

## **IB 173LF – Mammalogy (5 units)**

**Fall 2022**

Lectures: TuTh 10:00 - 11:00 am, 3095 Valley Life Sciences Bldg. (VLSB)

Labs: TuTh 2:00 – 5:00 pm, 3095 VLSB

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Class website: [bcourses.berkeley.edu](http://bcourses.berkeley.edu) (IB 173)

### **General Course Content**

This is a course on the biology of mammals of the world. It will combine experience from laboratories, lectures, and field work. The laboratory portion of the course will rely on the collections of the UC Berkeley Museum of Vertebrate Zoology. One major goal is to have students become familiar with the evolutionary diversification of mammals of the world and also with the ecology and evolution of the local mammalian fauna. Students will therefore be expected to learn the defining characteristics of mammalian Orders and Families worldwide as well as those of many California species. We will take a phylogenetic perspective and emphasize a functional understanding of the characters that define lineages. The goal is not simply to memorize characters (although there will be considerable memorization), but to learn their evolutionary and functional significance. At the end of the course you should be able to identify any mammalian specimen to Order and Family, and you should be able to describe aspects of its ecology, such as its food habits from an examination of its teeth and jaw structure, or its locomotory mode (and thus habitat) from an examination of its skeleton. By studying a single adaptive radiation in depth, you will hopefully come to appreciate more fully the details of the evolutionary process. The lecture portion of the course will cover a wide range of subjects in the ecology and evolution of mammals. Students will be expected to read from texts and from the primary literature. A portion of one lecture each week will be used for discussion of an assigned reading from the primary literature. There will be three required field trips in California. Field work is a critical part of the class: we will have the opportunity to observe, handle, and study wild mammals first-hand. These trips are intended to introduce students to the field identification of mammals and techniques used to study their population biology.

## Lecture Schedule - Fall 2022

1.	Aug.	25	Introduction (ch 1-2)
2.		30	Mammalian origins (ch 4)
3.	Sept.	1	Mammalian origins (Discussion: <i>Morens et al. 2020</i> )
4.		6	Dentition (ch 4)
5.		8	Dentition (Discussion: <i>Mao et al. 2020</i> )
6.		13	Locomotion (ch 6)
7.		15	Locomotion (Discussion: <i>Wilson et al. 2013</i> )
8.		20	The mammalian radiation (ch 3)
9.		22	The mammalian radiation (Discussion: <i>Springer et al. 2004</i> )
10.		27	Feeding mechanisms and physiological ecology (ch 7-8)
11.		29	Physiological ecology (Discussion: <i>Goldbogen et al. 2019</i> )
12.	Oct.	4	Echolocation (ch 21)
13.		6	Reproduction (ch 9) (Discussion: <i>Corcoran and Conner 2014</i> )
14.		11	Reproduction
15.		13	Catch-up lecture and review
16.		18	<b>Mid-term exam 1</b>
17.		20	Behavior and social systems (ch 22)
18.		25	Social systems (Discussion: <i>Lim et al. 2004</i> )
19.		27	Population ecology (ch 25)
20.	Nov.	1	Population ecology (Discussion: <i>Krebs et al. 1995</i> )
21.		3	Community ecology (ch 26)
22.		8	Community ecology (Discussion: <i>Mills et al. 2018</i> )
23.		10	Population genetics and geographic variation
24.		15	Population genetics (Discussion: <i>Barrett et al. 2019</i> )
25.		17	Speciation and zoogeography (ch 5, 28)
26.		22	Zoogeography (Discussion: <i>Moritz et al. 2008</i> )
27.		24	No class - Thanksgiving
28.		29	<b>Mid-term exam 2</b>
29.	Dec.	1	No lecture

Before each lecture, you are expected to read and study the appropriate chapters in Feldhamer (given above).

The textbook (Feldhamer) is on electronic reserve in the Biosciences Library in VLSB.

## Laboratory Schedule - Fall 2022

Aug.	25	Cranial anatomy
	30	Post cranial anatomy
Sept.	1	Cranial and post cranial anatomical diversity
	6	Data collection, museum specimens, field notes, zoonoses, CA mammals
	8	Teeth
	13	Teeth
	15	Locomotor adaptations, horns, antlers, integument, pelage, age determination
	20	Monotremata, Didelphimorphia, Paucituberculata, Microbiotheria, Notoryctemorphia
	22	Dasyuromorphia, Peramelemorphia, Diprotodontia
	27	Cingulata, Pilosa
	29	Tubulidentata, Macroscelidea, Tenrecoidea, Hyracoidea, Proboscidea, Sirenia
Oct.	4	Chiroptera
	6	Chiroptera
	11	Review
	13	Lab Mid Term Exam
	18	Dermoptera, Scandentia, Primates
	20	Primates
	25	Rodentia
	27	Rodentia
Nov.	1	Rodentia
	3	Rodentia (review), Lagomorpha
	8	Erinaceomorpha, Soricomorpha, Pholidota, Carnivora
	10	Carnivora
	15	Carnivora
	17	Cetacea
	22	Perissodactyla, Artiodactyla
	24	No class - Thanksgiving
	29	Review
Dec.	1	Lab Final Exam

