



NATIONAL MUSEUM *of* NATURAL HISTORY

☀ Smithsonian

The Science Behind Snarge

*Carla Dove, Director, Feather Identification Lab, Smithsonian Institution
National Museum of Natural History, Washington DC USA*



Happy 34th Meeting

1992 Inaugural Meeting Roster, Aug 4-6, JFK Airport

- | | | |
|-------------------------|--------------------------|-------------------------|
| 1. JAMES E. Forbes | 26. Tom NACHTMAN | 51. THOMAS W. SEAMANS |
| 2. BRIAN AROHULETA | 27. Julie Beegle | 52. Jerrold L. BELANT |
| 3. AL Godin | 28. DIANA McPHERSON | 53. PETER F. Voat |
| 4. VINCENT Cimino | 29. Linda S. MILLER | 54. Robert S. Dodd |
| 5. GENE LeBoeuf | 30. RICHARD E. Griffiths | 55. Richard Chipman |
| 6. RON Merritt | 31. DAVID M. HAMERSHOCK | 56. Kevin GRANT |
| 7. GARY LARSON | 32. Robert H. Schmidt | 57. TUYEN HOANG |
| 8. John Schmitt | 33. Dennis BALTRAN | 58. MARTYN J. HEXTER |
| 9. Richard Dolbeer | 34. Robert WALL | 59. Dennis Slate |
| 10. Tom Hopp | 35. Joe Rivas | 60. ALVIN L. MUMMART |
| 11. Harriet Nichols | 36. Mike Podlaski | 61. John H. Enders |
| 12. CAROLINA L. Mederos | 37. Dixie C. Laybourne | 62. GLENN MORSE |
| 13. RANDALL Green | 38. CLRLA Dove | 63. Robert P. SLIWINSKI |
| 14. VINCENT J. IGNIZIO | 39. J. E. "Red" JAMESON | 64. Joseph P. Schmitt |
| 15. JAMES M. Roberts | 40. DONALD F. CACCAMISE | 65. LAURA Henze |
| 16. JANE BRAND | 41. Victor E. F. Solman | 66. Scott Dowdy |
| 17. Dick PARKER | 42. William B. Diggle | 67. Joe Patermo |
| 18. NICK E. Proffitt | 43. William C. Finn, Jr. | 68. John ALGERI |
| 19. ROLPH A. DAVIS | 44. Janet L. Sillings | 69. John Comings |
| 20. W. John Richardson | 45. John P. KOWALCHYK | 70. RON Rathburn |
| 21. TRACY Casselman | 46. John STARACE | 71. Edward P. Hill |
| 22. BRUCE A. FRACK | 47. Scott MARSH | 72. ARLIE Winemiller |
| 23. Robert C. McCloud | 48. DONALD J. Wilda | |
| 24. HOWARD BANILOWER | 49. Dennis M. BULMAN | |
| 25. WILFRED EMONTS | 50. ARNOLD M. SLOANE | |

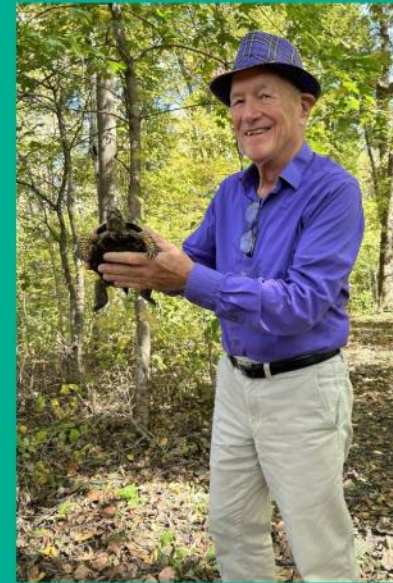
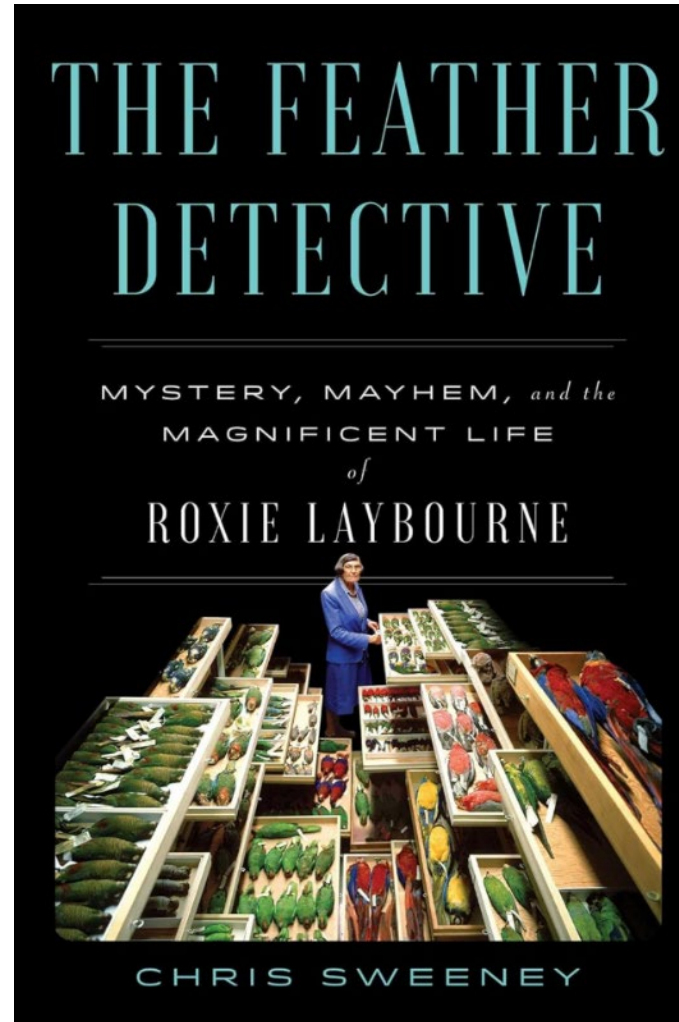
Dedication of Keynote Presentation



1995 BSC Dallas, TX



2018 Mid-winter Meeting



Sticking my neck out for 80 years

Life on the
Wild Side

Richard A. Dolbeer

The Science Behind Snarge



4 Oct 1960 – Boston Harbor Crash
62 fatalities – European Starlings



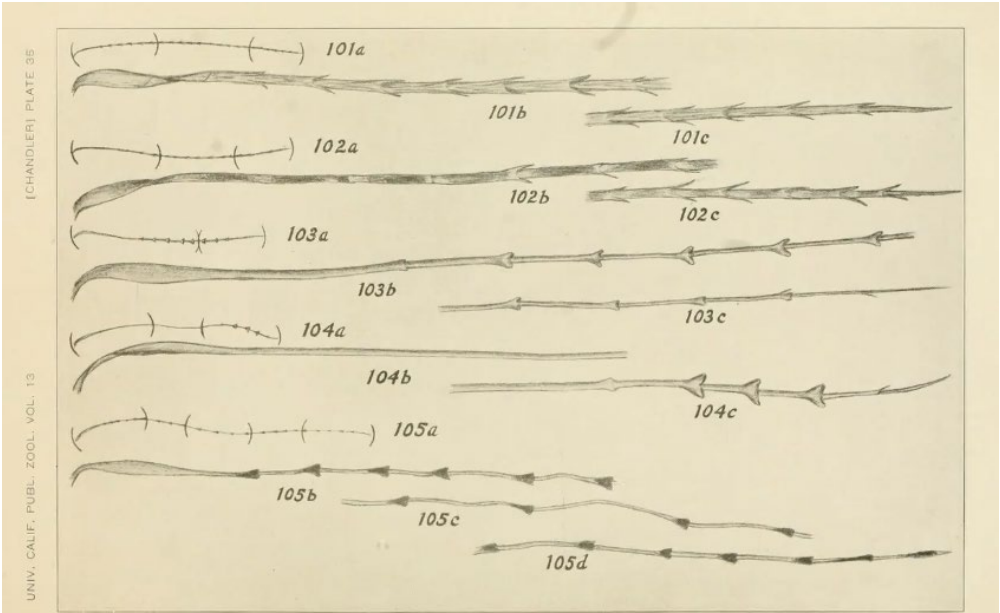
*Pioneer “Forensic Ornithology”
Roxie Laybourne, 1910-2003*



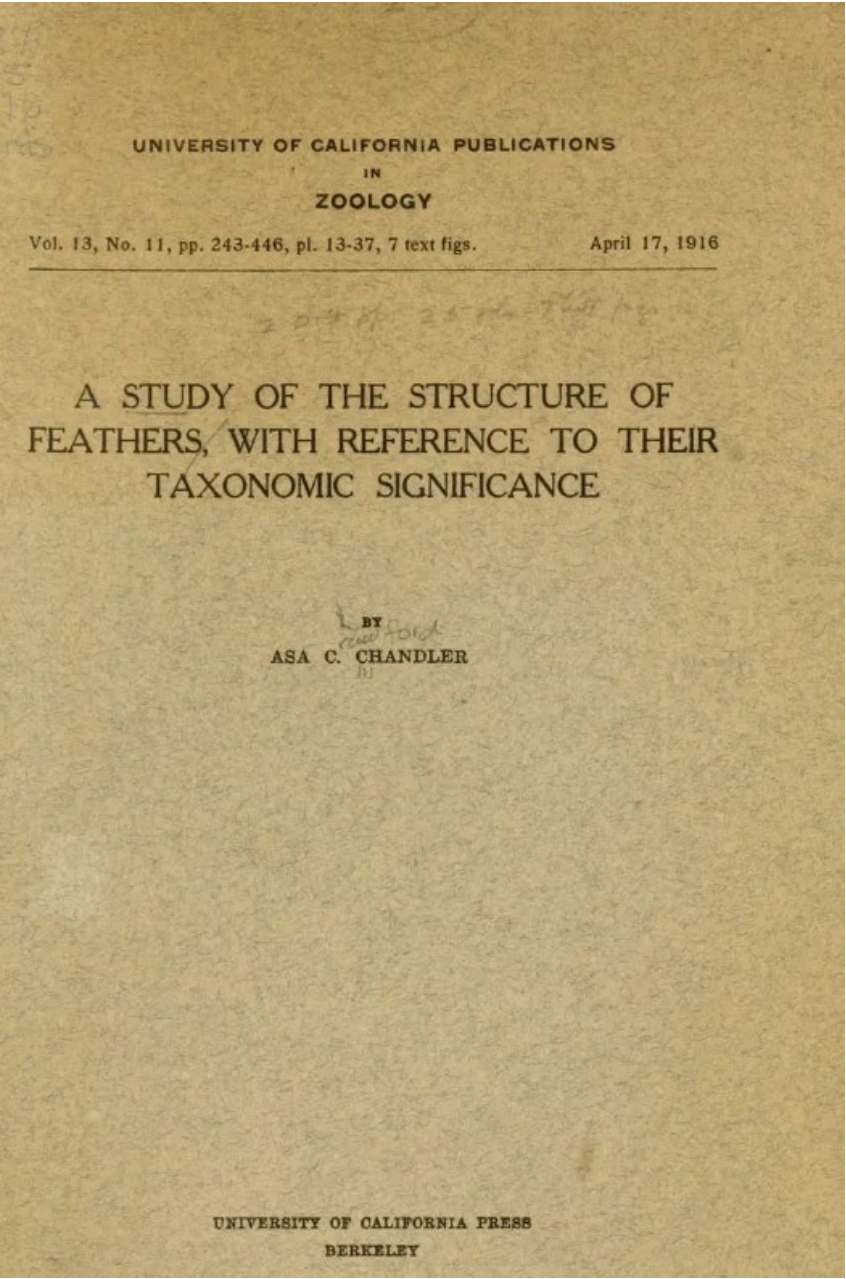
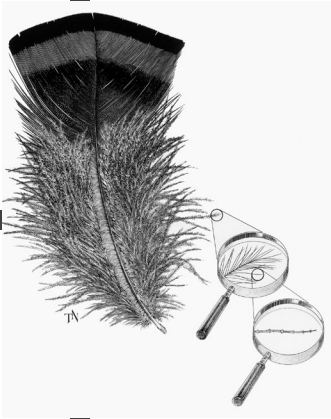
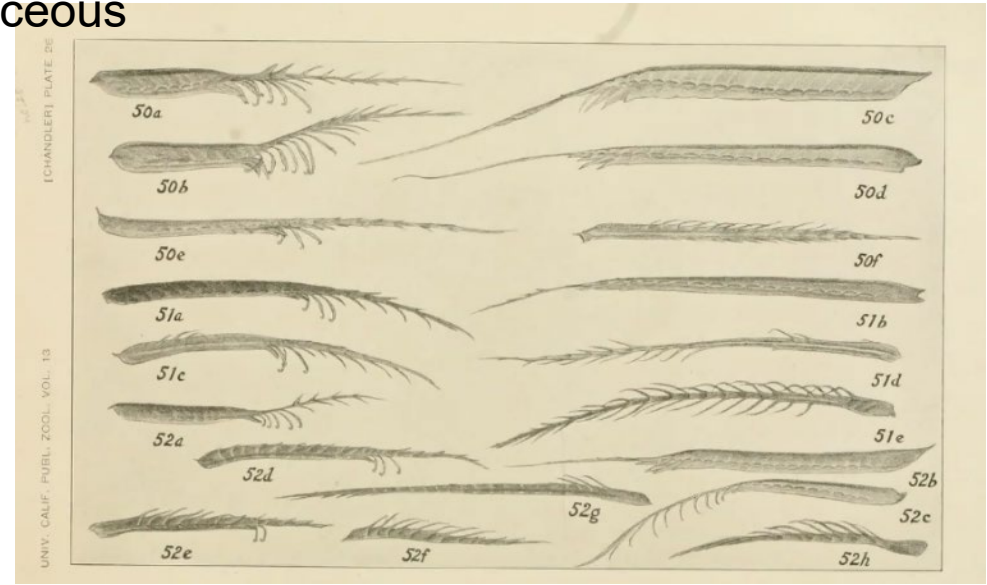
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Downy



