, RU | 4 | 50 | P. Rojas in litt. |
| Copper-rumped Hummingbird | *Amazilia tobaci* | Orb Weaver | W, RU | 5 | 50 | P. Clavijo M. in litt. |
| Rufous-tailed Hummingbird | *A.tzacatl* | *Nephila* sp. | NW, RU | 5 | 54 | B. Sanjur in litt. |
| Anna's Hummingbird | *Calypte anna* | Orb Weaver | NW, RU | 4 | 48 | Stott 1951 |
| Anna's Hummingbird | *C.anna* | ? | ?, K | 4 | 48 | Abbot 1931 |
| Anna's Hummingbird | *C.anna* | ? | NW, RU | 4 | 48 | Abbot 1931 |
| Costa's Hummingbird | *C.costae* | Orb Weaver | NW, RU | 3 | 43 | Woods 1934 |
| Ruby-throated Hummingbird | *Archilochus colubris* | Orb Weaver | W, K | 2 | 41 | K. Fraser in litt. |
| Ruby-throated Hummingbird | *A.colubris* | *Argiope* sp. | W, K | 2 | 41 | B. Freeman in litt. |
| Ruby-throated Hummingbird | *A.colubris* | ? | ?, K | 2 | 41 | J. Finley in litt. |
| Ruby-throated Hummingbird | *A.colubris* | *Neoscona hentzii* | NW, RD | 2 | 41 | McKenzie 1991 |
| Ruby-throated Hummingbird | *A.colubris* | *Aranens trifolium* | NW, RU | 2 | 41 | Kirkham 1925 |
| Ruby-throated Hummingbird | *A.colubris* | *Argiope caphinarium* | W, RD | 2 | 41 | McCook 1889 |
| Kingfishers | Alcedinidae | | | | | |
| African Pygmy Kingfisher | *Ispidina picta* | *Nephila* sp. | NW, RU | 13 | 55 | R. Hargreaves in litt. |
| Flycatchers | Tyrannidae | | | | | |
| Yellow-bellied Flycatcher | *Empidonax flaviventris* | *Argiope* sp. | NW, RU | 11 | 55 | B. Freeman in litt. |
| Acadian Flycatcher | *E. virescens* | *Nephila clavipes* | NW, RU | 12 | 64 | Cox and Nesmith 2007 |
| Common Tody-Flycatcher | *Todirostrum cinereum* | *Nephilengys cruentata* | NW, K | 6 | 50 | Peloso and de Sousa 2007 |
| Fairy-wrens | Maluridae | | | | | |
| Superb Fairywren | *Maluruscyaneus* | *Nephila clavipes* | W, K | 15 | 53 | J. Smart in litt. |
| Red-backed Fairywren | *M. melanocephalus* | *Nephilia maculata* | ?, K | 7 | 41 | Pratt 1974 |
| Honeyeaters | Meliphagidae | | | | | |
| Grey-headed Honeyeater | *Lichenostomus keartlandi* | ? | W, K | 15 | 72 | P. Veerman in litt. |
| Lewins' Honeyeater | *Meliphaga lewinii* | *Nephila* sp. | W, K | 34 | 96 | Anon. 2006 |
| New Holland Honeyeater | *Phylidonyris novaehollandiae* | Garden Orb-weaver (*Eriophora biapicata*) | W, K | 21 | 78 | Engel 2006 |

TABLE 1. Continued.