Before each lab, you are expected to read the corresponding taxonomic chapters in Feldhamer (and you are also expected to read and study the appropriate chapters in the lab manual, "A manual of the Mammalia: an homage to Lawlor's *Handbook to the Orders and Families of Living Mammals*."

## Field Trips

This course includes three field trips. These trips form an essential component of the course and are mandatory for all students enrolled in the class.

Sagehen Creek Field Station (1st night)  
<http://sagehen.ucnrs.org/>  
Camping at Chilcoot, CA (2<sup>nd</sup> night)

Depart Friday, Sept 9, 10:00 am  
Return Sunday, Sept 11, 5:00 pm

Hastings Natural History Reservation:  
<http://www.hastingsreserve.org/>

Depart Friday, Sept. 23, 10:00 am  
Return Saturday, Sept. 24, 5:00 pm

Point Reyes National Seashore  
[www.nps.gov/pore/](http://www.nps.gov/pore/)

Depart Friday, Nov. 18, 9:00 am  
Return Friday, Nov. 18, 5:00 pm

An important goal of these trips is to make you familiar with the natural history of mammals in California. You will have the opportunity to observe, trap, and handle a variety of mammals. Because of the presence of hantavirus and other zoonoses in some rodent populations, you will not be required to trap or handle live animals if you do not wish to do so. However, participation as an observer is still expected. Students who wish to prepare standard museum specimens from animals collected in the field will have the opportunity to do so.

## Course Policy and General Expectations

<u>Grading:</u>	Lecture Mid Term 1	100 pts
	Lecture Mid Term 2	100 pts
	Lab Mid Term	100 pts
	Lab Final	200 pts
	Participation (Field and Lab Work)	100 pts

### Expectations:

1. Regular attendance in lecture and lab is expected. You will need the entire 3 hour lab period every time. Lab exams cannot be made up. The final exam for lab will cover material from the entire course.
2. There are weekly readings from the text and the lab manual. There are also weekly readings from the primary literature (see following pages). We will discuss these papers in class. Everyone is expected to have read each paper *before lecture* and everyone is expected to participate in these class discussions. Some exam questions will derive from this material.
3. Field trips. All students are expected to attend the field trips.
4. All students are expected to adhere to the UC Berkeley honor code: "As a member of the UC Berkeley community, I act with honesty, integrity, and respect for others." (see <http://asuc.org/honorcode/index.php>).

### Required Texts:

- Feldhamer, G.A., J.F. Merritt, C. Krajewski, J.L. Rachlow, and K.M. Stewart, 2020. Mammalogy, Fifth Edition. Johns Hopkins University Press, Baltimore. (This is on two-hour reserve in the Biosciences Library in VLSB.)
- Kelt, D.A., and J.L. Patton, 2020. A manual of the Mammalia: an homage to Lawlor's *Handbook to the Orders and Families of Living Mammals*. The University of Chicago Press.

## Weekly Readings

### Sept 1 – Zoonoses, coronavirus

#### *Required reading:*

Morens, D.M., J.G. Breman, C.H. Calisher, P.C. Doherty, B.H. Hahn, et al., 2020. The origin of COVID-19 and why it matters. *American Journal of Tropical Medicine and Hygiene* 103: 955-959.

Kelt, D.A., M.S. Hafner, and The American Society of Mammalogists Ad Hoc Committee for Guidelines on Handling Rodents in the Field. 2010. Updated guidelines for protection of mammalogists and wildlife researchers from Hantavirus pulmonary syndrome (HPS). *J. Mammalogy* 91: 1524-1527.

#### *Additional readings (optional):*

Mandl, J.N., C. Schneider, D.S. Schneider, and M.L. Baker. 2018. Going to bat(s) for studies of disease tolerance. *Frontiers in Immunology* 9: 2112.

Letko, M., S.N. Seifert, K.J. Olival, R.K. Plowright, and V.J. Munster. 2020. Bat-borne virus diversity, spillover and emergence. *Nature Reviews Microbiology* 18: 461-471.