Pennaceous



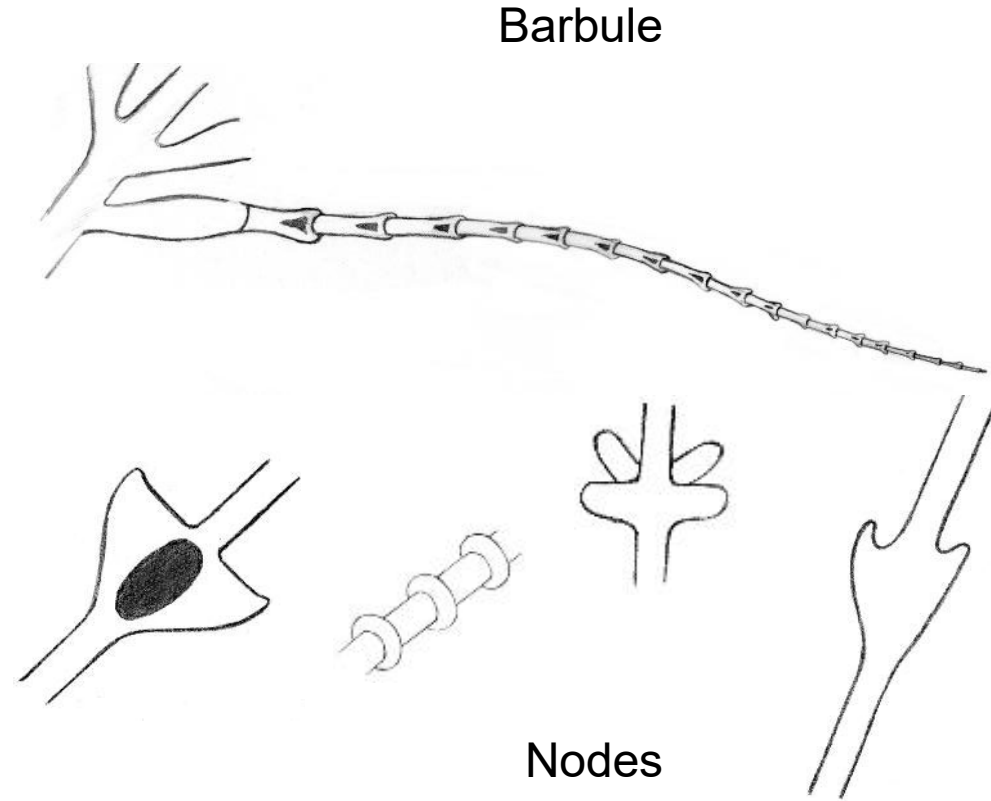
Downy Feather Parts



Feather



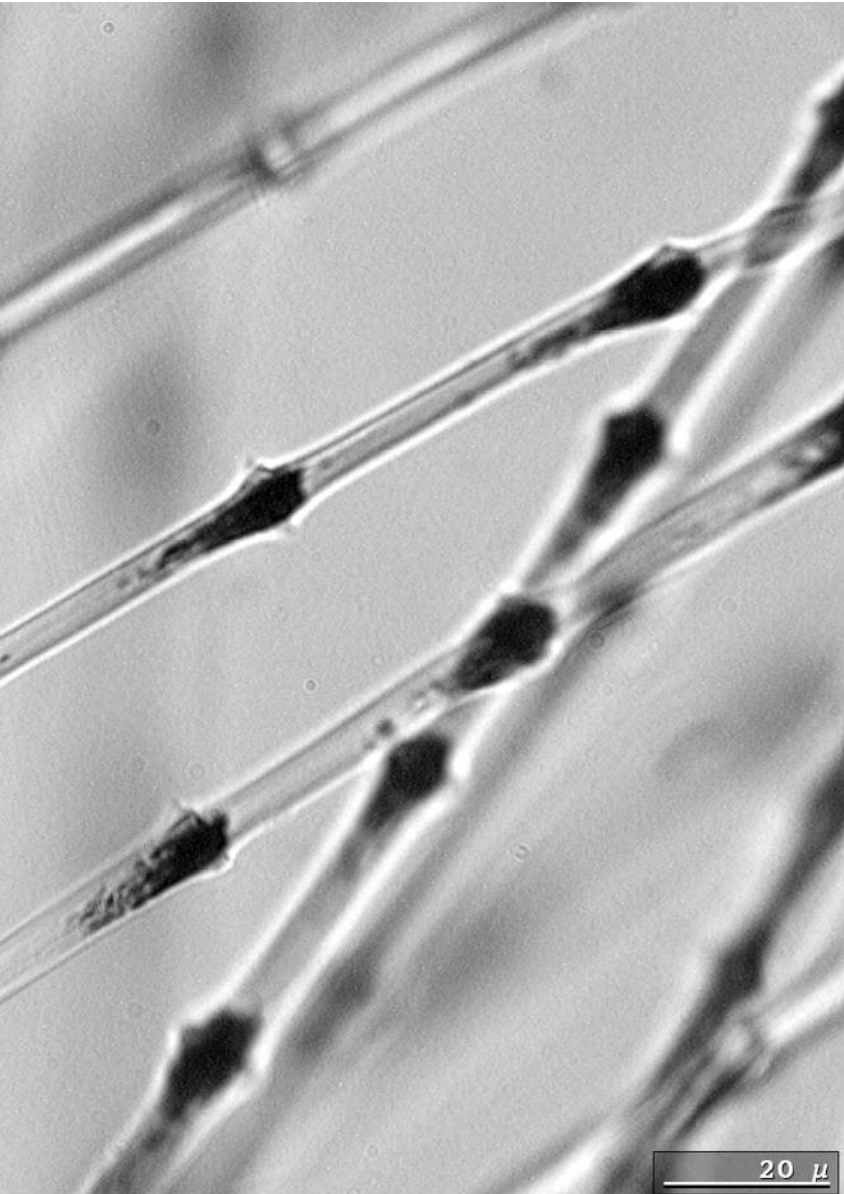
Barb



Barbule

Nodes

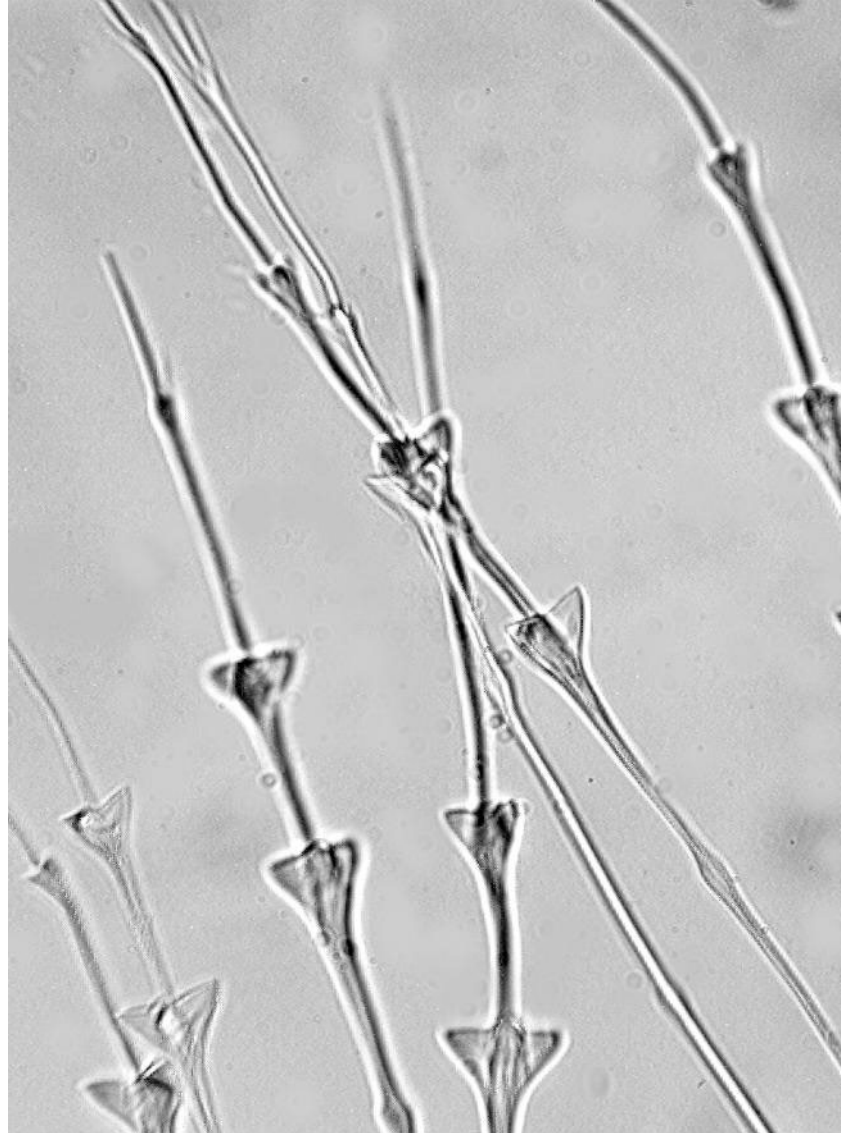
Passeriformes - songbirds



Columbiformes - doves



Anseriformes - ducks



Gilroy, B.A. 1987. Microscopic Variation in Plumulaceous Barbules of the Rock Dove, *Columba livia* (Aves: Columbidae)

Microslide Preparation





Burmese Pythons in Everglades National Park



Passeriformes



Anseriformes



Galliformes



Podicipediiformes



Columbiformes



Charadriiformes



Pelecaniformes

Gruiformes



Ciconiiformes



Research Article

Birds Consumed by the Invasive Burmese Python (*Python molurus bivittatus*) in Everglades National Park, Florida, USA

Carla J. Dove , Ray W. Snow, Michael R. Rochford & Frank J. Mazzotti

Pages 126-131 | Received 09 Jun 2010, Accepted 27 Sep 2010, Published online: 01 Mar 2011



ARCTIC
VOL. 69, NO. 1 (MARCH 2016) P. 29–36
<http://dx.doi.org/10.14430/arctic4546>

Identification of Bird Species Used to Make a Viking Age Feather Pillow

Carla J. Dove¹ and Stephen Wickler²

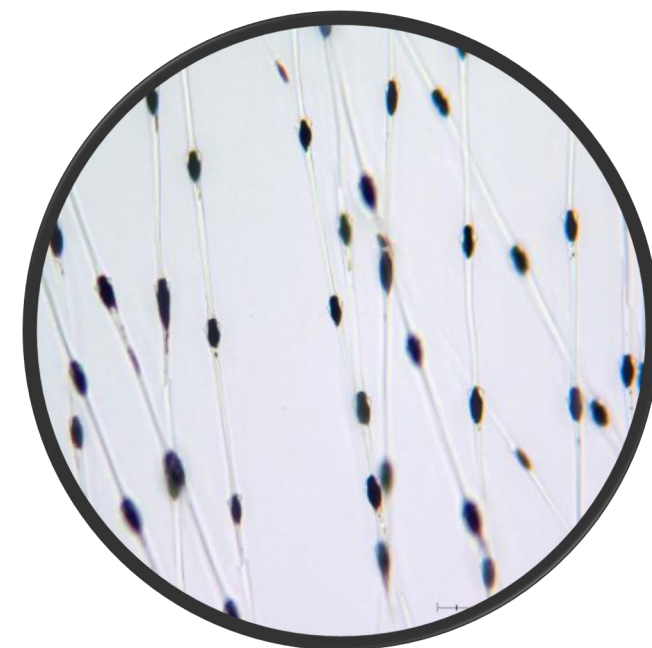
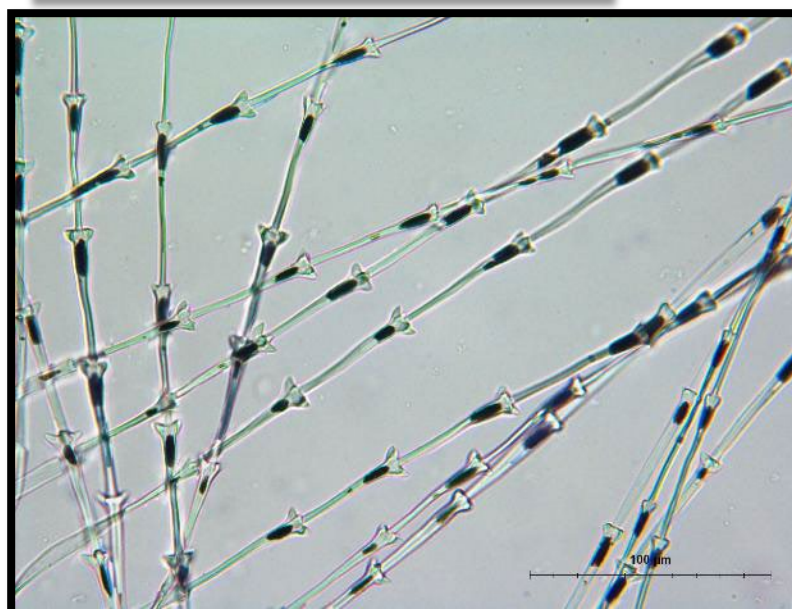
(Received 24 July 2015; accepted in revised form 4 November 2015)

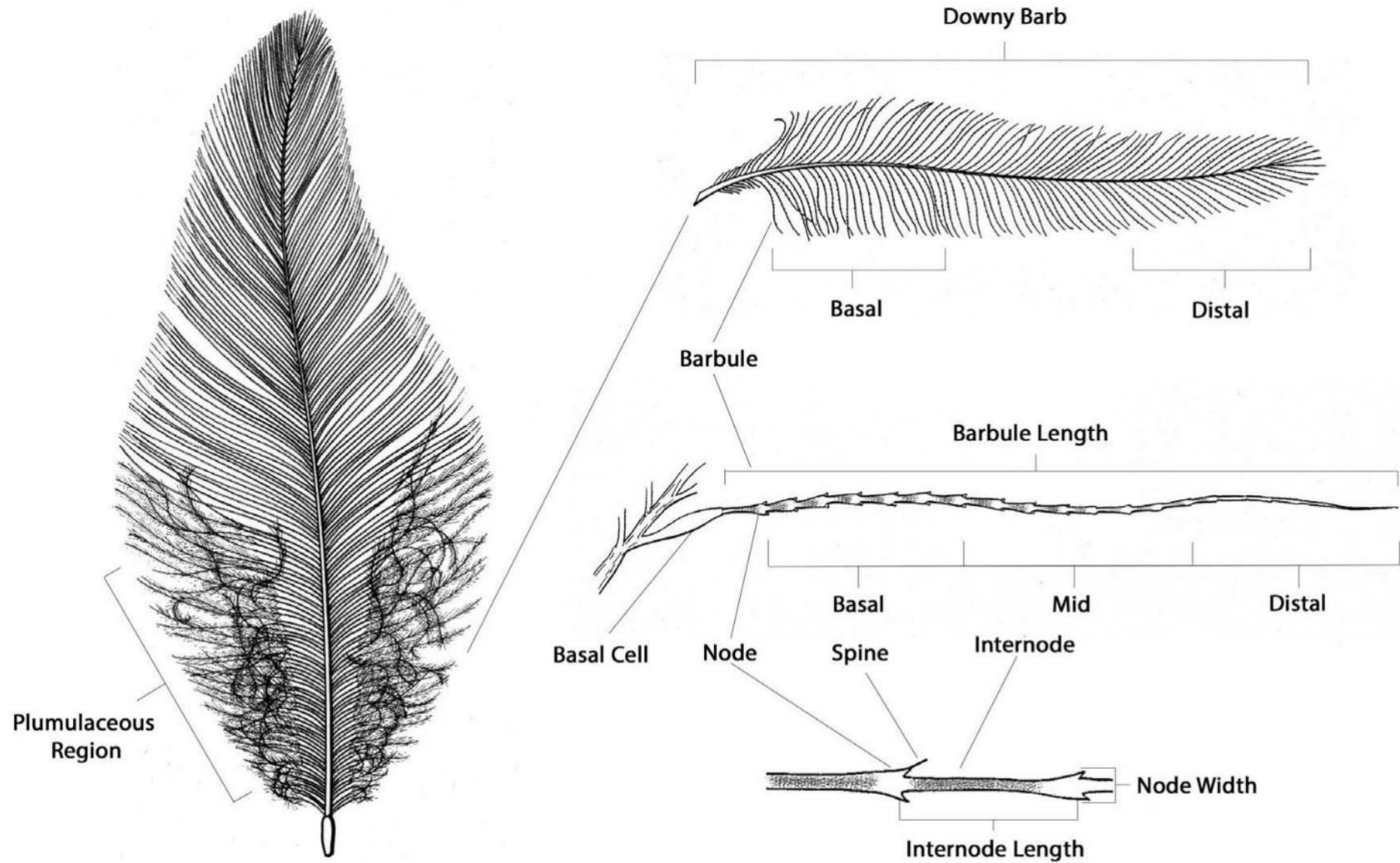
TRACT. A grave containing the remains of a wooden boat was discovered in 1934 under a low mound in a bog on the Vesterålen islands of northern Norway. The boat grave dates to the 10th century in the Viking Age, and goods found in the boat include an iron axe, a cowhide in which the body was wrapped, and pillow remains consisting of a wool textile cover and a downy pillow. A microscopic analysis of the feathers from a subsample of the pillow fill identified the following orders: Anseriformes (eider); Suliformes (cormorant), and Charadriiformes (unspecified gull). It was possible to achieve species-level identification of Great Cormorant (*Phalacrocorax carbo*) and to narrow the gull types to the "white-winged" group. The sample was composed of a nearly equal mix of downy and pennaceous feather types. Downy feathers were the most abundant, followed by eider down, and then gull feathers.



VIKING PILLOW







Feather Characters in N.A. Plovers

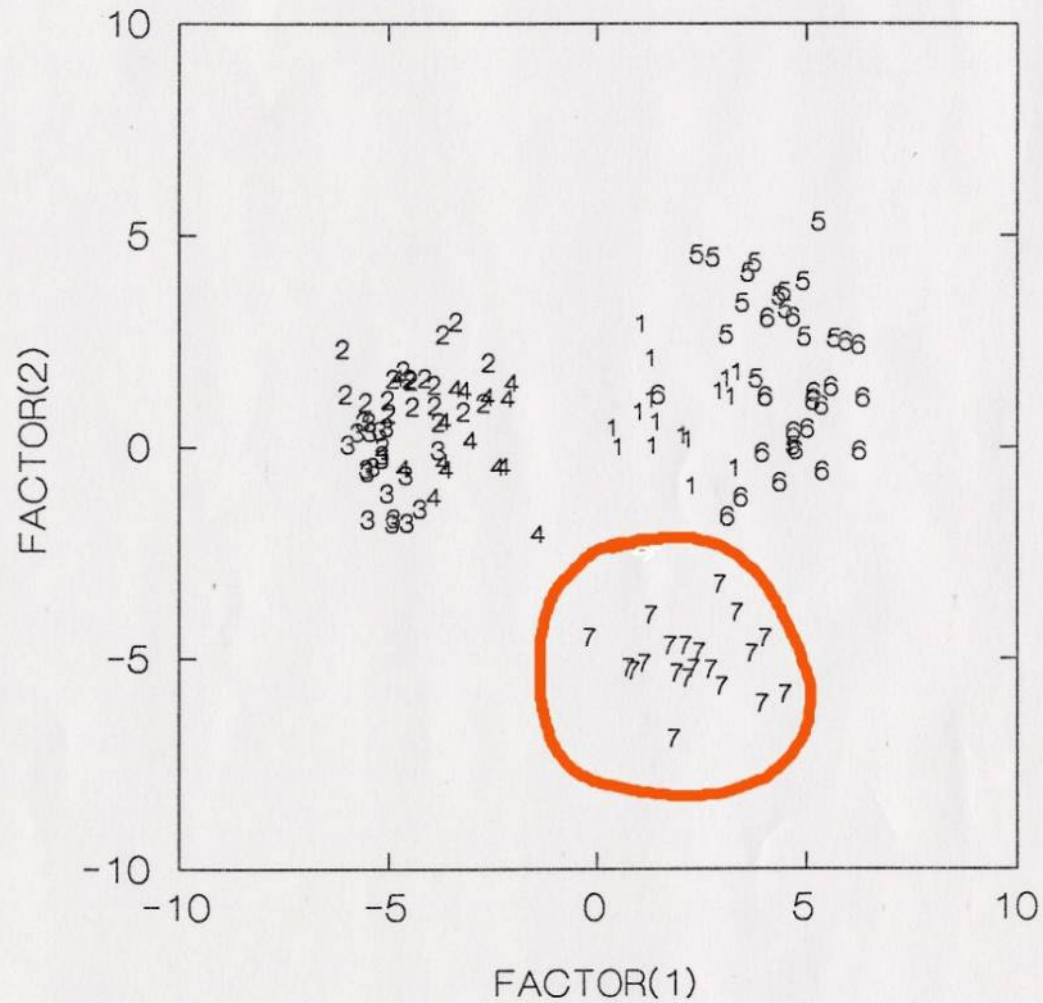


Figure 5. Discriminant function plot showing separation of species based on three characters:
 Factor (1) = Pigmented nodes per barbule C,B
 Factor (2) = Subpennaceous length

- | | | |
|-----------------------------------|--------------------------------|--------------------------------|
| 1- <i>Charadrius semipalmatus</i> | 4- <i>Charadrius wilsonia</i> | 7- <i>Pluvialis squatarola</i> |
| 2- <i>Charadrius alexandrinus</i> | 5- <i>Charadrius montanus</i> | |
| 3- <i>Charadrius melodus</i> | 6- <i>Charadrius vociferus</i> | |

