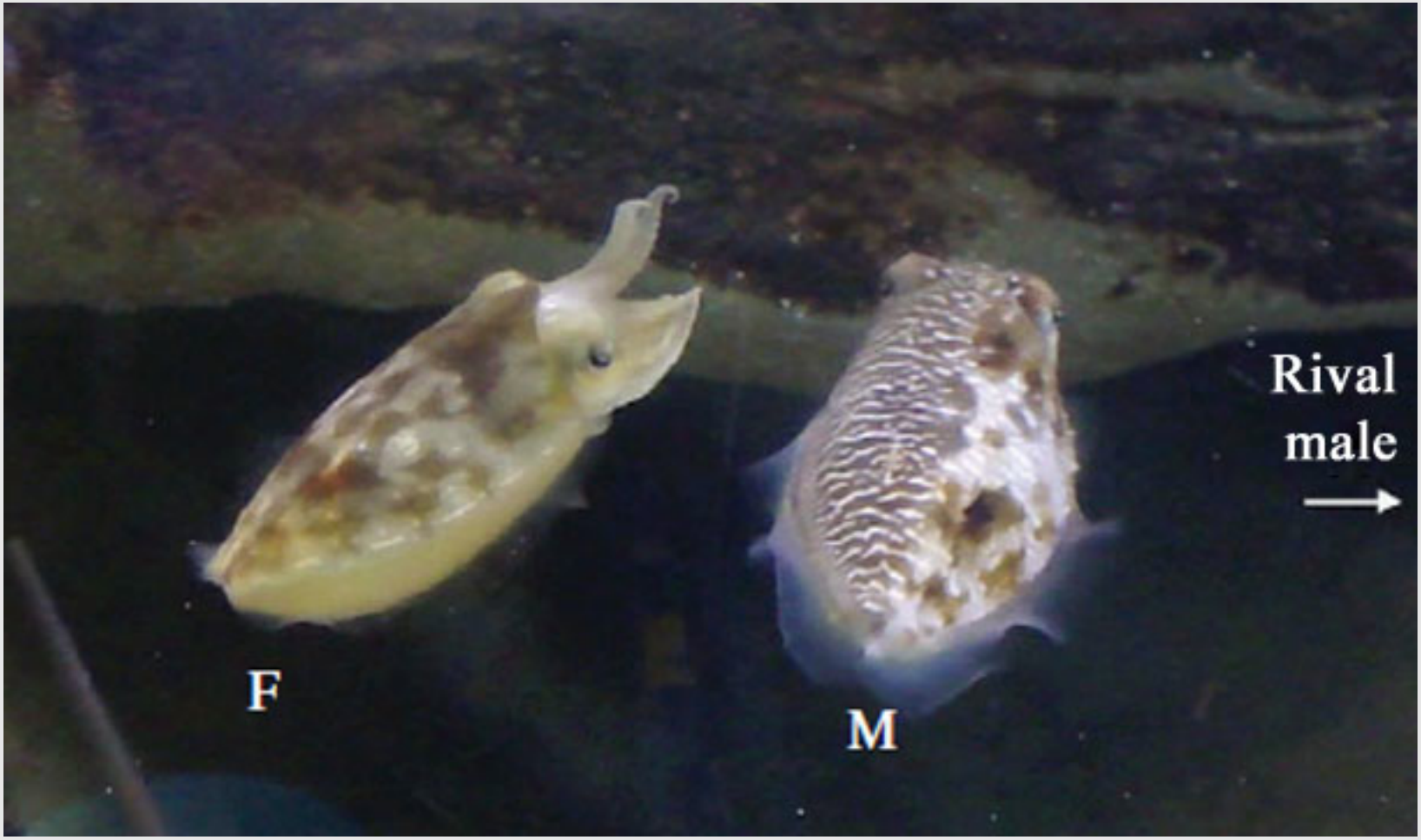
Game theory



m/notrocketscience/2012/07/03/cuttlefish-woos-female-and-dupes-male-with-split-personality-skin/#.VDKY1kvL1FM photo from Culum Brown