Gorbunova, V., A. Seluanov, and B.K. Kennedy. 2020. The world goes bats: living longer and tolerating viruses. *Cell Metabolism* 32: 31-43.

Watsa, M., and Wildlife Disease Surveillance Focus Group. 2020. Rigorous wildlife disease surveillance. *Science* 369: 145-147.

Flies, A.S., and Wild Comparative Immunology Consortium. 2020. Rewilding immunology. *Science* 369: 37-38.

Olival, K.J., P.R. Hosseini, C. Zambrana-Torrel, N. Ross, T.L. Bogich, and P. Daszak. 2017. Host and viral traits predict zoonotic spillover from mammals. *Nature* 546: 646-650.

Moratelli, R., and C.H. Calisher. 2015. Bats and zoonotic viruses: can we confidently link bats with emerging deadly viruses? *Mem. Inst. Oswaldo Cruz* 110: 1-22.

### September 8 - Mammalian origins

#### *Required reading:*

Schultz, J.A. 2020. Eat and listen- how chewing and hearing evolved; mammalian middle ear bones separated from the jaw of vertebrate ancestors. *Science* 367: 244-246.

Mao, F., Y. Hu, C. Li, Y Wang, M. Hill Chase, A.K. Smith, J. Meng. 2020. Integrated hearing and chewing modules decoupled in a Cretaceous stem therian mammal. *Science* 367: 305-308.

#### *Additional readings (optional):*

Bhullar B.A.S., A.R. Manafzadeh, J.A. Miyamae, E.A. Hoffman, E.L. Brainerd, C. Musinsky, and A.W. Crompton. 2019. Rolling of the jaw is essential for mammalian chewing and tribosphenic molar function. *Nature* 566: 528-533.

Luo, Z.-X. 2007. Transformation and diversification in early mammal evolution. *Nature*: 450: 1011-1019.

Pickrell, J. 2019. The making of mammals. *Nature* 574: 468-472.

Hoffman, E.A., and T.B. Rowe. 2018. Jurassic stem-mammal perinates and the origin of mammalian reproduction and growth. *Nature* 561: 104-108.

Hopson, J. 1973. Endothermy, small size, and the origin of mammalian reproduction. *Am. Nat.* 107: 446-452.

Hopson, J. 1950. The origin of the mammalian middle ear. *Am Nat.* 6: 437-450.

Crompton, A.W., and P. Parker. 1978. Evolution of the mammalian masticatory apparatus. *Amer. Scientist* 66: 192-201.

Rowe, T.B. T.E. Macrini, and Z.H. Luo. 2011. Fossil evidence on the origin of the mammalian brain. *Science* 332: 955-957.

Northcutt, R.G. 2011. Evolving large and complex brains. *Science* 332: 926-927.

Pond, C.M. 1977. The significance of lactation in the evolution of mammals. *Evolution* 31: 177-199.

- Farmer, C. G. 2000. Understanding endothermy and other convergent features of birds and mammals. *American Naturalist* 155: 4326-334.
- Kemp, T.S. 2006. The origin of mammalian endothermy: a paradigm for the evolution of complex biological structure. *Zool. J. Linn. Soc.* 147: 473-488.

### Sept. 15 - Locomotion

#### *Required reading:*

- Wilson, A.M., J.C. Lowe, K. Roskilly, P.E. Hudson, K.A. Golabek, and J.W. McNutt, 2013. Locomotion dynamics of hunting in wild cheetahs. *Nature* 498: 185-189.

#### *Additional readings (optional):*

- Biewener, A.A. 1990. Biomechanics of mammalian terrestrial locomotion. *Science* 250: 1097-1103.

### Sept. 22 – The mammalian radiation

#### *Required reading:*

- Springer, M.S., M.J. Stanhope, O. Madsen, and W.W. deJong. 2004. Molecules consolidate the placental mammal tree. *Trends in Ecology and Evolution* 19: 430-438.

#### *Additional readings (optional):*

- Meredith et al. 2011 Impacts of the Cretaceous terrestrial revolution and KPg extinction on mammal diversification. *Science* 334: 521-524.
- O’Leary, M.A., J.I. Bloch, J.J. Flynn, T.J. Gaudin, A. Giallombardo et al. 2013. The placental mammal ancestor and the post K-Pg radiation of placentals. *Science* 339: 662-667.

### Sept. 29 – Feeding mechanisms

#### *Required reading:*

- Goldbogen, J.A., D.E. Cade, D.M. Wisniewska, J. Potvin, P.S. Segre et al. 2019. Why whales are big but not bigger: physiological drivers and ecological limits in the age of ocean giants. *Science* 366: 1367-1372.
- Williams, T.M. 2019. The biology of big; whales became the world’s largest animals thanks to giant gulps of “bit-size” prey. *Science* 366: 1316-1317.