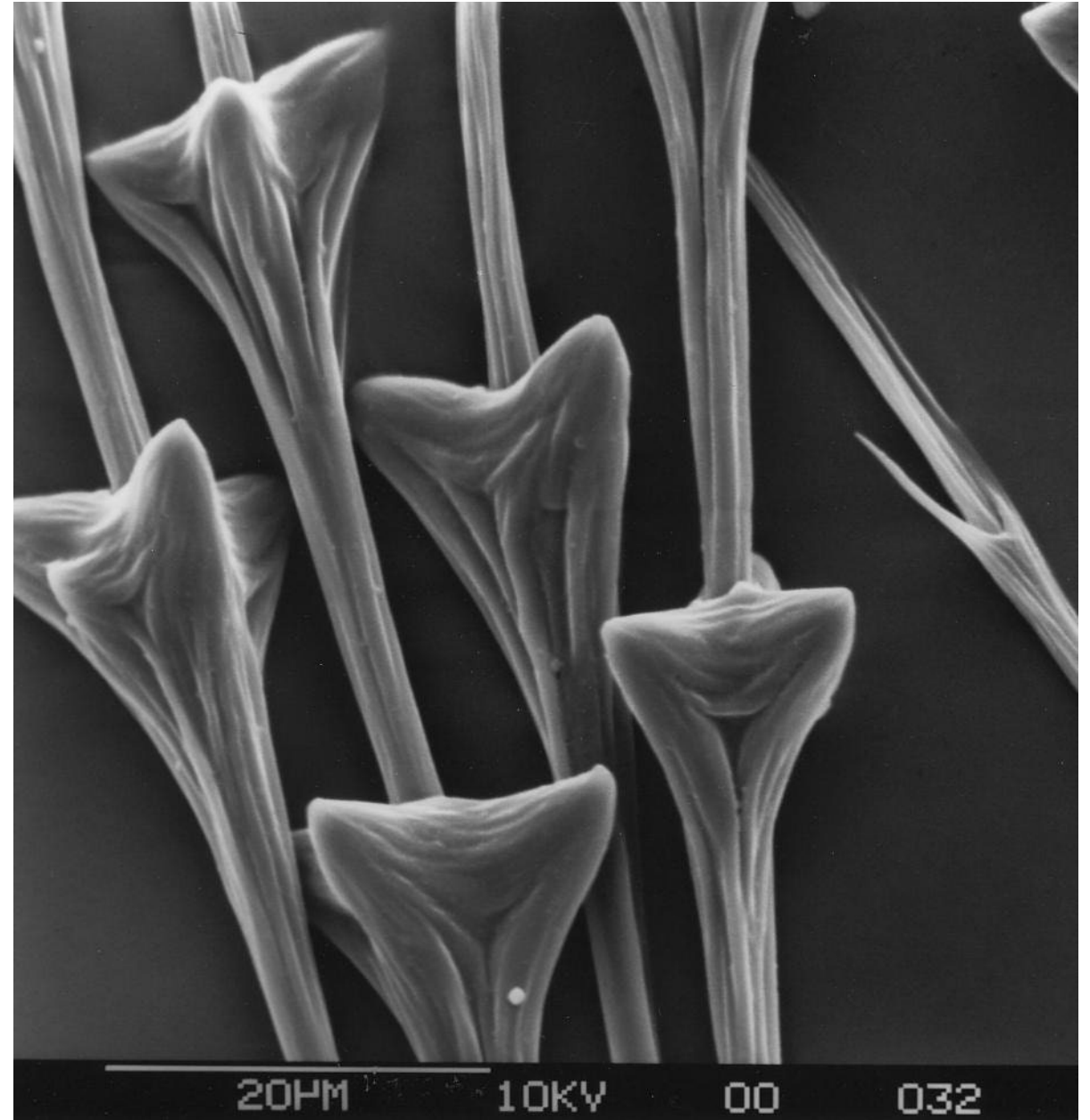
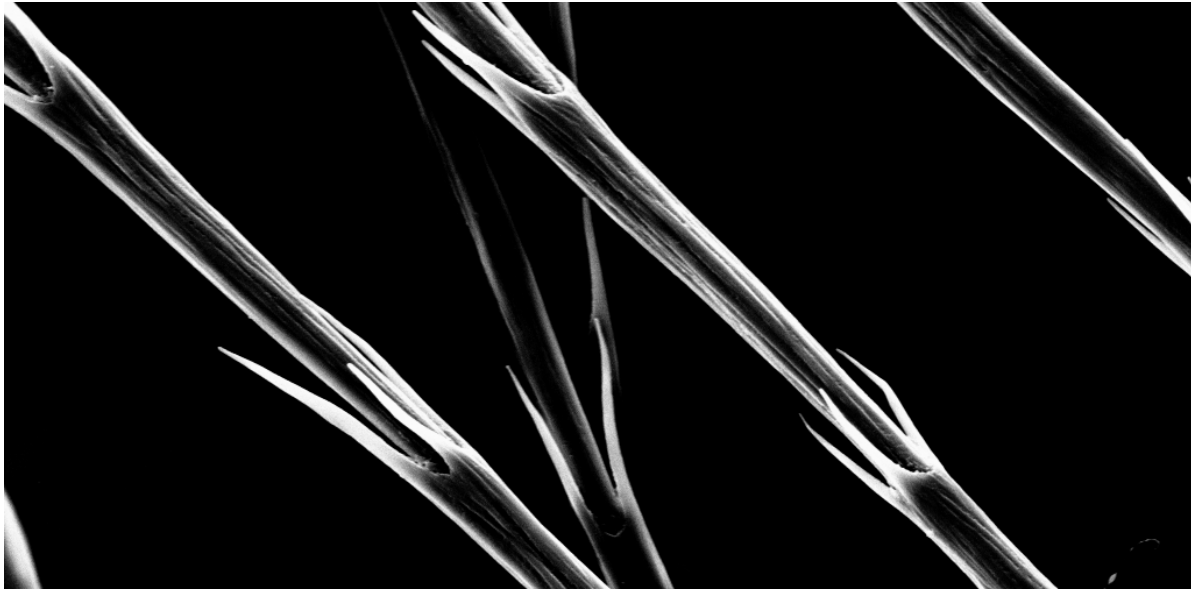
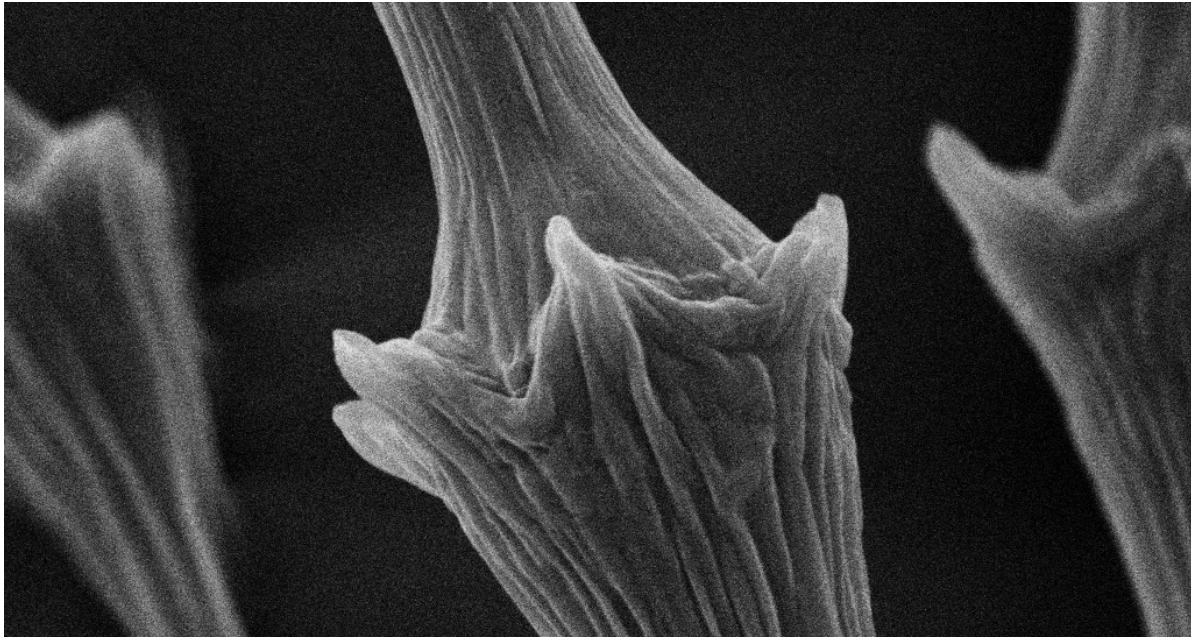


QUANTIFICATION OF MICROSCOPIC FEATHER CHARACTERS USED IN THE IDENTIFICATION OF NORTH AMERICAN PLOVERS¹

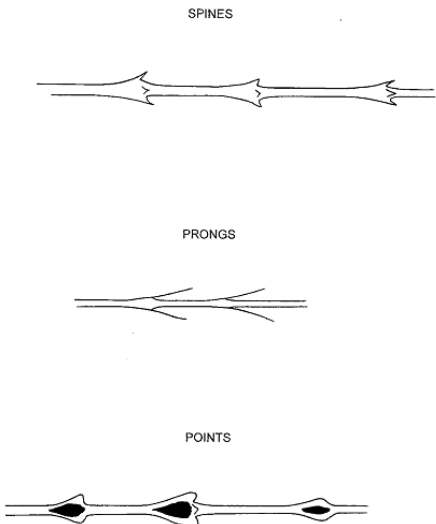
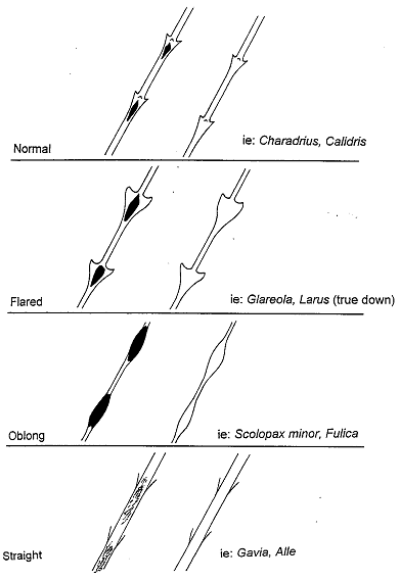
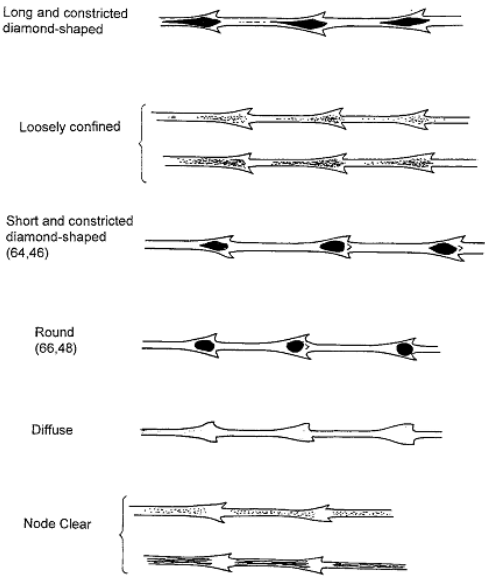
CARLA J. DOVE

Smithsonian Institution, National Museum of Natural History,
 Department of Vertebrate Zoology, Washington, D.C. 20560





Plumulaceous Feather Characters in Charadriiformes



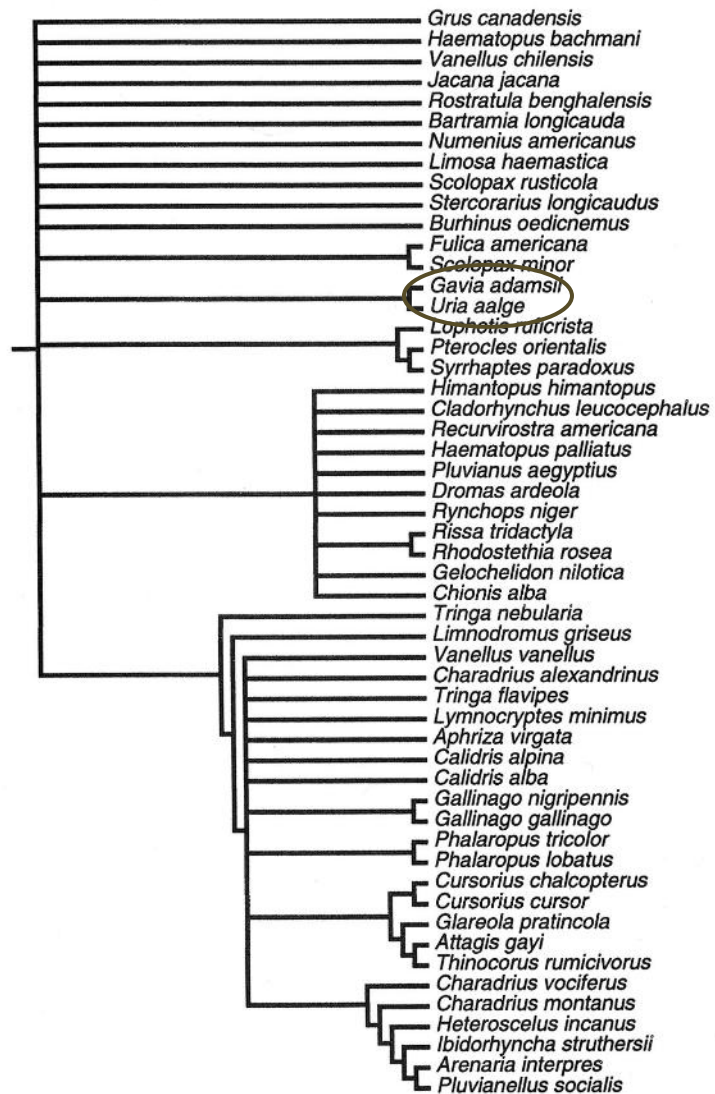
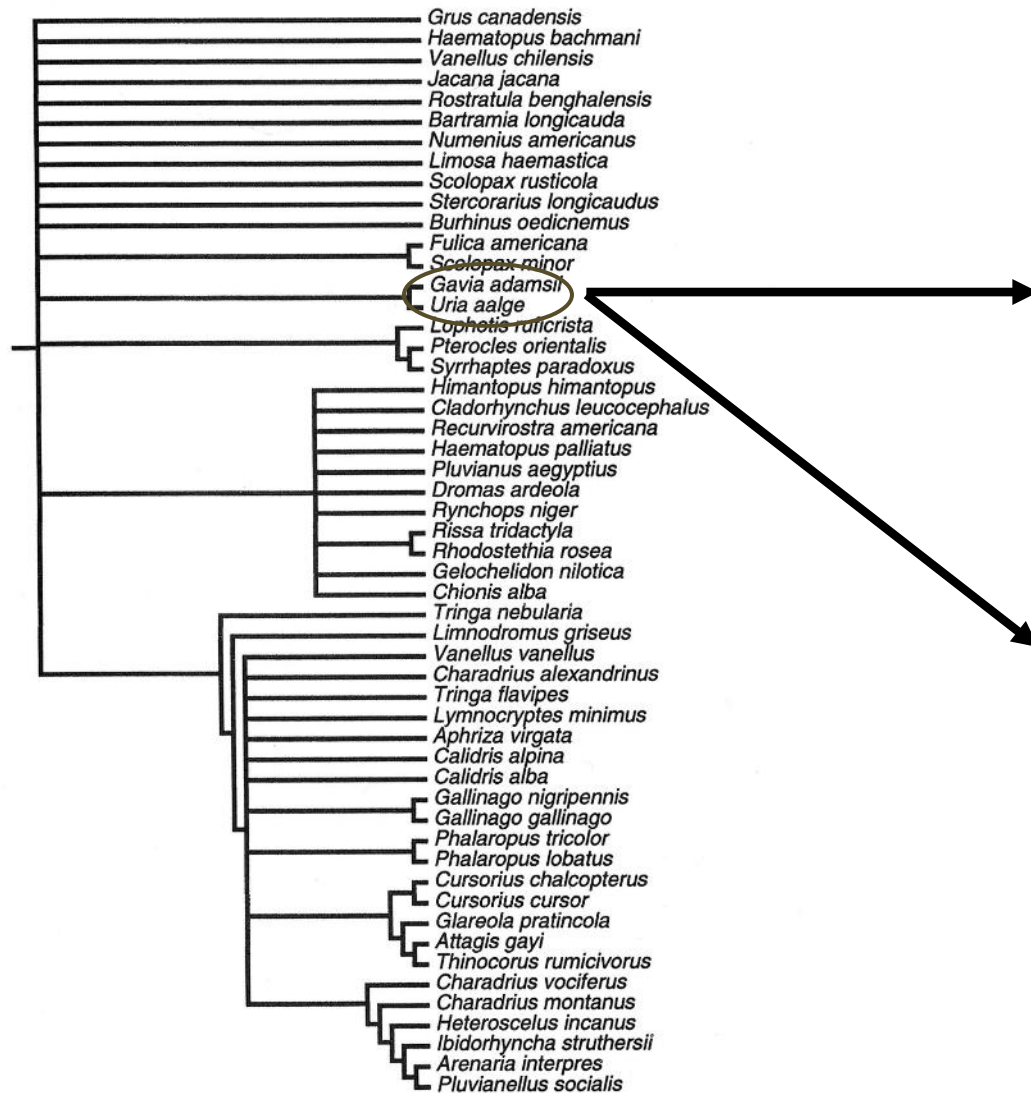


FIG. 147. Strict consensus of 6,646 trees using 53 taxa and 38 microscopic downy feather characters.