| Common name | Latin name | Spider sp. | Fate | Mass (gm) | Wing (mm) | Source |
|---|---|---|---|---|---|---|
| Australasian Warblers | Acanthizidae | | | | | |
| Inland Thornbill | *Acanthiza apicalis* | ? | ?, ? | 8 | 48 | D. Hadden in litt. |
| Vireos | Vireonidae | | | | | |
| White-eyed Vireo* | *Vireo griseus* | *Nephila clavipes* | ?, ? | 13 | 60 | Forbush and May 1939 |
| Drongos | Dicruridae | | | | | |
| Fork-tailed Drongo | *Dicrurus adsimilis* | Orb Weaver | NW, F | 34 | 129 | Robinson 1941 |
| Swallows | Hirundinidae | | | | | |
| Blue-and-white Swallow | *Notiochelidon cyanoleuca* | smaller than a *Nephila* sp. | NW, RU | 11 | 90 | S. Cabanne in litt. |
| Barn Swallow | *Hirundo rustica* | ? | NW, RU | 10 | 112 | K. Garrett in litt. |
| Welcome Swallow | *H.neoxena* | *Nephilia maculata* | NW, RU | 15 | 115 | Pratt 1974 |
| African Warblers | Macrosphenidae | | | | | |
| Red-faced Crombec | *Sylvietta whytii* | ? | W, K | 11 | 64 | Vernon 1976 |
| Bushtits | Aegithalidae | | | | | |
| Bushtit | *Psaltriparus minimus* | ? | NW, RD | 5 | 43 | Abbot 1931 |
| Leaf Warblers | Phylloscopidae | | | | | |
| Dusky Warbler | *Phylloscopus fuscatus* | ? | NW, RU | 11 | 57 | D. Zetterström in litt. |
| Goldcrests and Kinglets | Regulidae | | | | | |
| Goldcrest | *Regulusregulus* | Orb Weaver | NW, RU | 5 | 55 | Dean 1984 |
| Golden-crowned Kinglet | *R. satrapa* | Orb Weaver | NW, RU | 5 | 57 | K. Garrett in litt. |
| Wrens | Troglodytidae | | | | | |
| Bewick's Wren | *Thryomanes bewickii* | ? | NW, F | 10 | 52 | T. Riecke in litt. |
| Winter Wren | *Troglodytes hiemalis* | Araneidae | NW, RU | 9 | 52 | Gosling 1984 |
| House Wren | *T. aedon* | ? | NW, RU | 10 | 53 | Anon. 2007 |
| Thrushes | Turdidae | | | | | |
| Swainson's Thrush | *Catharus ustulatus* | *Nephila clavipes* | NW, RU | 23 | 93 | Brooks et al. 2008 |
| Old World Flycatchers | Muscicapidae | | | | | |
| Spotted Flycatcher | *Muscicapa striata* | ? | NW, RU | 14 | 80 | Doberski 1973 |
| Sunbirds | Nectariniidae | | | | | |
| Olive Sunbird | *Cyanomitra olivacea* | ? | W, K | 10 | 53 | Cheke and Mann 2001 |
| Olive Sunbird | *C.olivacea* | ? | W, K | 10 | 53 | Cheke and Mann 2001 |
| Amethyst Sunbird | *Chalcomitra amethystina* | Orb Weaver | NW, F | 10 | 71 | J. Norman in litt. |
| Seychelles Sunbird* | *Cinnyris dussumieri* | Palm Spiders | W, K | 11 | 63 | Cheke and Mann 2001 |
| Weavers | Ploecidae | | | | | |
| Red-headed Weaver | *Anaplectes rubriceps* | ? | NW, RU | 20 | 80 | Shaw 1994 |
| Waxbills and Munias | Estrildidae | | | | | |
| Red-billed Firefinch | *Lagonosticta senegala* | *Latrodectes* sp. | ?, K | 8 | 47 | Morris 1963 |

TABLE 1. Continued.