### Oct 6 - Echolocation

#### *Required reading:*

- Corcoran, A.J., and W.E. Conner, 2014. Bats jamming bats: food competition through sonar interference. *Science* 346: 745-747.

#### *Additional readings (optional):*

- Barber, J.R. and W.E. Conner, 2007. Acoustic mimicry in a predator-prey interaction. *Proceedings of the National Academy of Sciences USA* 104: 9331-9334.
- Corcoran, A.J., J.R. Barber, and W.E. Conner, 2009. Tiger moth jams bat sonar. *Science* 325: 325-327.
- Neuweiler, G. 1989. Foraging ecology and audition in echolocating bats. *Trends Ecol. Evol.* 4: 160-166.

### Oct. 25 – Behavior, reproduction, and social systems

#### *Required reading:*

- Lim, M.M., Z. Wang, D.E. Olazabal, X. Ren, E.F. Terwilliger, and L.J. Young. 2004. Enhanced partner preference in a promiscuous species by manipulating the expression of a single gene. *Nature* 429: 754-757.

#### *Additional readings (optional):*

- Bedesky, A., Y-M. Kwon, J-M. Lassance, C.L. Lewarch, S. Yao et al. 2017. The genetic basis of parental care evolution in monogamous mice. *Nature* 544: 434-439.
- Lukas, D., and T.H. Clutton-Brock. 2013. The evolution of social monogamy in mammals. *Science* 341: 526-530.

- Jarvis, J.U.M., M.J. O'Riain, N.C. Bennett, and P.W. Sherman. 1994. Mammalian eusociality: a family affair. *Trends Ecol. Evol.* 9: 47-51.
- Clutton-Brock, T. 2021. Social evolution in mammals. *Science* 373: eabc9699.
- Clutton-Brock, T.H., and P.H. Harvey. 1978. Mammals, resources and reproductive strategies. *Nature* 273: 191-195.
- Thom, M.D., D.D.P. Johnson, and D.W. Macdonald. 2004. The evolution and maintenance of delayed implantation in the mustelidae (Mammalia: Carnivora). *Evolution* 58: 175-183.
- Ferguson, S.H., J.W. Higson, and S. Lariviere. 2006. Does seasonality explain the evolution and maintenance of delayed implantation in the family Mustelidae (Mammalia: Carnivora)? *Oikos* 114: 249-256.

### Nov. 1 - Population and community ecology

#### *Required reading:*

- Krebs, C.J., S. Boutin, R. Boonstra, A.R.E. Sinclair, J.N.M. Smith, M.R.T. Dale, K. Martin, and R. Turkington. 1995. Impact of food and predation on the snowshoe hare cycle. *Science* 269: 1112-1115.

#### *Additional readings (optional):*

- Stenseth, N.C. 1995. Snowshoe hare populations: squeezed from below and above. *Science* 269: 1061-1062.
- Valone, T.J., and J.H. Brown. 1995. Effects of competition, colonization, and extinction on rodent species diversity. *Science* 267: 880-883.
- Brown, J.H., and E.J. Heske. 1990. Control of a desert-grassland transition by a keystone rodent guild. *Science* 250: 1705-1707.

### Nov. 8 – Community ecology, adaptation and climate change

#### *Required reading:*

- Mills, L.S., E.A. Bragina, A.V. Kumar, M. Zimova, D.J.R. Lafferty, et al. 2018. Winter color polymorphisms identify global hot spots for evolutionary rescue from climate change. *Science* 359: 1033-1036.

### Nov. 15 - Population genetics and geographic variation

#### *Required reading:*

- Barrett, R.D.H., S. Laurent, R. Mallarino, S.P. Pfeifer, C.C.Y. Xu, M. Foll et al. 2019. Linking a mutation to survival in wild mice. *Science* 363: 499-504.