A DESCRIPTIVE AND PHYLOGENETIC ANALYSIS
OF PLUMULACEOUS FEATHER CHARACTERS IN
CHARADRIIFORMES

CARLA J. DOVE

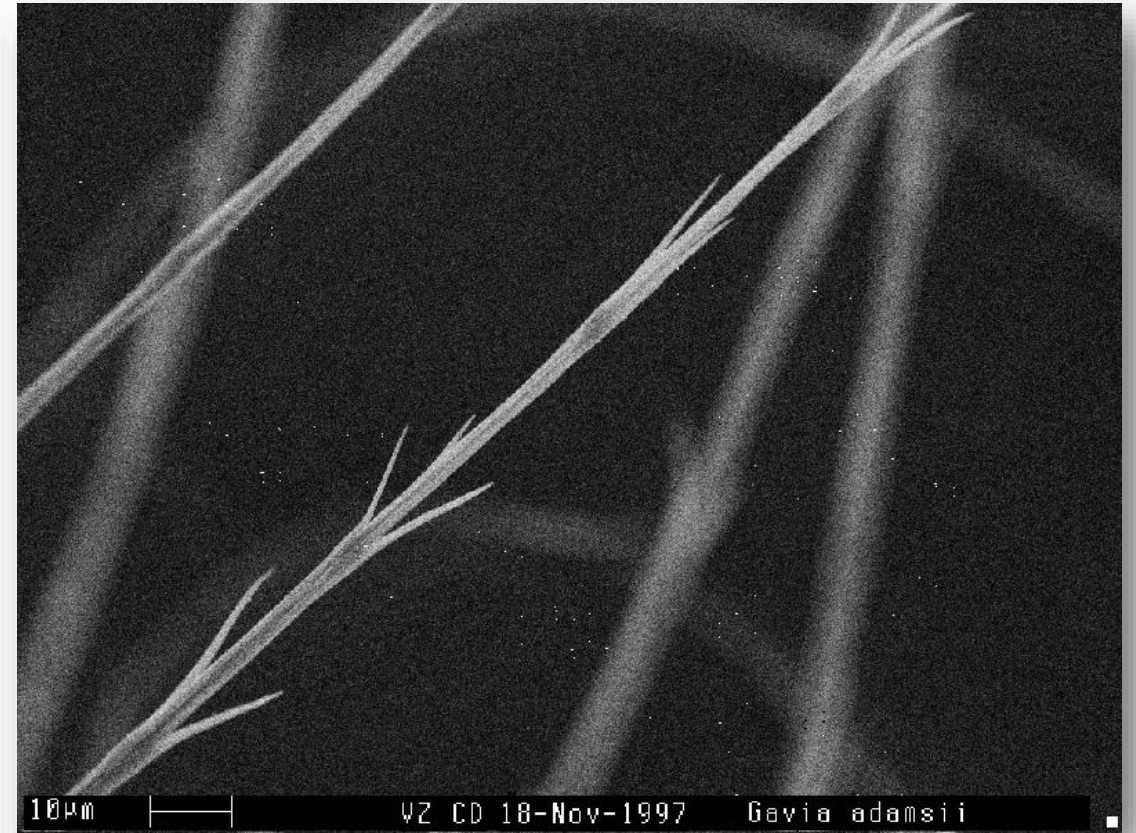
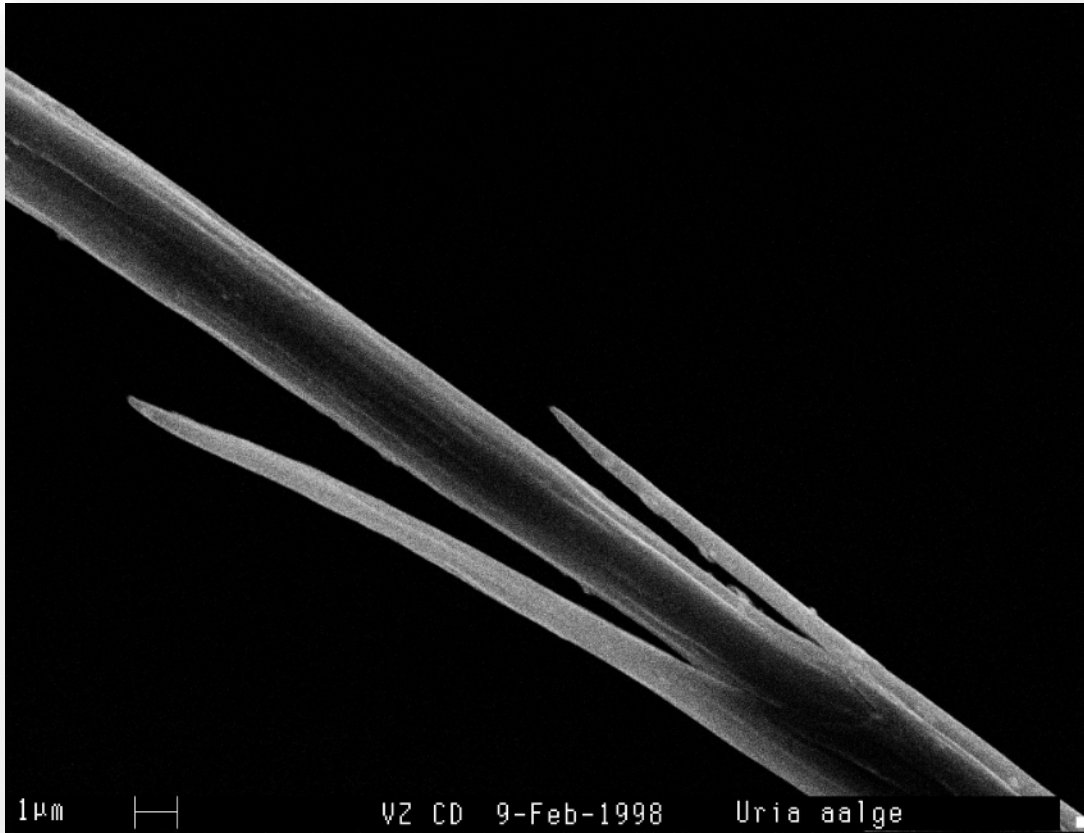


Yellow-billed Loon (Gaviiformes)



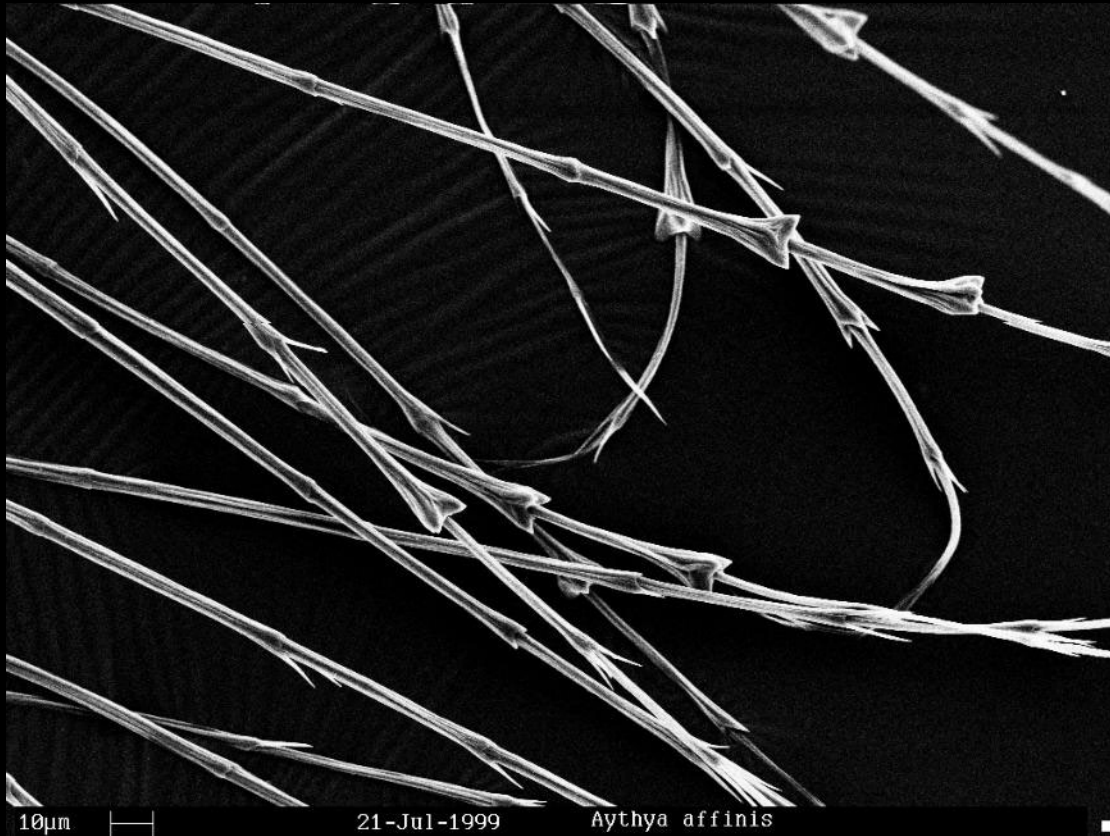
Common Murre (Charadriiformes)

FIG. 147. Strict consensus of 6,646 trees using 53 taxa and 38 microscopic downy feather characters.

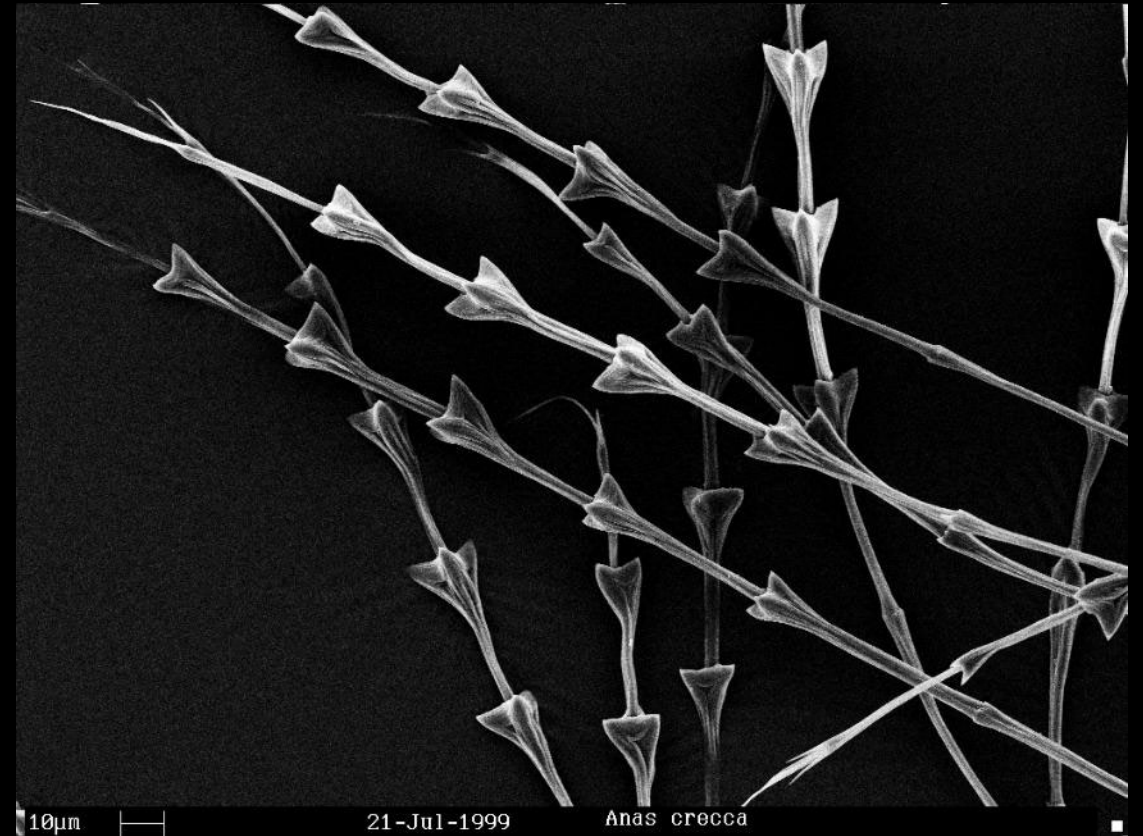


Convergent evolution: The independent evolution of structural or functional similarity in two or more unrelated or distantly related lineages or forms that is not based on genotypic similarity and common ancestry.

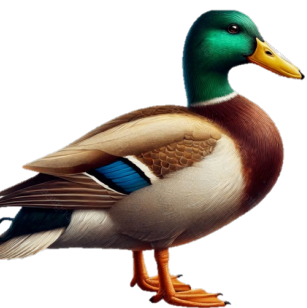
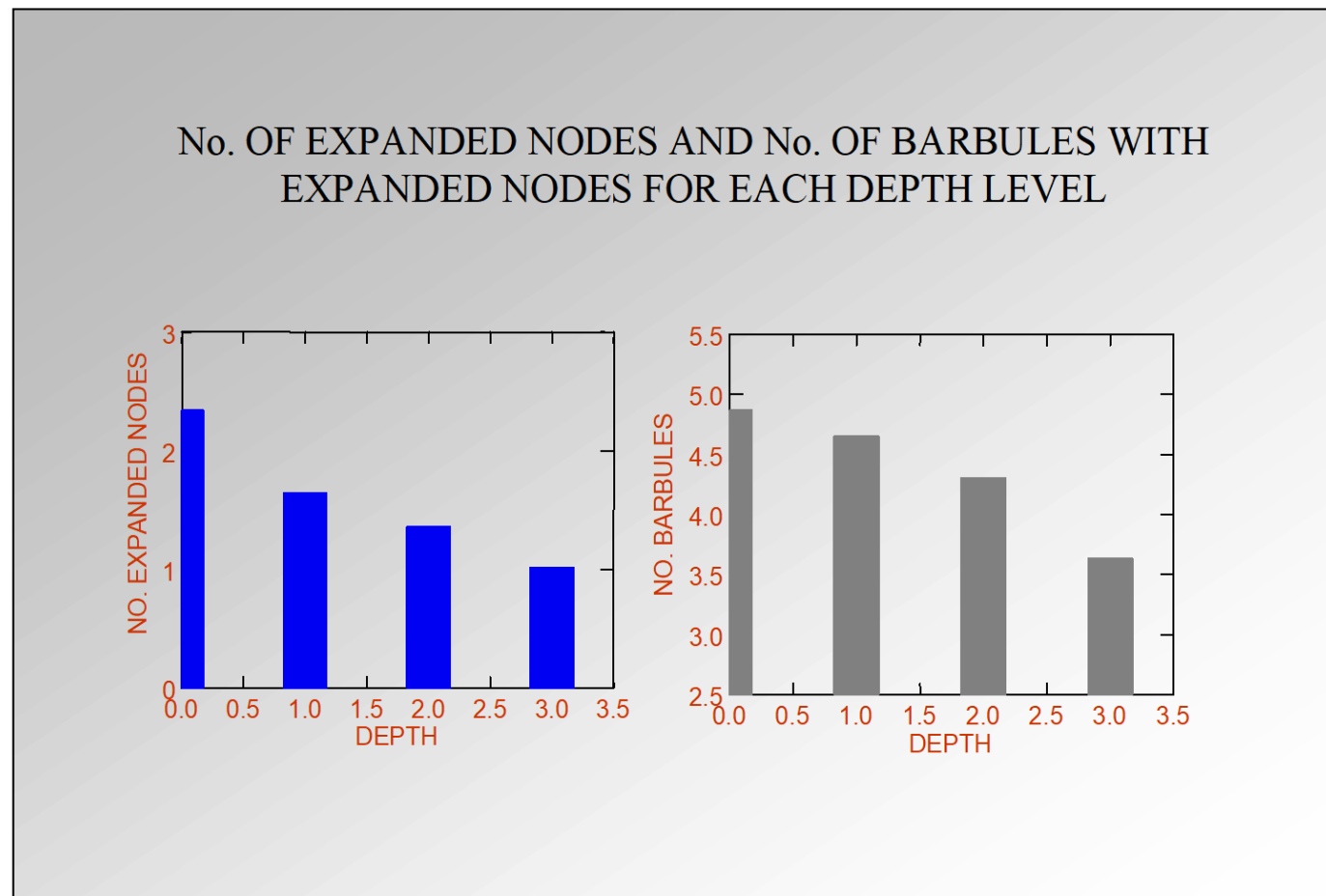
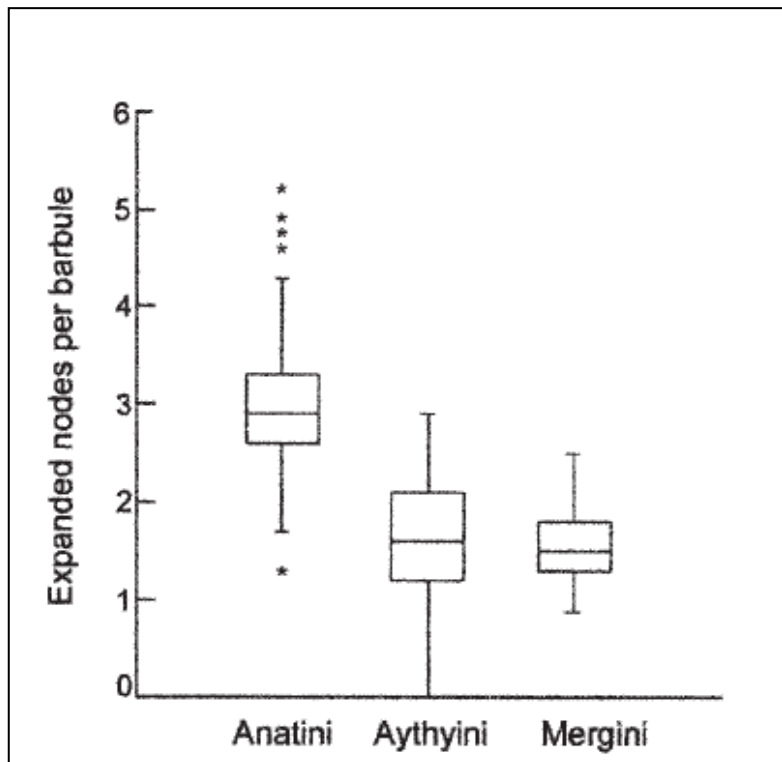
Nodal Function – Insulator