Brian O'Meara

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Learning objectives

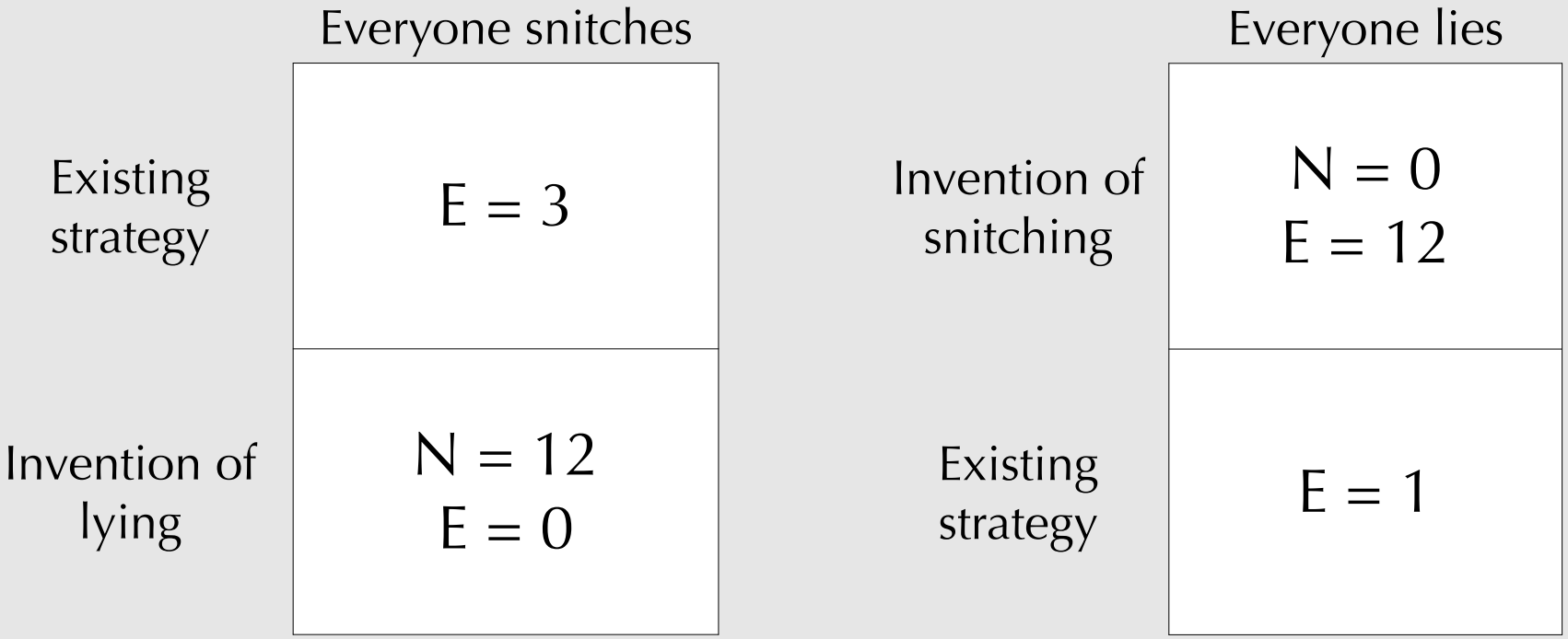
- Learn basics of game theory
- Understand classic examples

Class question

	If no more than two people choose B	**If more than two people choose B**
People who choose A	2 candies	1 candy
People who choose B	5 candies	1 candy

- You and an acquaintance are arrested for a crime you committed together.
- Unless at least one of you testifies, there isn't enough evidence to convict either of you of the main crime, but you each get a month for a secondary charge.
- If one of you provides evidence, the snitch goes free and the other one goes to jail for a year.
- If both of you provide evidence, you both go to jail for three months.
- Regardless of what happens, you will never interact with this acquaintance again (too risky).
- What do you do?

	Partner snitches	Partner lies
You snitch	Y = 3 P = 3	Y = 0 P = 12
You lie	Y = 12 P = 0	Y = 1 P = 1



Evolutionarily stable strategy (ESS): Stable under natural selection

http://www.youtube.com/watch?v=R_JfY3dnEEs

BBC Planet Earth 2 https://www.youtube.com/watch?v=Aro-Kz2e_eg

http://www.youtube.com/watch?v=tufnqWNP9AA

http://www.youtube.com/watch?v=VwScjT5NPc0

~~Good of the species~~

The Logic of Animal Conflict

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Conflicts between animals of the same species usually are of "limited war" type, not causing serious injury. This is often explained as due to group or species selection for behaviour benefiting the species rather than individuals. Game theory and computer simulation analyses show, however, that a "limited war" strategy benefits individual animals as well as the species.

