The cultural lives of cetaceans
Part of Animal Cultures: Core Discoveries and New Horizons
(https://synergy.st-andrews.ac.uk/animalcultures-horizons/)

Photo courtesy J. Levenson

Luke Rendell  @_lrendell
Tail walking in a bottlenose dolphin community: the rise and fall of an arbitrary cultural ‘fad’

M. Bossley¹, A. Steiner², P. Brakes¹,³, J. Shrimpton¹, C. Foster¹ and L. Rendell⁴

Courtesy Mike Bossley
Synchrony, social behaviour and alliance affiliation in Indian Ocean bottlenose dolphins, *Tursiops aduncus*

RICHARD C. CONNOR*, RACHEL SMOLKER† & LARS BEJDER‡

Courtesy Richard Connor
Synchrony, social behaviour and alliance affiliation in Indian Ocean bottlenose dolphins, *Tursiops aduncus*

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Courtesy Richard Connor
Culture

information or behavior – shared by a population or subpopulation – which is acquired from through some form of social learning

Y U NOT HAVE MEANING?!?!?
What we think:

In some species of whale and dolphin...

*Culture is vital*
social structure – the shape of a community

See also Rendell et al. (2019):
doi:2018006. 10.1098/rstb.2018.0066

OVERVIEW

- Small odontocetes: Foraging traditions and signature whistles
- Baleen whales: Humpback song and lobtail feeding
- Large odontocetes: Cultures in groups
Small odontocetes: Foraging traditions

- Huge diversity of foraging tactics in bottlenose dolphins: **Beaching**\(^1\), ‘kerplunking’, **mud-ring feeding**\(^2\), **hydroplaning**\(^3\), herding, bottom-grubbing, sponging, **cooperative fishing**\(^4\), cuttlefish processing

(1) [http://www.youtube.com/watch?v=nyvDEerOV3E](http://www.youtube.com/watch?v=nyvDEerOV3E)
(2) [https://www.youtube.com/watch?v=bfzqPq-ThU](https://www.youtube.com/watch?v=bfzqPq-ThU)
(3) [http://www.youtube.com/watch?v=j9ffKMyDsY&feature=related](http://www.youtube.com/watch?v=j9ffKMyDsY&feature=related)
(4) [http://www.youtube.com/watch?v=42MpfPqWkhk](http://www.youtube.com/watch?v=42MpfPqWkhk)

Cuttlefish processing
(Finn et al. 2009 *PLoS ONE* 4(1))

Upper Spencer Gulf, Southern Australia
tail-walking (Port River)
Bossley et al 2018 *Biology Letters*

**conch carrying (Shark Bay)**
Allen et al 2010 *Marine Mammal Science*

**synchrony in male alliances**
Connor et al 2006 *Animal Behaviour*
See also Jaakkola et al 2018 *Proc Roy Soc B*
humpback lobtail feeding

Lobtail

↓

Feeding bubbles

↓

Surface lunge

Figure 2: The study area (a) with the boundaries of the Stellwagen Bank National Marine Sanctuary (NOAA 2005) and (b) the bathymetry which makes it such an important feeding ground (NOAA 2006).
1980-2007: 73,790 sighting records of 653 individuals
sand lance abundance (▲) vs frequency of lobtail feeding (●)
network-based diffusion analysis: humpback lobtail feeding

- Uninformed
- lobtail feeders (informed)
network-based diffusion analysis

innovation

Social transmission important

Social transmission less important
Order of acquisition analysis (OADA)

\[
\lambda_i(t) = \lambda_0(t)(1 - z_i(t)) \left( \sum_{j=1}^{N} a_{i,j} z_j(t) \right) + \exp \left( \sum_{k=1}^{V} \beta_k x_{k,i} \right)
\]

- \( \lambda_i(t) \): learning rate of individual \( i \) at time \( t \)
- \( \lambda_0(t) \): initial learning rate
- \( 1 - z_i(t) \): adoption rate
- \( a_{i,j} \): strength of social effect from individual \( j \)
- \( z_j(t) \): adoption status of individual \( j \)
- \( s \sum_{j=1}^{N} \): sum of social effects
- \( \exp \left( \sum_{k=1}^{V} \beta_k x_{k,i} \right) \): exponential term with individual attributes (age, sex etc.)
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<tr>
<th>Analysis type</th>
<th>Social transmission model</th>
<th>$\sum \omega_i$</th>
<th>Social transmission parameter estimate</th>
<th>95% CI</th>
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models without social learning had no support
Sperm whale social structure

Gero & Rendell (2015) in Animal Social Networks
Sperm whale coda diversity

- ‘3+1’
- ‘6R’
- ‘1+1+3’
- ‘Brazilian’
Galápagos unit repertoires

Clans have different foraging success…

El Niño

N= 9
1987

Normal

N= 5
1989

Daily defecation rate

Regular +1

Cultural turnover among Galápagos sperm whales

Mauricio Cantor¹, Hal Whitehead¹, Shane Gero² and Luke Rendell³
Shane Gero

Dominica
Sperm Whale Project
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“Culture has led to fundamental changes in the way that our species responds to natural selection”
The reach of gene-culture coevolution in animals

Hal Whitehead¹*, Kevin N. Laland², Luke Rendell², Rose Thorogood³,⁴,⁵, Andrew Whiten⁶

Nature Communications (2019)
Cultural Selection and Genetic Diversity in Matrilineal Whales

Fig. 1. mtDNA nucleotide diversity trajectories of four simulated populations of 200,000 females

Whitehead (1998) Science
Composition of the Southern Residents’ Summer Diet

- Sockeye
- Chum
- Steelhead
- Coho
- Other
- Chinook
Genome-culture coevolution promotes rapid divergence of killer whale ecotypes

Foote et al. (2016)
Evolution according to...

- Religion: Creationism ✓ Evolution ×
- Pokémon
- Digimon
- People
- Science

Sketching Science
The evolution of menopause in cetaceans and humans: the role of demography
Rufus A. Johnstone and Michael A. Cant

Adaptive Prolonged Postreproductive Life Span in Killer Whales
Emma A. Foster, Daniel W. Franks, Sonia Mazzi, Safi K. Darden, Ken C. Balcomb,
John K. B. Ford, Darren P. Croft

Ecological Knowledge, Leadership, and the Evolution of Menopause in Killer Whales
Brent et al., 2015, Current Biology 25, 746–750

Reproductive Conflict and the Evolution of Menopause in Killer Whales
Croft et al., 2017, Current Biology 27, 298–304

Postreproductive killer whale grandmothers improve the survival of their grandoffspring
Stuart Natrass, Darren P. Croft, Samuel Ellis, Michael A. Cant, Michael N. Weiss,
Brianna M. Wright, Eva Stredulinsky, Thomas Doniol-Valcroze, John K. B. Ford,
Kenneth C. Balcomb, and Daniel W. Franks

FNAS first published December 9, 2019. https://doi.org/10.1073/pnas.1903844116

Courtesy Jennifer Modigliani

Courtesy David Ellifrit
Animal cultures matter for conservation
Understanding the rich social lives of animals benefits international conservation efforts

Spread of Longline Depredation

Courtesy SEASWAP
Spread of Longline Depredation

Figure 3. Spatial radiation of depredation and Wave-of-Advance model shows a positive correlation between time and the distance of new observations of depredation from origin ($r^2 = .55$, $p = 0.003$).