Diving duck (Aythyinae)



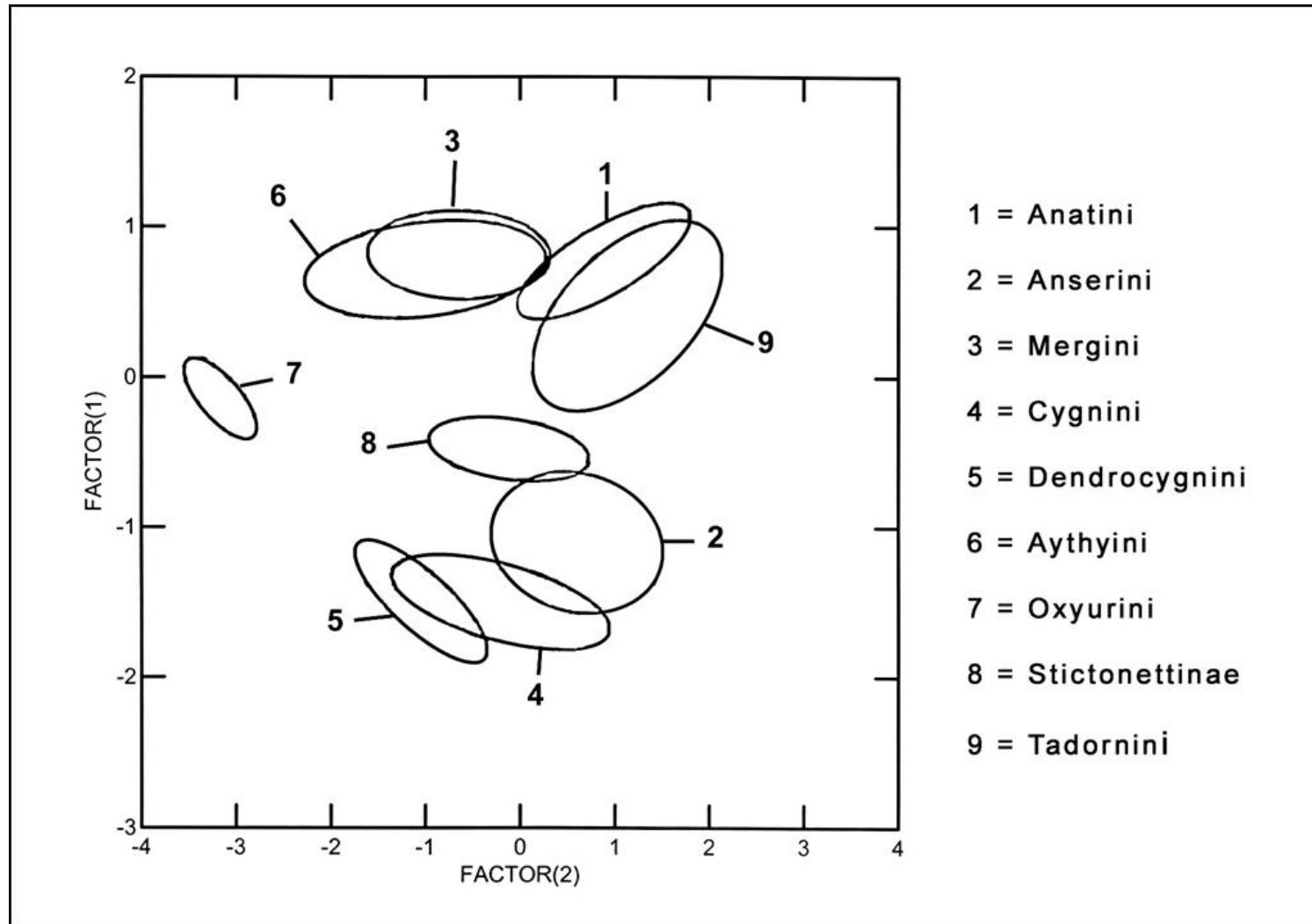
Dabbling duck (Anatinae)



The Condor 109:192–199
© The Cooper Ornithological Society 2007

DIFFERENCES IN PLUMULACEOUS FEATHER CHARACTERS OF DABBLING AND DIVING DUCKS

CARLA J. DOVE^{1,3} AND ANA AGREDA²



Marcy Heacker 2000
USDA via FAA

Heacker-Skeans, M.A. 2002. A Quantitative and Phylogenetic Study of the Plumulaceous Feather Characters of the Waterfowl (Aves: Anseriformes)

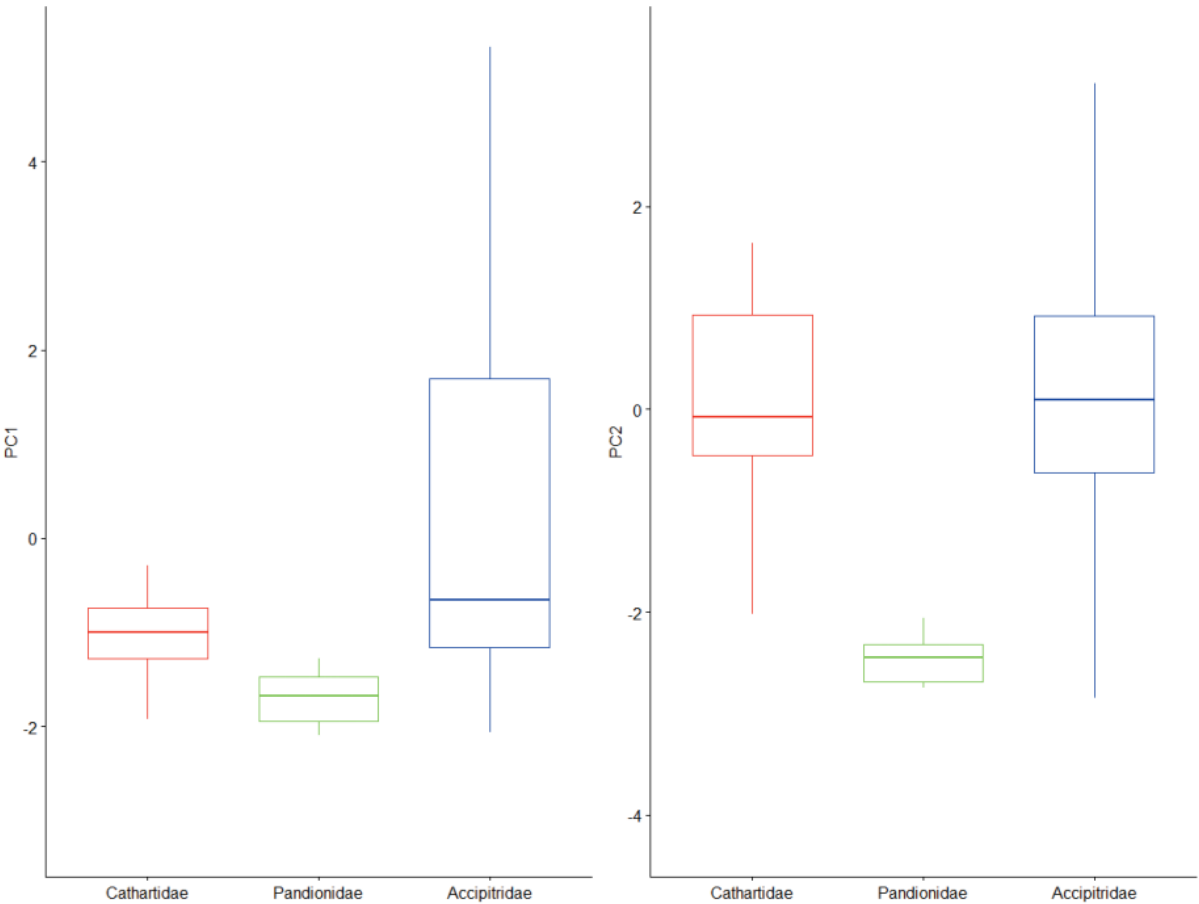
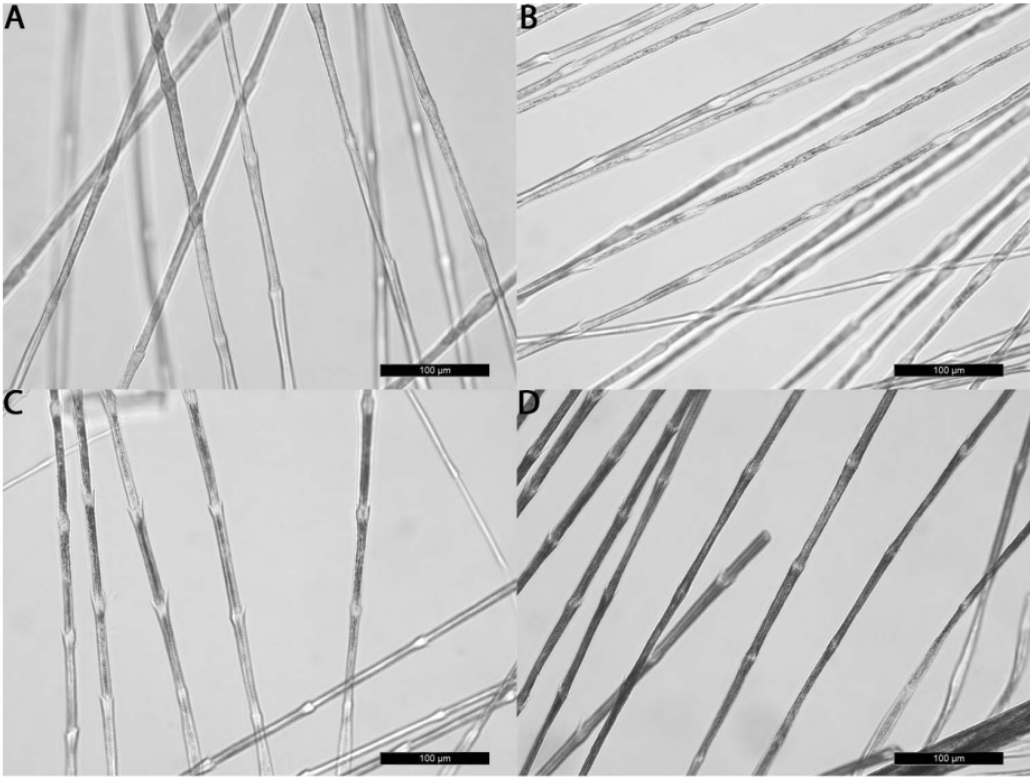


Figure 6. The separation of Cathartidae, Pandionidae, Accipitridae via principal components (PC): PC 1 (left) and PC 2 (right). Plots show mean (middle horizontal line), first quartile (bottom horizontal line), third quartile (top horizontal line), maximum value (top vertical line), minimum value (bottom vertical line). PC1 is negatively weighted with the characters basal node width (distal section), basal node width (midsection), average nodes/barbule, basal internode length (distal section), basal internode length (midsection). PC2 is positively weighted with barbule length and internode length measured at the midsections of basal barbules. Overlap is noted in ranges of most measurements.



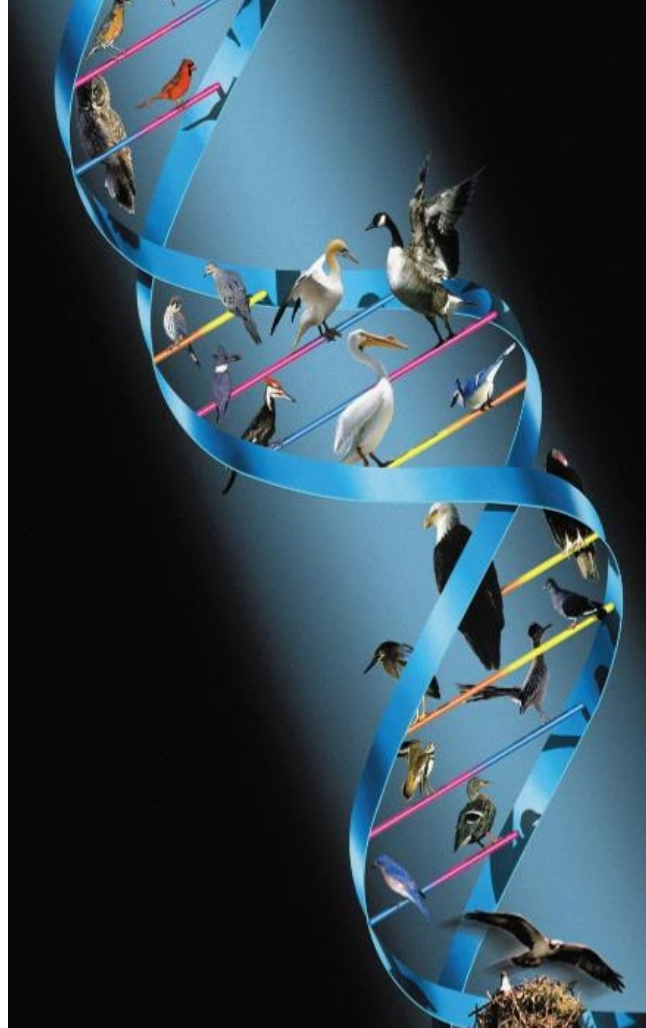
J. Raptor Res. 56(1):75–88
© 2022 The Raptor Research Foundation, Inc.

MICROSCOPIC ANALYSIS OF THE PLUMULACEOUS FEATHER CHARACTERISTICS OF CATHARTIFORMES AND ACCIPITRIFORMES IN NORTH AMERICA

CHARLES P. J. CODDINGTON¹ AND CARLA J. DOVE
*Smithsonian Institution, Division of Birds, Feather Identification Lab, NHB E-600, MRC 116,
Washington, DC 20560 USA*

DAVID A. LUTHER
George Mason University, 4400 University Drive, MS 3E1, Fairfax, VA 22030 USA

DNA



- Henri Ouellet - Canadian Ornithologist, National Museum of Canada, Ottawa (taxidermist)
- 1990s helped Transport Canada identify birdstrikes.
- Begin to think about using DNA (electrophoresis) for identification of birdstrike remains.

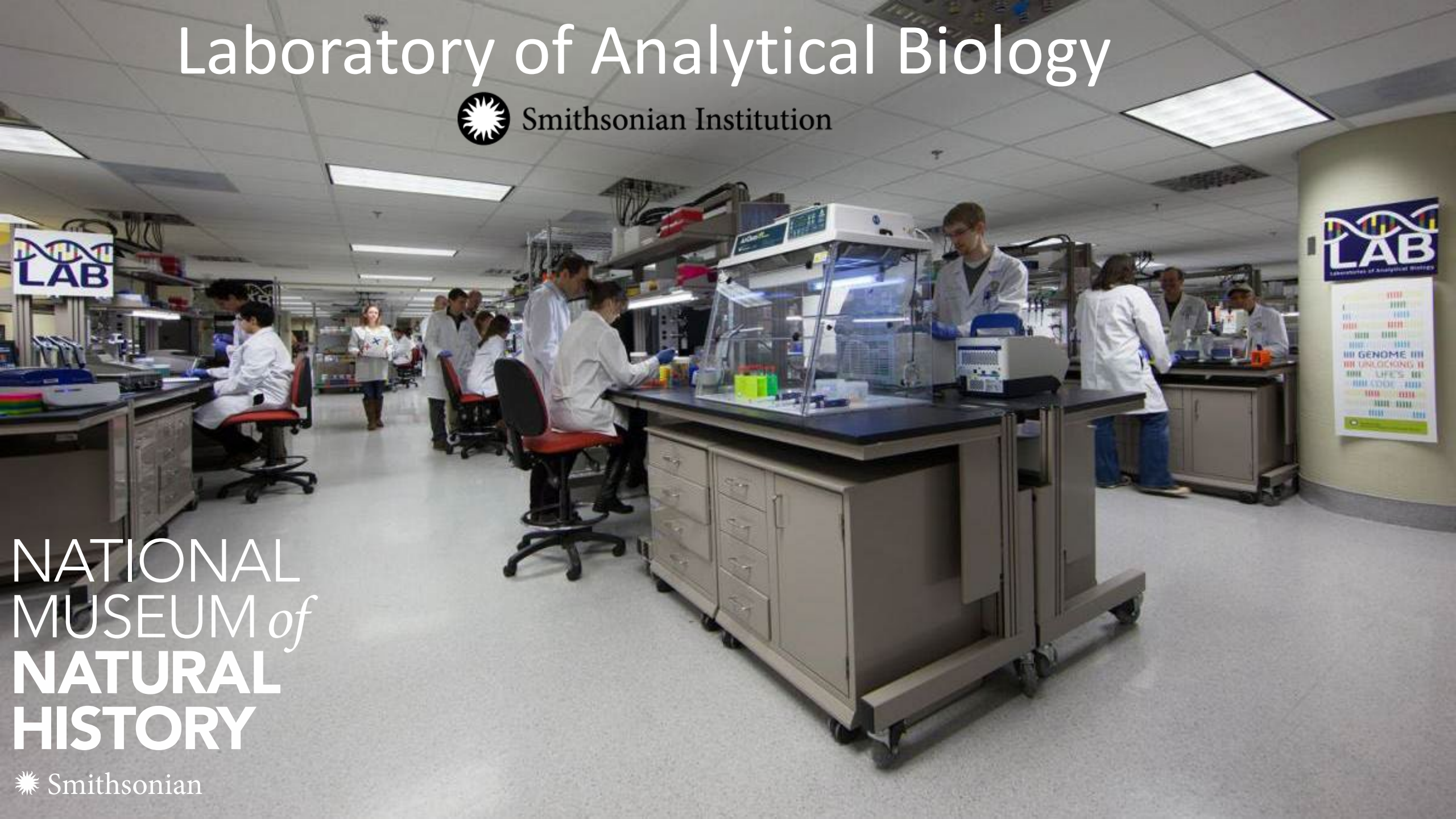
Laboratory of Analytical Biology



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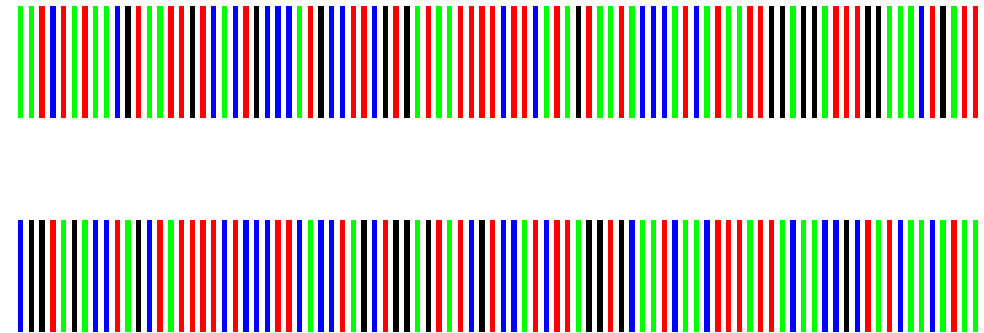
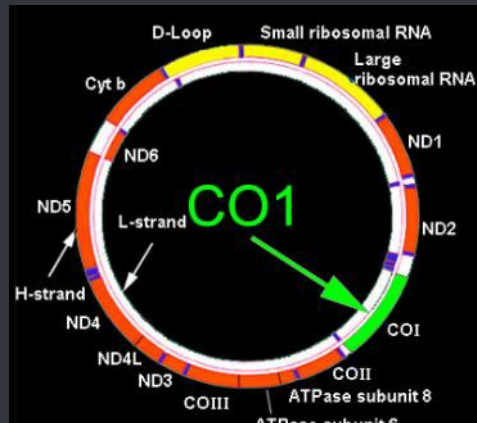