| Common name | Latin name | Spider sp. | Fate | Mass (gm) | Wing (mm) | Source |
|---|---|---|---|---|---|---|
| Jameson's Firefinch | *Lagonosticta rhodopareia* | Golden Orb Spider *(Nephilengys cruentata)* | NW, RU | 9 | 49 | Riddell 2001 |
| Blue Waxbill | *Uraeginthus angolensis* | *Nephila* sp. | NW, RU | 9 | 51 | Webber 1974 |
| Chestnut-breasted Mannikin | *Lonchura castaneothorax* | Garden Orb-weaver | W, K | 14 | 55 | Malkin 2008 |
| New World Finches | Fringillidae | | | | | |
| House Finch | *Carpodacus mexicanus* | ? | NW, RU | 15 | 76 | Abbot 1931 |
| Lesser Goldfinch | *Spinus psaltria* | ? | NW, RU | 11 | 65 | F. Beaudry in litt. |
| American Goldfinch | *S.tristis* | *Argiope aurantia* | W, RU | 12 | 68 | Mackay 1929 |
| New World Warblers | Parulidae | | | | | |
| Virginia's Warbler | *Oreothlypis virginiae* | ? | NW, F | 10 | 62 | G. Wallace in litt. |
| Yellow Warbler | *Septophaga petechia* | ? | W, RU | 9 | 60 | Coale 1912 |
| Yellow-throated Warbler | *S. dominica* | *Nephila clavipes* | NW, RU | 10 | 63 | Bent 1953 |
| Yellow-throated Warbler | *S. dominica* | *N.clavipes* | W, K | 10 | 63 | Bent 1953 |
| Common Yellowthroat | *Geothlypis trichas* | ? | NW, F | 9 | 50 | Ross 1950 |
| Common Yellowthroat | *G.trichas* | *Argiope aurantia* | NW, RU | 9 | 50 | Heck and Heck 2001 |
| American Redstart | *Setophaga ruticilla* | *Nephila clavipes* | NW, RU | 5 | 65 | S. and B. Hills in litt. |
| New World Sparrows | Emberizidae | | | | | |
| Yellow-bellied Seedeater | *Sporophila nigricollis* | ? | NW, F | 8 | 52 | A. M. Cuervo in litt. |
| Greater Antillean Bullfinch | *Loxigilla violacea* | Banana Orb Weaver | NW, RU | 24 | 79 | B. Howe in litt. |
| Grasshopper Sparrow | *Ammodramus savannarum* | *Argiope aurantia* | NW, RU | 17 | 55 | Terres 1939 |

KEY: * = fledglings, ? = unknown, W = wrapped in web threading, NW = not wrapped in web threading, *F* = freed self, RU = disentangled and released unharmed by human intervention, RD = disentangled by human intervention but did not survive, *K* = killed/consumed by spider or found dead in web. Taxonomy follows American Ornithologists' Union (2011) and Gill and Donsker (2011).

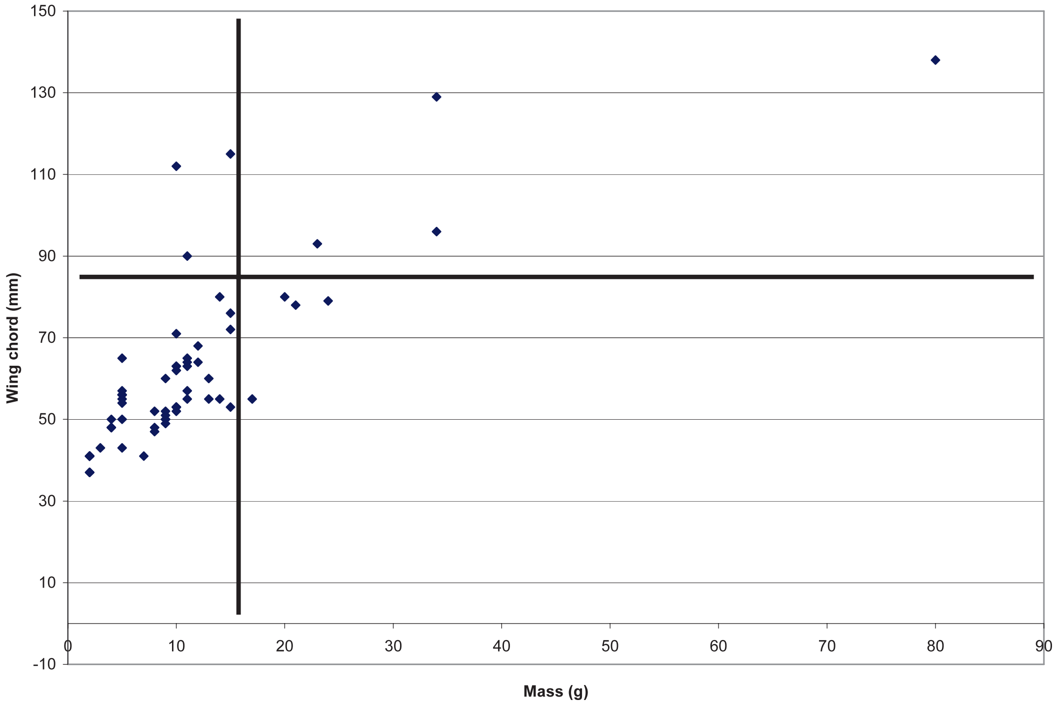


FIG. 1. Size of birds entrapped in spider webs. Data points to the left of the vertical line represent species with mass ≤15 g. Data points below the horizontal line represent species with wing chord <90 mm.