#### *Additional optional reading:*

- Campbell-Staton, S.C., B.J. Arnold, D. Goncalves, P. Granli, J. Poole, R.A. Long, and R.M. Pringle, 2021. Ivory poaching and the rapid evolution of tusklessness in African elephants. *Science* 374: 483-487.
- Anderson, T.M., B.M. vonHoldt, S.I. Candillee, M. Musiani, C. Greco, D.R. Stahler, D.W. Smith, B. Padhukasahasram, E. Randi, J.A. Leonard, C.D. Bustamante, E.A. Ostrander, H. Tang, R.K. Wayne, and G.S. Barsh. 2009. Molecular and evolutionary history of melanism in North American gray wolves. *Science* 323: 1339-1343.
- Daly, J.C., and J.L. Patton. 1990. Dispersal, gene flow, and allelic diversity between local populations of *Thomomys bottae* pocket gophers in the coastal ranges of California. *Evolution* 44: 1283-1294.
- Nachman, M.W., Hoekstra, H.E., and S.L. D'Agostino, 2003. The genetic basis of adaptive melanism in pocket mice. *Proc. Nat. Acad. Sci. USA* 100: 5268-5273.

### Nov. 22 - Zoogeography

#### *Required reading:*

- Moritz, C., J.L. Patton, C.J. Conroy, J.L. Parra, G.C. White, and S.R. Beissinger, 2008. Impact of a century of climate change on small-mammal communities in Yosemite National Park, USA. *Science* 322: 261-264.

### Useful web sites:

University of Michigan Museum of Zoology, Animal Diversity Web:

<http://animaldiversity.ummz.umich.edu/> (click on "mammals")

American Society of Mammalogists Website (has links to many other useful sites)

<http://www.mammalogy.org/>

The Mammalian Species pdf web site:

<https://academic.oup.com/mspecies>

Vertnet

<http://www.vertnet.org/about/about.html>

UC Berkeley Museum of Vertebrate Zoology

<http://mvz.berkeley.edu/>

National Museum of Natural History, Mammal Division

<https://vertebrates.si.edu/mammals/>

Morphosource

<https://www.morphosource.org/>

Digimorph

<http://digimorph.org/listbygroup.phtml?grp=Mammals%20an&sort=SpeciesName>

Interactive models of organisms from Sean Beckman

[https://docs.google.com/document/d/1yH5\\_Wuy\\_R-f8slldyNGFTlioVv--Zm37YyUT1udN0yo/edit](https://docs.google.com/document/d/1yH5_Wuy_R-f8slldyNGFTlioVv--Zm37YyUT1udN0yo/edit)

### **Journals Specifically Oriented to Mammals**

Australian Mammalogy

Publication of the Australian mammal society

Bat Research News

Informal newsletter on bat biology

Bat Conservation Newsletter

Publication of Bat Conservation International

Folia Primatologica

Publication of the European Federation for Primatology

Honyurui Kagaku (Mammal Science)

Japanese journal

Journal of Mammalogy

Publication of the American Society of Mammalogists

Mammalia

French journal

Mammal Research

Formerly Acta Theriologica

Mammal Review

Publication of the Mammal Society (UK)

Theriologica

Russian journal

Zeitschrift fur Saugetierkunde

German journal



### **Additional General References**

- Anderson, S., and J.K. Jones, Jr. (eds.) 1984. Orders and Families of Recent mammals of the world. John Wiley & Sons.
- Eisenberg, J.F. 1981. The mammalian radiations. An analysis of trends in evolution, adaptation, and behavior. The Chicago University Press.
- Elbroch, M.E., 2006. Animal skulls: A guide to North American species. Stackpole Books.
- Feldhamer, G.A., L.C. Drickamer, S.H. Vessey, J.F. Merritt, and C. Krajewski, 2015. Mammalogy, Fourth Edition. Johns Hopkins University Press, Baltimore.
- Glass, B.P. 1972. A key to the skulls of North American mammals. 2nd Edition. Oklahoma State University.
- Hall, E.R. 1981. The mammals of North America, vol. 1 and 2. John Wiley & Sons.
- Jameson, E.W. Jr, and H.J. Peeters, 2004. Mammals of California. University of California Press.
- Kielan-Jaworowska, Z, R.L. Cifelli, and Z.X. Luo, 2004. Mammals from the age of dinosaurs. Columbia University Press, New York.
- Macdonald, D. (ed.) 2009. The encyclopedia of mammals. 2nd revised edition. Oxford University Press.
- Nowak, R.M. 1999. Walker's Mammals of the World. 6th edition. Johns Hopkins Univ Press.
- Rose, K.D. and J.D. Archibald, eds. 2005. The rise of placental mammals. Johns Hopkins University Press.
- Simpson, G.G. 1945. The principles of classification and a classification of mammals. Bulletin of the American Museum of Natural History, 85: 1-350.
- Ungar, P.S. 2010. Mammal teeth: origin, evolution, and diversity. Johns Hopkins University Press, Baltimore.
- Wilson, D.E. and D.M. Reeder (eds). 2005. Mammal species of the world. 3<sup>rd</sup> ed. Johns Hopkins University Press, Baltimore.