DNA ‘Barcoding’ ABBI – All Birds Barcode Initiative

- Initial Meeting April 2004
- Smithsonian, Royal Ontario Museum, Harvard, Univ. of Guelph, Rockefeller University
- Birds of North America completed 2006

DNA Barcode

- A DNA “barcode” is a short, standardized gene region for identifying animal, plant and fungal species





Field Expeditions



Avian surveys near Camp Lemonnier and Day Forest, Djibouti, Africa

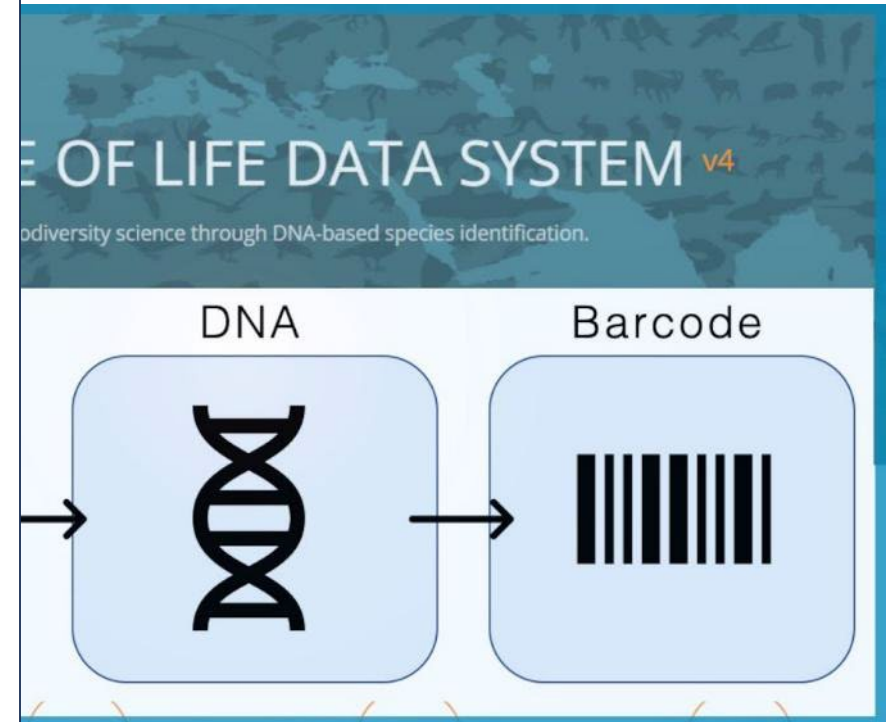
Carla J. Dove¹, James F. Whatton¹, Jacob R. Saucier¹, Brian K. Schmidt¹, Steve W. Gotte¹, Matthew W. Klope², Houssein Rayaleh³

Expedition Funding Sources: DoD Legacy, US Navy, US Air Force, Smithsonian

*BoLD Reference
Library
21 M public records
1.6 M species
4,000+ birds*

Troublesome species do occur:

- **Anatidae and Laridae**
exhibit extraordinarily
low divergences
- Evolutionarily young
species, especially where
hybrids occur, are often
problematic



Comprehensive DNA barcode coverage of North American birds

KEVIN C. R. KERR,* MARK Y. STOECKLE,† CARLA J. DOVE,‡ LEE A. WEIGT,‡
CHARLES M. FRANCIS§ and PAUL D. N. HEBERT*

*Department of Integrative Biology, Biodiversity Institute of Ontario, University of Guelph, Guelph, Ontario, Canada N1G 2W1,

†Program for the Human Environment, The Rockefeller University, New York, NY 10021, USA ‡Smithsonian Institution, National

Museum of Natural History, Washington, DC 20013-7012, USA, §National Wildlife Research Centre, Canadian Wildlife Service,

Environment Canada, Ottawa, Ontario, Canada K1A 0H3

- Transformed our species identification ability!
- Airport management applications and
Database Improvements!



Similar plumages, microstructure is difficult, and mtDNA-barcoding is inconclusive for species identification

- *Species identification problematic*



>50 species of gulls world-wide
~16 species of 'white-headed' gulls



Multi-locus Approach

Microsatellite genotypes (nuclear)

- bi-parentally inherited, high rate of mutation, short tandem repeats in non-coded regions of nDNA

Nuclear gene intron sequences

- bi-parentally inherited, slow rate of mutation, non-coded regions of nDNA

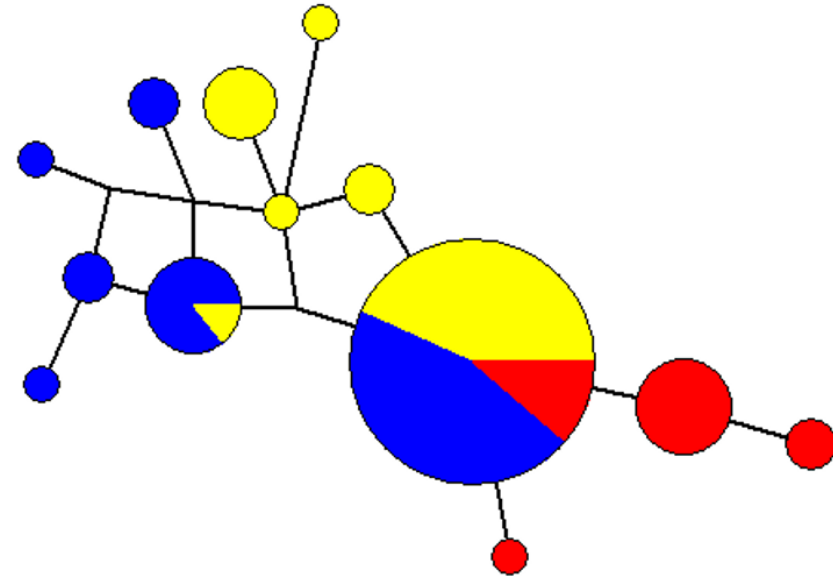
Mitochondrial DNA control region sequences

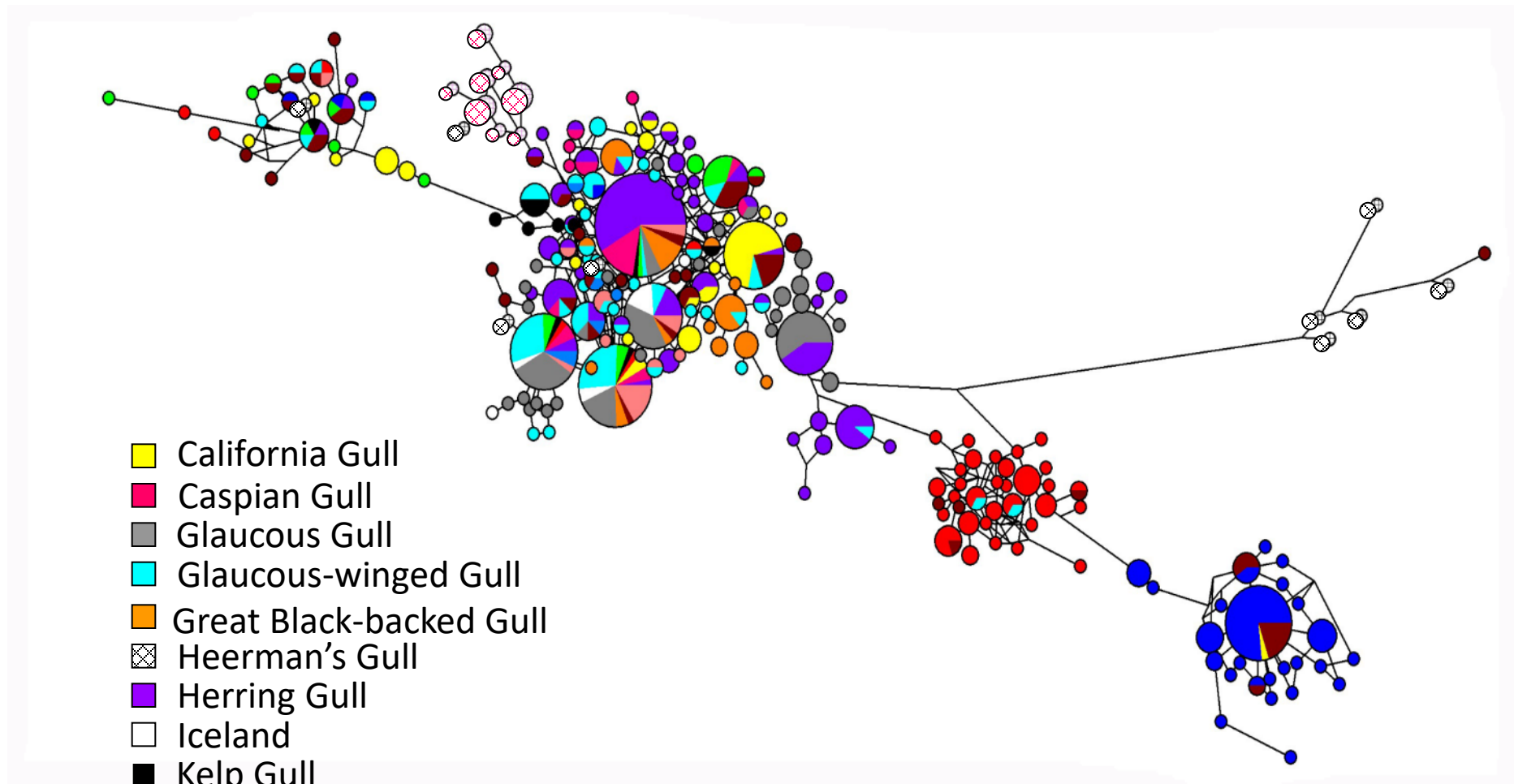


Sarah Sonsthagen – FAA
Sponsored Post-doctoral Fellow

Haplotype Network Map

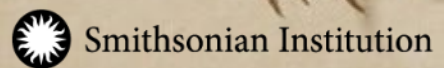
- Each circle represents a unique haplotype (i.e. unique sequence)
- Size of circle is indicative of the number of individuals that had that haplotype
- Each color is a different species
- Each clump is a closely related bunch of haplotypes
- The distance between clumps is equivalent to the genetic distance between them (i.e. the number of nucleotide differences)





Recurrent hybridization and recent origin obscure phylogenetic relationships within the 'white-headed' gull (*Larus* sp.) complex

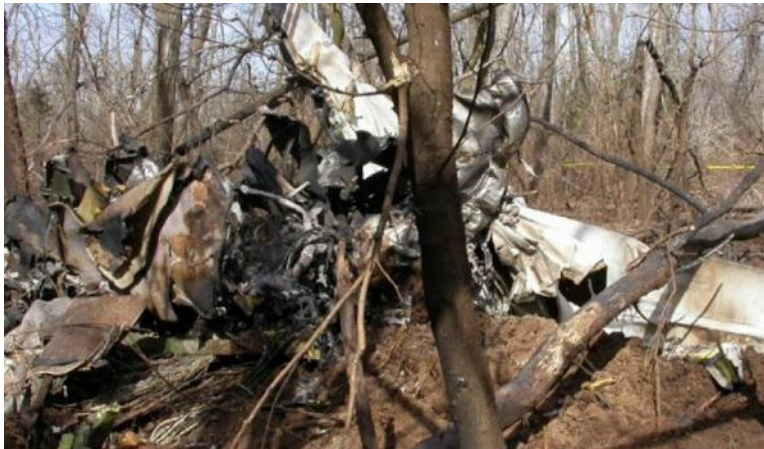
Sarah A. Sonsthagen^{a b c}, Robert E. Wilson^{c d}, R. Terry Chesser^e, Jean-Marc Pons^{f g}, Pierre-Andre Crochet^h, Amy Driskell^b, Carla Dove^a



BSI –Birdstrike Investigation



E-3 AWACS, Elmendorf AFB, 22 Sept 1995, Canada Geese, 24 fatalities



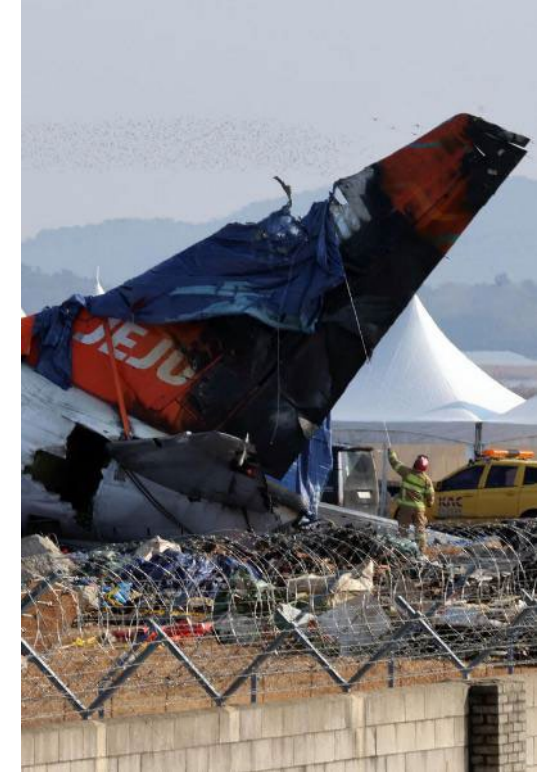
Cessna Citation, Oklahoma March 4 2008, American White Pelican, 5 fatalities



USAirways Flight 1549, Airbus 320, 15 Jan 2009, Hudson River, NY, Canada Geese



Sikorsky Pave Hawk HH-60G, 7 January 2014, RAF Lakenheath, UK - Pink-footed Goose, 4 fatalities



Jeju Air Muan Int. Airport, South Korea (ongoing)
29 December 2024
179 fatalities, 2 survivors, Baikal Teal



4 January 2009 – Sikorsky S-76C crash in Louisiana
8 fatalities, 1 survivor

- *Lack of FAA guidance for windscreens*
- *T-handles jarred loose, require modifications*
- *Windscreen had been replaced with a lighter material*

Bell 206L-3, Hydro, Oklahoma, 21 January 2024, Air Medical, 3 fatalities

- 500-600 feet AGL
- 95-110 knots
- 2323 central time
- 3 fatalities

Medical helicopter enroute back home after dropping off a patient

Cackling Geese;

3 samples DNA-sex all female (4.2 lbs., males larger)

7 photographs of carcasses indicated at least 2 different birds (at least 3 feet visible)



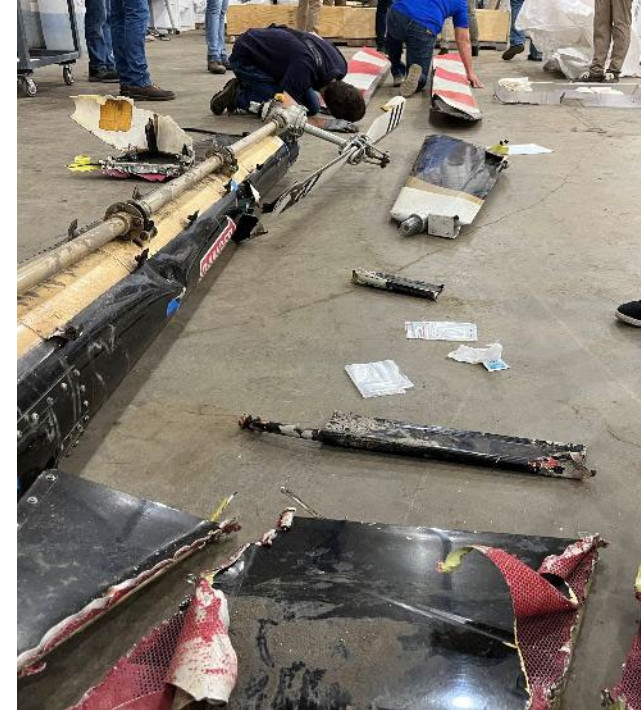
Bell 206L-4, New York Helicopters, 10 April 2025, Jersey City, NJ, 6 fatalities (on going)