African black widow (*Latrodectus* sp.) that killed a Red-billed Firefinch (*Lagonosticta senegala*). One-half of all reported cases ($n$ = 23) that identified the spiders entrapping birds in webs were in the genus *Nephila*, including *N. inaurata* (1), *N. maculata* (2), and *N. clavipes* (14). Other forms of orb weavers included six cases for the genus *Argiope* including *A. aurantia* (1) and *A. caphinarium* (3), two cases for *Eriophora biapicata* and *Nephilengys cruentata*, and single cases for *Aranens trifolium, Mastophora* sp., and *Neoscona hentzii*.

The only species of spider with sufficient data for analysis of patterns of bird entrapment was *N. clavipes*. This species entrapped nine species representing 14 cases (31% of all spider records). Trapped birds ranged in size from Vervain Hummingbird (mass = 2 g, wing chord = 37 mm) to Swainson's Thrush (mass = 23 g, wing chord = 93 mm). Four (31%) of the 13 birds with fate data were wrapped in the web, and nine (69%) were not. Two cases each were found for unwrapped birds dying, unwrapped birds freeing themselves, and wrapped birds dying in the web; the remaining seven were released with human intervention.

## DISCUSSION

*Patterns of Birds Trapped in Spider Webs.*— Most entrapped birds had a mass of ≤15 g and wing chord <90 mm. Larger species of birds are especially vulnerable to entrapment when the web was approached at an indirect angle with slow flight speed (Cox and Nesmith 2007). Larger birds with longer, more powerful wings appear to be able to break through webs easier than smaller birds, which would explain the higher rates of entanglement for smaller species (Fig. 1). The longer a bird is entrapped, the more likely it is to succumb due to stress and fatigue. It is possible that large species (> 15 g mass, ≥ 90 mm wing chord) were entangled more frequently, but freed themselves before the event could be documented.

It is not surprising that hummingbirds (range = 2–5 g mass, 37–56 mm wing chord) represent not only the most diverse family (9 species), but also the family with the most cases of being trapped in a spider web (20 cases). The small size of members of this family makes them more vulnerable to web entrapment, especially the smaller species: six (67%) of the nine species and 14 (70%) of the 20 cases have a mass ≤4 g and wing chord ≤50 mm. The next smallest birds trapped in comparison include only three cases in two families: Aegithalidae (Bushtit, *Psaltriparus minimus*; 5 g mass, 40 mm wing chord) and Regulidae (Goldcrest, *Regulus regulus*; 5 g mass, 55 mm wing chord and Golden-crowned Kinglet, *R. satrapa*; 5 g mass, 57 mm wing chord).

More than one-half ($n = 36$) of the cases of birds entrapped in spider webs were released unharmed by the humans reporting the incident. When these cases were excluded, 73% ($n = 22$) died due to web entrapment, and the only cases of birds naturally freeing themselves ($n = 8$) were not wrapped in silk. Consequently, the chance for a bird to survive web entrapment is affected by its ability to free itself prior to being immobilized by the spider. The sheer size of a bird alone could deter a spider from immobilizing it, as spiders are often reluctant to wrap prey too large to successfully consume (Sakai 2007).