In a typical combat between two male animals of the same species, the winner gains mates, dominance rights, desirable territory, or other advantages that will tend toward transmitting its genes to future generations at higher frequencies than the loser's genes. Consequently, one might expect that natural selection would develop maximally effective weapons and fighting styles for a "total war" and ask what strategy will be favoured under individual selection. We first consider conflict in species possessing offensive weapons capable of inflicting serious injury on other members of the species. Then we consider conflict in species where serious injury is impossible, so that victory goes to the contestant who fights longest. For each model, we seek a strategy that will be stable under natural selection; that is, we seek an "evolutionarily stable strategy" or ESS. The concept of an ESS is fundamental to our argument; it has been derived in part from the theory of games, and in part from the work of MacArthur[8] and of Hamilton[9] on the evolution of the sex ratio. Roughly, an ESS is a strategy such that, if most of the members of a population adopt it, there is no "mutant" strategy that would give higher reproductive fitness.

A Computer Model

A main reason for using computer simulation was to test whether it is possible even in theory for individual selection to account for "limited war" behaviour.

We consider a species that possesses offensive weapons capable of inflicting serious injuries. We assume that there

C		Conventional move	Push, squawk, trumpet, bang chest
D		Dangerous move	Bite with lethal fangs, claw at throat, spray with poison
R		Retreat	Run away, roll over

Win	+60
Retreat	0
Successfully defend against dangerous attack	-2
Unsuccessfully defend against dangerous attack	-100
Decide winner quickly	up to +20

Maynard-Smith & Price, 1973

C		Conventional move	Push, squawk, trumpet, bang chest
D		Dangerous move	Bite with lethal fangs, claw at throat, spray with poison
R		Retreat	Run away, roll over

Opponent	
Mouse	
Hawk	
Bully	
Retaliator	
Prober-Retaliator	

Maynard-Smith & Price, 1973

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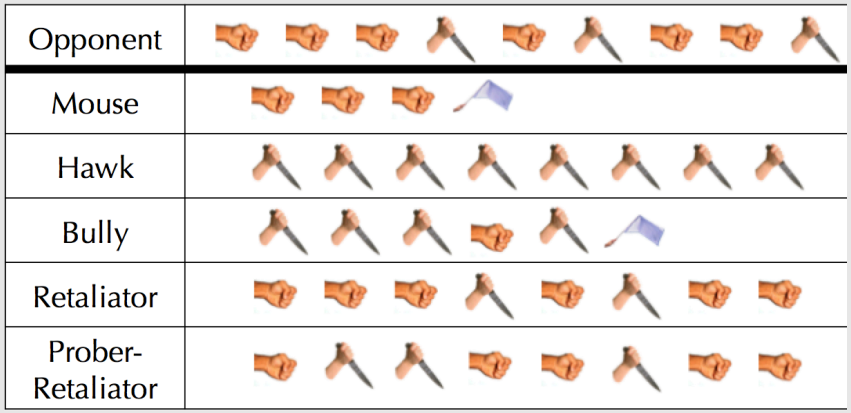
Maynard-Smith & Price, 1973



Opponent→	Mouse	Hawk	Bully	Retal.	Prob-Ret.
Mouse	29	19.5	19.5	29	17.2
Hawk	80	-19.5	74.6	-18.1	-18.9
Bully	80	4.9	41.5	11.9	11.2
Retaliator	29	-22.3	57.1	29	23.1
Prober-Retaliator	56.7	-20.1	59.4	26.9	21.9

Maynard-Smith & Price, 1973

Opponent	
Mouse	
Hawk	
Bully	
Retaliator	
Prober-Retaliator	

Opponent→	Mouse	Hawk	Bully	Retal.	Prob-Ret.
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Maynard-Smith & Price, 1973

http://www.youtube.com/watch?v=8b-2TFrx3fg

BBC Earth: https://www.youtube.com/watch?v=qr5Sru8gGSk