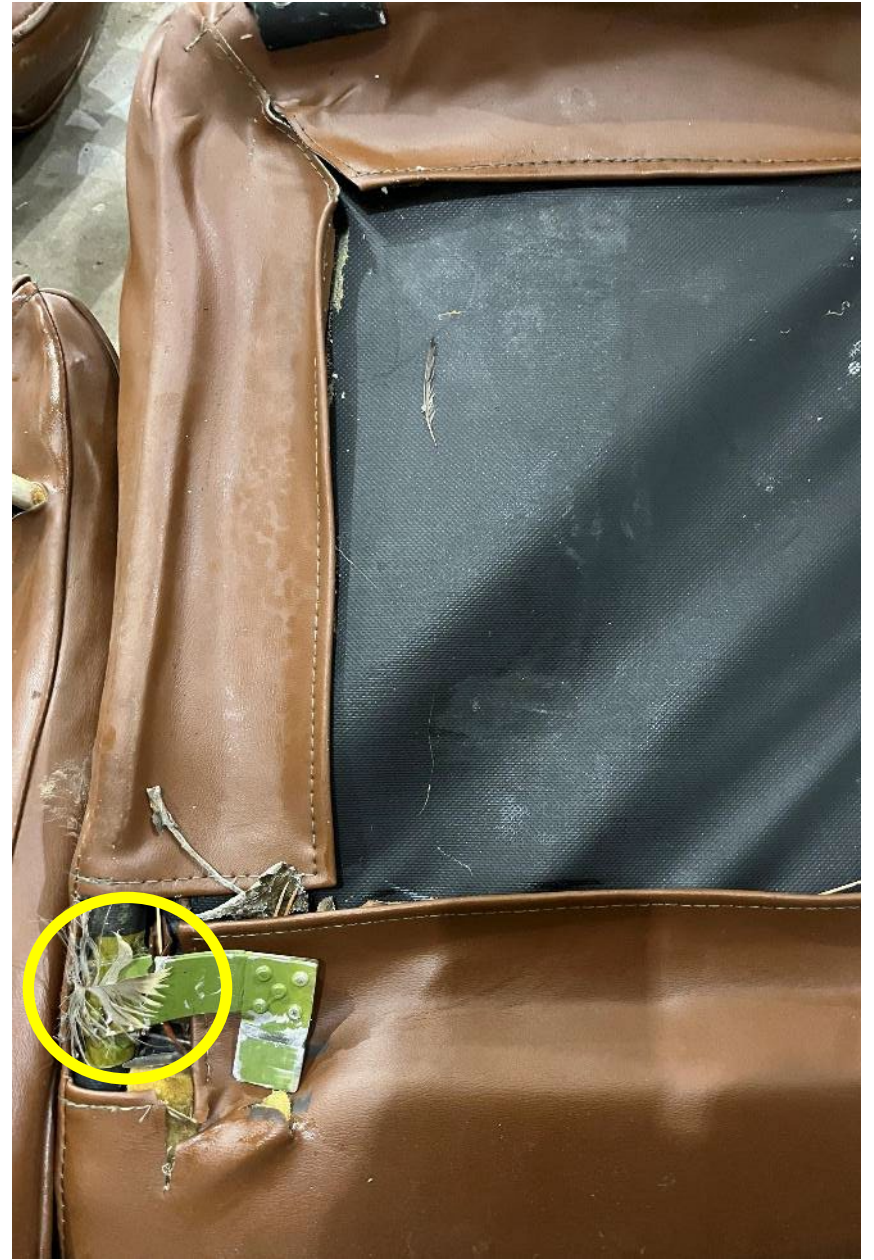
- 1515 ~EDT
- Sightseeing flight
- Inflight breakup at cruise
- About 400 ft msl
- 90-95 knots



17- 18 June 2025 MA collecting team - collaboration



- 126 sample bags
- 9 NTSB, mid-April
- 82, storage facility, MA, June
- 35, NTSB headquarters, DC, September



CONTAMINATIONS?

17 samples were determined (by CJD) to be contaminated by environmental conditions (submersed in water in mud); or because bird species identified do not comingle (e.g. American Woodcock), or because plant matter was detected in the sample (possible floating and originated in water).

Cockpit was not contaminated by clothing or jacket filling.

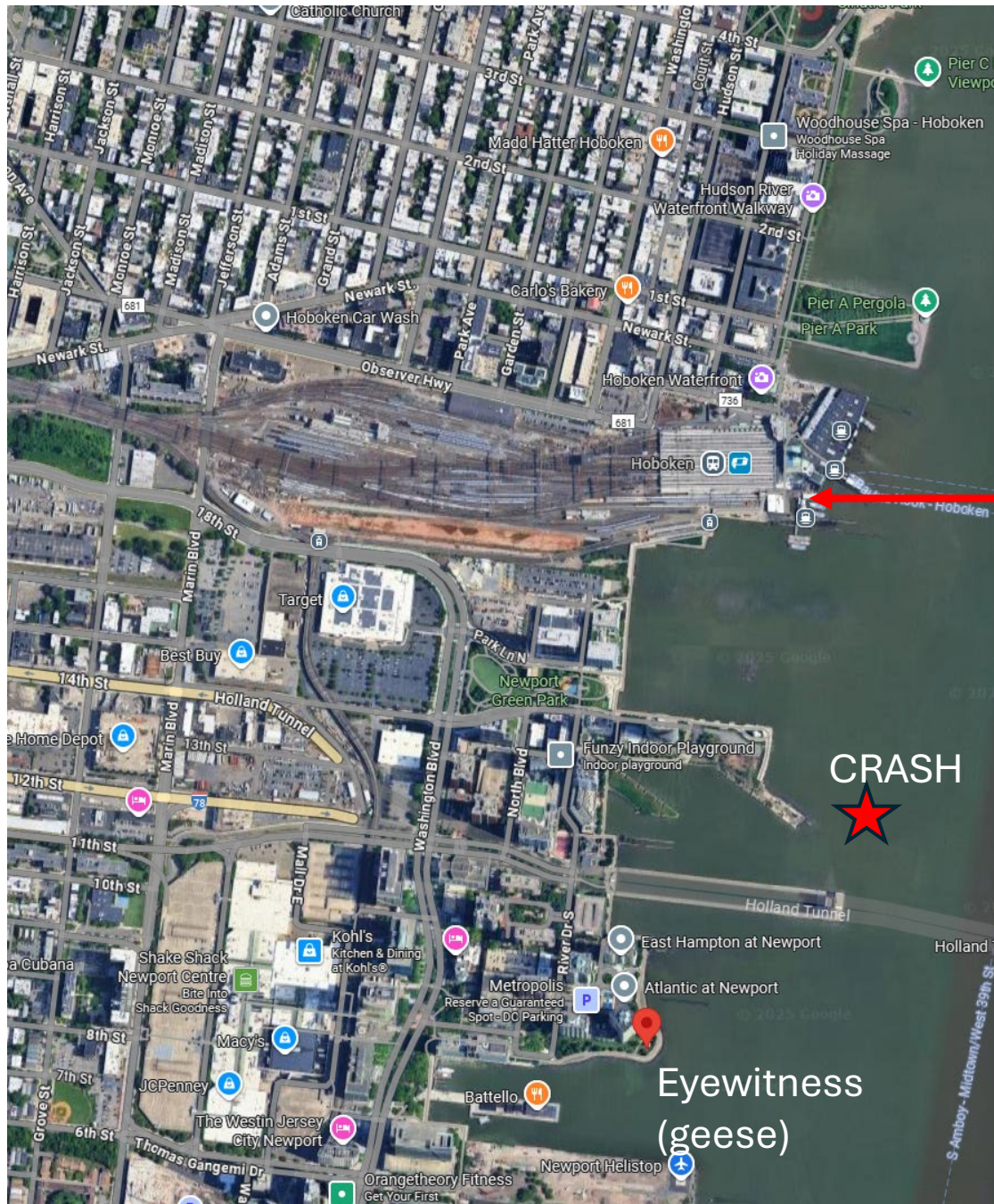


Sample 1.77 (7 species)

Photos from internet searches of accident



Canada Goose
American Woodcock
'white-headed gull'
Brant
Passerine
Gadwall
Mallard/Black Duck



Eyewitness: Running north along path parallel to Hudson in NJ. Running around light house on Newport just south of Holland Tunnel ventilation towers when a flock of 20 very big, fat birds, believed to be geese, took flight right in front of her headed easterly toward the river. A dog park near the small green space near light house. Dog may have spooked the birds. The birds almost hit her.

Black-backed Gull wing on rooftop



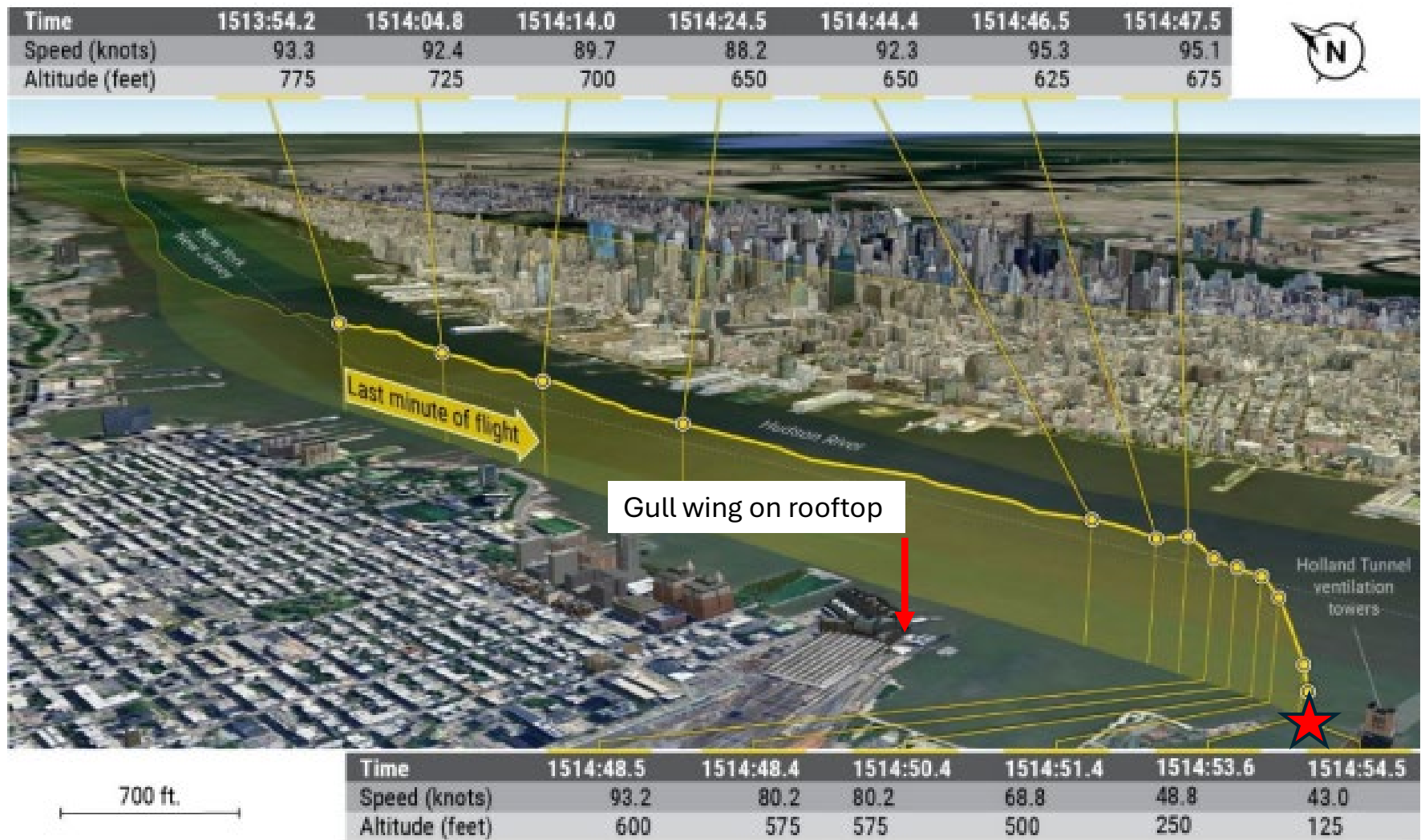
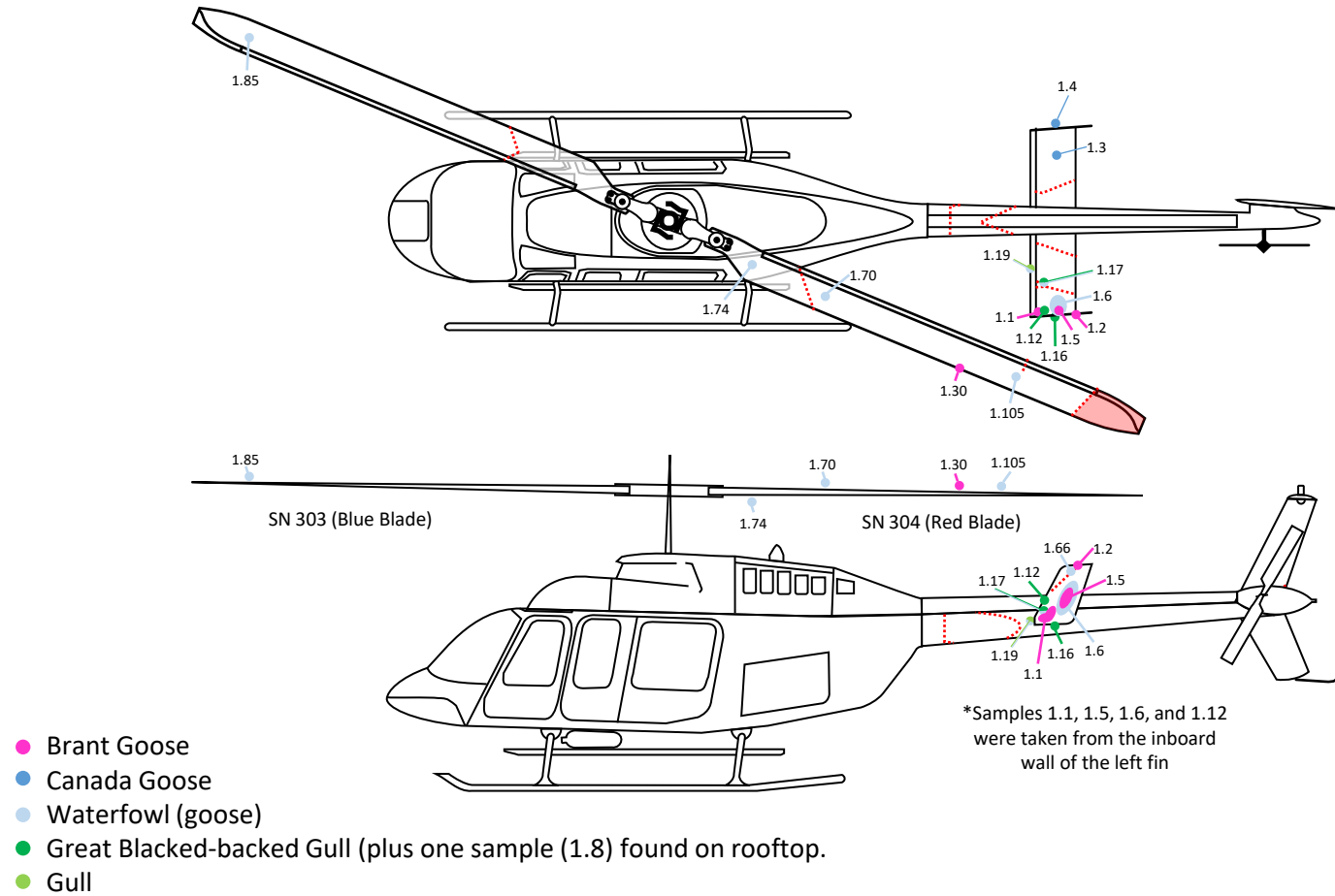


Figure 2. ADS-B flight track and geographic data highlighting the last minute of the flight through breakup, uncontrolled decent and loss of signal.

Eyewitness
(geese) ★

VALIDATED BIRD EVIDENCE AT IMPACT POINTS ON HELICOPTER



Numbers listed above color code points correspond to sample numbers in Attachment 1 - Birds (validated) mapped tab.

“Bird Zone” 500-5,000 feet

Special report for Federal Aviation Administration, Airports Division, Washington DC, 15 May 2025
(In press as a FAA Airports Technical Center publication, not for public distribution until published)

Wildlife strikes involving civil rotorcraft: implications for Advanced Air Mobility Operations

Richard A. Dolbeer, *Science Advisor, Airport Wildlife Hazards Program, U.S. Department of Agriculture, Wildlife Services, 6100 Columbus Ave., Sandusky, OH 44870*

- Fly <80 knots when possible
- Fly > 500 feet when possible
- Beware of night flying, especially during spring and fall migration
- Windshield vulnerability
- Lighting systems (pulsed)
- Bird-detecting radar

Trend Analysis of Wildlife Strikes
Involving Civil Rotorcraft:
Awareness for Advanced Air
Mobility Operations
“coming soon”

- Electric-powered Advanced Air Mobility Aircraft
- 500-5,000 feet
- Operate quietly
- Amazon targets a total of 100K delivery vehicles globally by 2030.