*Are Spiders and their Webs a Threat to Birds?*—Orb weavers will cut their web to rid it of undesirable debris (Robinson and Mirick 1971). However, it is not desirable for a web to be destroyed by a bird flying through it, and one of the many functions of a web is to visually deter birds from flying into them (Bruce et al. 2005). This was illustrated by Robinson and Robinson (1976) who described how a tame, experimental Hooded Butcherbird (*Cracticus cassicus*) accidentally flew through a *Nephila maculata* web with devastating results to both the spider with a destroyed web, and the bird which took several minutes to preen the web threading from its feathers and was cautious for the subsequent 3 weeks. This case details the consequences to both bird and spider of a web collision but, more importantly, indicates that webs do not always serve as visible deterrents to flying birds. This synthesis presents 69 cases of birds entangled in spider webs, suggesting that spider webs can fail as visual deterrents for many species of birds, concordant with Robinson and Robinson (1976).

The primary purpose of venom in most species of spiders is to subdue insect prey rather than harm larger species of vertebrates (Shear 1986). Certain tarantulas (e.g., *Theraphosa, Avicularia*) are sufficiently large to predate eggs and nestlings of birds but do not specialize on them (Shear 1986). Orb weaver size, web radius, and web height are the most important factors affecting abundance and size of prey captured; these same parameters are important for interspecific niche separation (Brown 1981). These spiders catch winged prey in higher webs whereas larger, jumping insect prey are caught more frequently at lower strata (Brown 1981). Orb weavers use a variety of tactics to immobilize prey. More primitive forms such as *Nephila* often bite to subdue their prey whereas *Argiope* and *Eriophora* wrap their prey in silk (Weems and Edwards 1978). Most research on orb weaver foraging has shown specialization on insects (Rypstra 1985, Higgins 1987). Orb weaver mouthparts are too small to specialize on birds (Sakai 2007) or to suggest coevolution for bird specialization, but orb weavers will opportunistically predate a small bird that gets caught in the web. This review documents 18 cases of birds wrapped in silk for consumption, and each case resulted in death unless freed by a human observer. A more limited number of cases showed actual consumption by a spider without the bird being wrapped in silk (Levy 1987, Peloso and de Sousa 2007). These cases are contrary to Graham's (1997) speculation that orb weavers do not prey on birds.

*Spider Webs and Natural Environmental Threats to Birds.*—A variety of avian species feed on spiders and use spider web for nesting material (Waide and Hailman 1977); birds in these situations are likely to be aware of the web and do not become entangled (McKenzie 1991). Birds traveling along direct flight paths, the same open understory areas favored by orb weavers to build webs (Graham 1997), are more likely to become caught, just as a bird can collide with a mist-net. Trapped birds may have been moving within a lek site (Sakai 2007), chasing prey, fleeing danger, or traveling to a new site. Orb weavers are perhaps the largest arboreal spiders with a web that can attain >1 m in radius with strong and sticky fresh silk strands (Lubin 1978, Griffiths and Salanitri 1980). Over 50 different species of birds (Table 1) have been trapped in these large webs spanning open flight paths. Being trapped in a web also makes a bird vulnerable to predation by a larger vertebrate predator (Graham 1997), if the bird is not immobilized by the spiders themselves.

Natural environmental hazards are rare in nature. Another example besides spider webs is bird entanglement in plants, which was reviewed by Hager et al. (2009). They similarly reviewed the anecdotal literature and found 32 cases of plant entanglements affecting 25 species of birds, compared to a much higher 69 cases of spider web entanglement of 54 species in my study. The overall size of birds trapped in plants was much greater with seabirds (e.g., pelicans, gulls, and murrelets) and hawks representing one-third of the cases. Moreover, all but one of those cases involving larger species resulted in mortality. The overall mortality rate between the two studies was similar with 78% ($n$ = 25) of avian mortalities due to plant entanglement versus 73% ($n$ = 22) of 30 cases of birds trapped in spider webs that were not assisted by human observers. More than one-half of the cases involved the plant burdock (*Arctium minus*), whereas all birds but one case in my study were trapped in orb weaver webs.

The number of orb weaver webs increases with environmental disturbances, such as following a hurricane (Brooks et al. 2008) or local extinction of predators which consume spiders (e.g., Guam; Haldre Rogers, pers. comm.). The number of webs could ostensibly increase following increased environmental disturbance with increasing environmental instability. This may increase the number of birds trapped in webs (Brooks et al. 2008) as spider webs become concentrated at higher densities.

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