Amazon Drone Strike



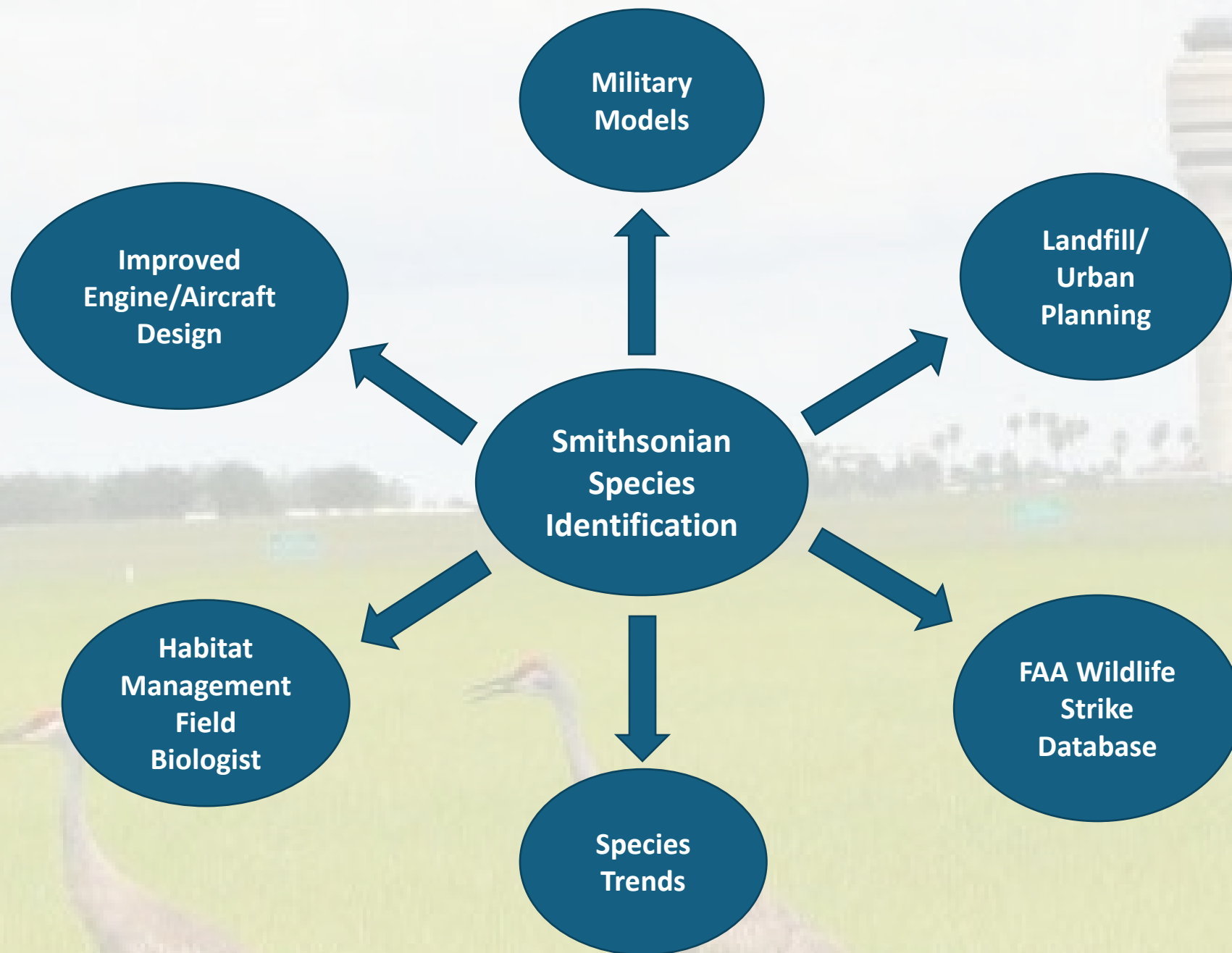
Western Cattle Egret (12 ounces)

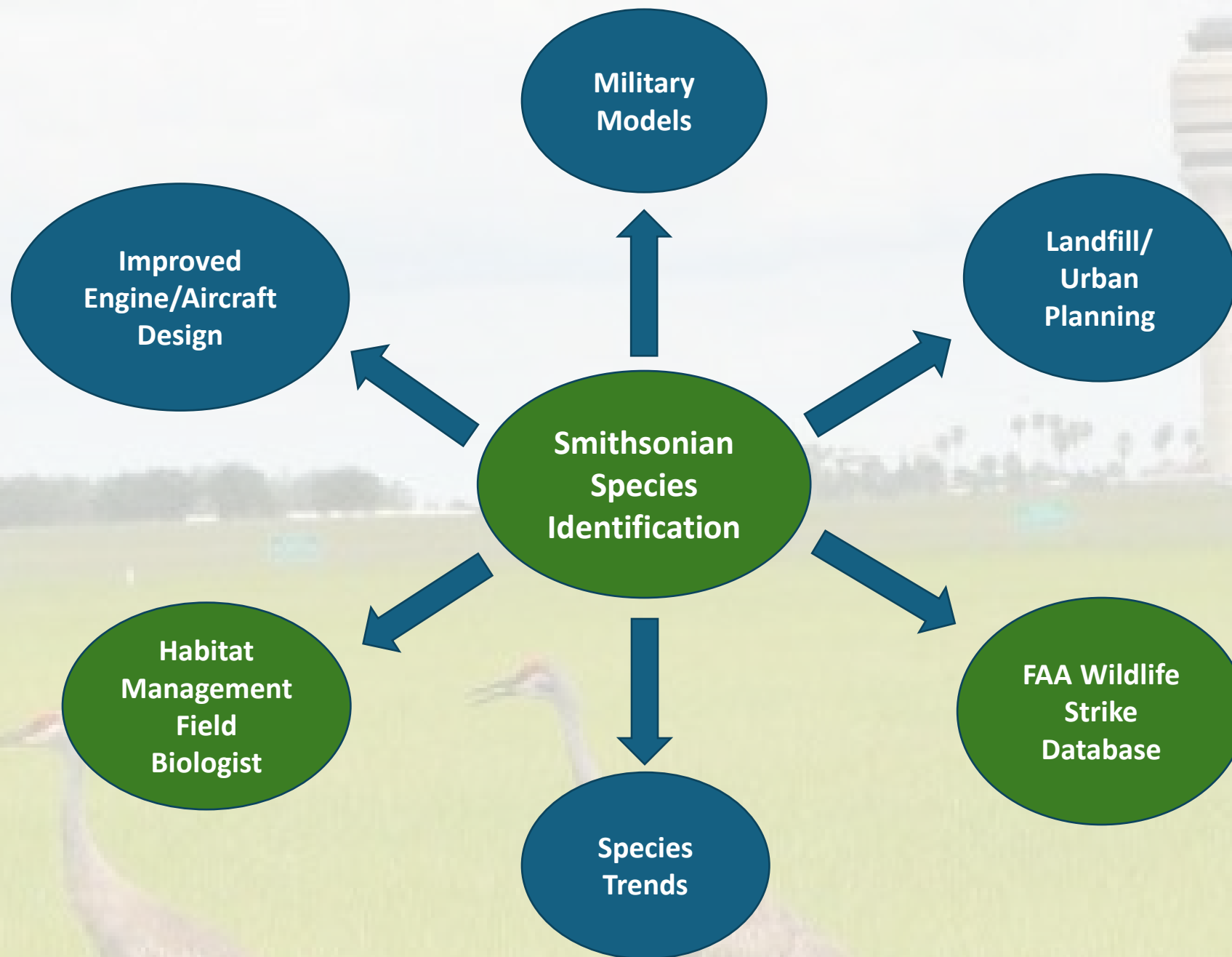
285 Height; 62 knots
15 April 2026
Richardson, TX



Remarks (Describe damage, injuries, and other pertinent information):
N396PA was returning from delivery when a bird struck the drone. The drone system behaved as expected, commanding a switchover from the Primary to the Recovery flight controller lane and enacted a Straight Land. The Straight Land concluded in a landing atop a tree. When the incident response crew arrived onsite 15 minutes later, the drone fell from the tree and sustained damage. There were no injuries to persons or any damage to third party property. A more detailed report will be provided after Prime Air's investigation of this event is completed. QTX1 Amazon Prime Air. NOTE: OWNER/ OPERATOR= AMAZON.COM SERVICES LLC. Model: MK30. Engine Manufacturer: Unknown. Engine Model: Unknown. Western cattle egret (Ardea ibis)

Aircraft Time out of Service (hours): 45.00	Estimated Cost of Repairs or Replacements (U.S. \$):	Estimated other Cost (U.S.\$) (e.g. loss of revenue, fuel, hotels): 70000
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3 ELEMENTS TO A SUCCESSFUL BIRDSTRIKE PROGRAM

<https://wildlife.faa.gov/print?StrikeReportNum=2024-08-31-232647&StrikeReportId=1508609>

Strike Report Confirmation:
2024-08-31-232647

Revision: 1



Date of Incident: 08/31/2024	Local Time of Incident: 12:42	Time of Day: Day
Airport Name/CAO Code: (KCAE) COLUMBIA METRO - SC	Runway Used: Runway 11	Sky Condition: Some Cloud Precipitation: ☐ Fog ☐ Rain ☐ Snow ☒ None
Height (AGL):	Speed (AS):	Phase of Flight: Approach
Operator: Piedmont Airlines	Aircraft Registration: N339AE	Flight Number: AUS14
Aircraft Make/Model: EMBRAER	Engine Make/Model: Rolls Royce	Wildlife Identification: Black vulture (Coragyps atratus), Black vulture (Coragyps atratus)

Location, if en route/Nearest Town/Reference and State/Airport:
Lexington, SC

Distance (nm) from Airport/Nearest Town/Reference and State/Airport:
Effect on Flight:
☐ None ☐ Aborted take-off ☐ Precautionary Landing ☐ Engine Shutdown ☐ Other. Specify Effect on Flight if "Other" is checked:

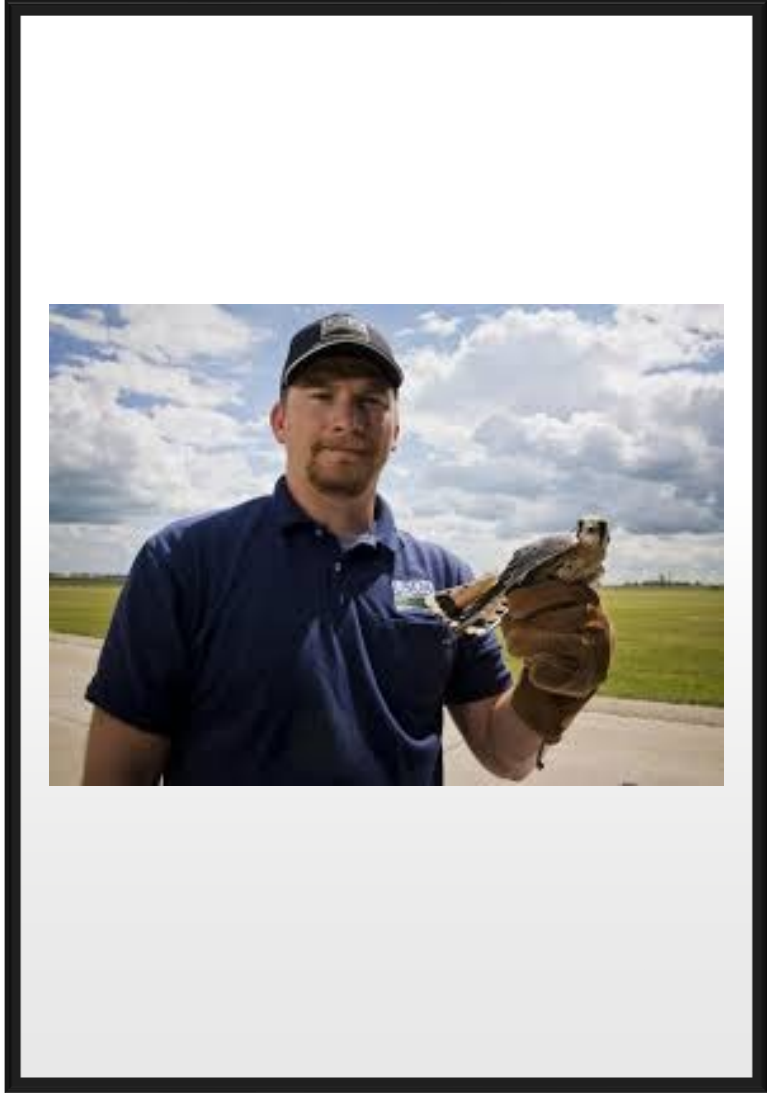
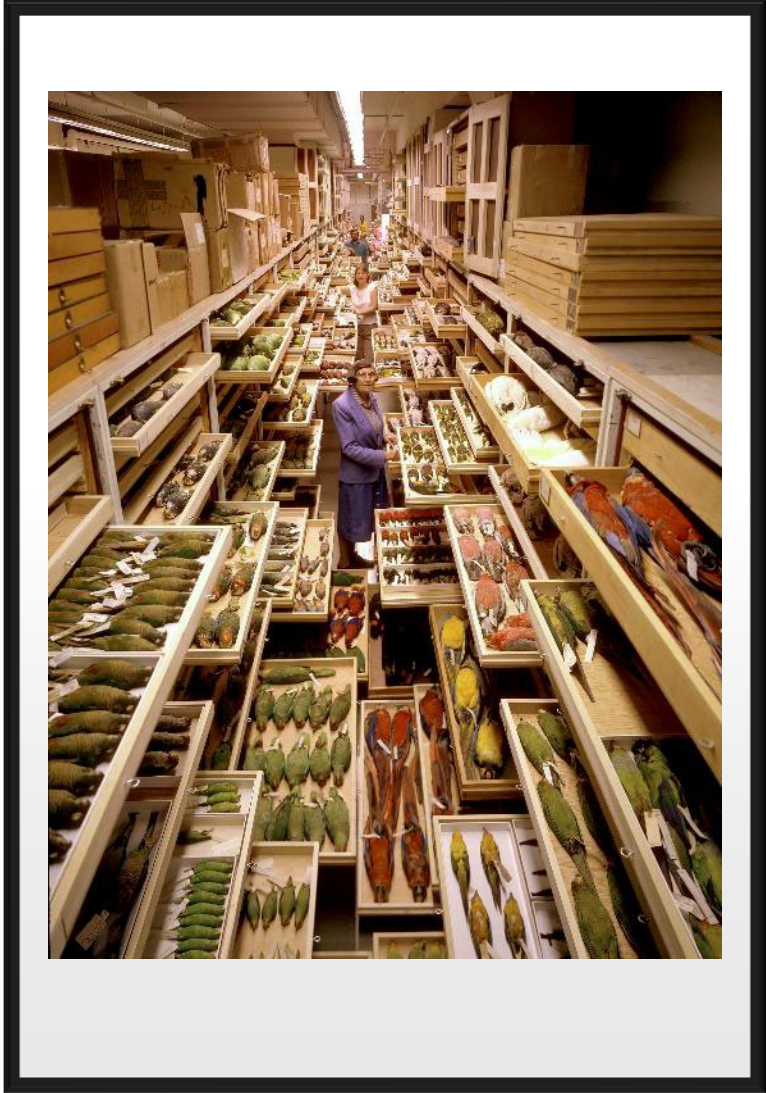
Aircraft Part(s)	Struck	Damaged	Ingested		Struck	Damaged
Fuselage	☐	☐		Propeller	☐	☐
Wing/hood	☐	☐		Wing/Rotor	☐	☐
Nose	☐	☐		Fuselage	☐	☐
Engine #1	☒	☒	☒	Landing Gear	☐	☐
Engine #2	☐	☐	☐	Tail	☐	☐
Engine #3	☐	☐	☐	Lights	☐	☐
Engine #4	☐	☐	☐	Specify part struck/damaged/ingested if "Other" is checked		
Other	☐	☐	☐			

Remarks (Describe damage, injuries, and other pertinent information):

Aircraft Time out of Service (hours):	Estimated Cost of Repair or Replacements (U.S. \$): 100000	Estimated other Cost (U.S.\$) (e.g. loss of revenue, fuel, hotels):
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Smithsonian Wildlife Identification:
Black vulture, Black vulture

Smithsonian Wildlife Identification Comments:
Two bags of animal's droppings. Both bags identified as Black Vulture.



Wildlife Strike Database Species Identification Airport Biologist



Helicopter



Urban Air Taxi



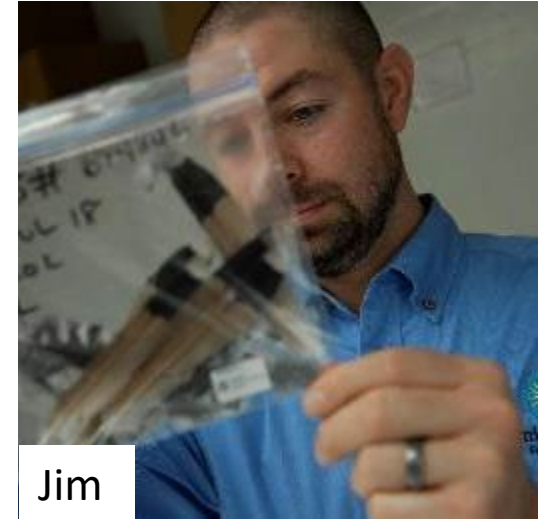
Drone Delivery Service



Ingrid



Sarah



Jim



Smithsonian Institution



Faridah



Panel Discussion and Poster



Carla



1960s



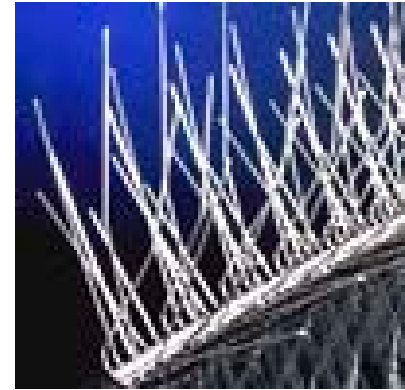
1991



2000-2002



2008



Keep Birds and Aircraft Apart SAFER SKIES FOR ALL WHO FLY



Thanks!



Smithsonian Institution