“Welcome to Mars”
LB144-Pandemic edition

(Preparing for) **Tuesday's lecture:**

Budgeting homework time (45 min): Ch. 18, section 18.1 (the second half on **frogs**) is 2166 words in length. At what's considered slow reading speed, 200 words per minute, reading the second half of section 18.1 should take 11 minutes. But when done properly, when you pause to review figures, read and think about a few of the Integrating Questions, and take careful notes, if you focus (avoid distraction) it should take you approx. 45 minutes.

1. _______ **For the second lecture,** slowly read the second half of section 18.1 "Frog choruses attract predators." As you read it on your computer or tablet, please be sure to **take handwritten notes on paper in your lecture notebook** (handwritten notes lead to far greater learning).
2. _______ **Try to answer some Integrating Question and Review Questions.** As you read the ICB textbook always attempt to answer at least one of the yellow **Integrating Questions** each time you get to a set of them. Also try to answer the green Review questions.
3. _______ (Trifecta): **Prepare to explain (aloud) Figures 18.6 and Table 18.2 in class**. As you read a section from the ICB textbook always attempt to pause and study **each figure/drawing/table** that is discussed. In class, during lecture, you may be randomly chosen to explain these aloud (the LA will hand you a microphone so everyone can hear you in lecture) so prepare well.
4. _______ **Advanced TIP**: scroll down to the bottom of the page, in the Bibliography, and click on the link to an original paper by Dr. Rachel Ryan to see which data was used to make figure 18.6 and Table 18.2, and look at Ulagaraj's research paper on crickets to get used to, and in a habit of, checking original papers.

Reading ~~Chapter 18~~ – section 1

Exploiting communication between others

–> some species intercept information transfer between members of another species

L.O.s – identify commonalities between communication within or between species

– evaluate how info is used to find/exploit other species

– provide examples

Intro

– One risk in communicating ... is other species could eat you. (predators + parasites vs. prey + hosts)

Example:

"Frog choruses attract predators" Ryan, Cornell + Merlin Tuttle 1981, Tuttle, Milwaukee Museum ~~Univ. of Texas (Austin)~~

Mike Ryan – studied frogs in Panama. Male frogs vocalize to attract mates, and in large groups. Risk: discovered by enemy. Do predators to frog (opossum + bats) hear or see or what?

Study #1 Ryan et al

Researchers did purely observational experiment, watched frogs vs opossums. Saw via night vision scope. Saw 31 events.

Purpose: how opossums hunt? Methods: Observe, scope, record.

Findings: n=39 captures, general trend opossum approached edge of pond, turned toward vocalizing frogs, as walked closer stopped again, turned head side to side rotating ears. Then finally ran forward + pounced attempting a capture.

Study #2 Ryan et al

Did a "playback" experiment. Speaker away from pond edge

(Ryan et al + Tuttle, study #2 cont.)

M: Playback used speaker, placed 2 meters away from Pond edge (why?). "was Location frogs not even found?!

Play recordings of tungara frog vocalizations ONLY when a Oppossum was near speaker BUT facing away. + not when other frogs were vocalizing.

F: (findings) In 5 out of 5 trials (n=5) oppossum turned toward speaker, did head tilting/turns + ear rotating. Then approach speaker + pounced. 3 of 5 times (n=3/5).

Researchers claim in 2 times not pouncing animal spotted humans.

IQ 10 think it uses acoustic or visual cues to locate prey?

Can philander opossum (nocturnal) intercept frog communications?

Ryan et al, study #3 Predator #2 fringe-lipped bat vs frogs

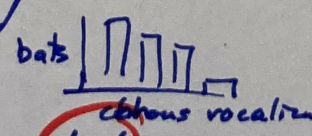
Purpose: Can predator distinguish between species of frog? via vocalization (e.g. poisonous frog prey)

(this bat uses hearing to find prey)

Methods (M):

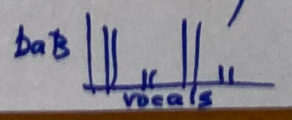
Visit frog breeding Ponds Jan. to June. Observational study. Half ponds had Tungara frogs (tasty). Categorized data into amount of group males vocalizations: "full chorus" "partial chorus" "few" "none" calling. Recorded # bat visits:

Figure 18.6 A



Ryan et al study #4, Playback to captive + wild bats vocalizations of edible vs poisonous frog, or small vs oversized.

Figure 18.6 B



IQs 11, 12, 13

Rachel Page + Mike Ryan – bat learning – Univ Texas (Austin) 2006

Q: How do bats learn which vocalizations = small vs big, or edible vs poisonous?

* know fringe-lipped bat lives in social groups, get taught?

Study # 1 + 2 + 3

Purpose: How/when do bats learn which frog calls are "good/tasty"?

Methods: Use cane toad vocalization in playback experiments. Cane toad is both too BIG + poisonous to bats.

Used caged bats, in captivity, First (1) just play vocalization and observe if any are attracted (nope). Next (2) attempt to train bats to become attracted to cane toad's call (speaker). Gave reward for landing on speaker (raw fish treat). Last (3) they paired a bat successfully trained (experienced) with naive partner (inexperienced) + did controls. – 2 inexperienced – 1 inexperienced alone

In each trial 1-5 speakers set-up, one randomly chosen to play cane toad calls. Keep track how many times needed for each inexperienced bat to learn (3 times fly + land on speaker in a row)

Learn = inexperienced bat flys + lands on "cane" speaker + get treat three trials in a row!

Findings: First, bats never flew to any silent speaker(s), even w/ food. Ultimately, bats learn fast from peers.

Table 18.2 mixed pair learned quickly – average 5.3 trials n=10 but controls took long time 96 trials. n=5, n=5

IQ 14, 15 Review Bibliography (click + look) see figures

Section 18.1 What is a learning goal from last class (what part of biology are we exploring)?

Section 18.1 Have organisms evolved to exploit communication between individuals of other species?

Biology Learning Objectives

- Identify the commonalities between communication within a species and communication between species.
- Evaluate how information is used by organisms to find and exploit other species.
- Provide examples of adaptations of one species to the information passed between individuals of another species.

Section 18.1: What did you find the most interesting from today's reading (how might these readings help you)?

Test your knowledge

- These pop quiz questions are designed to reward students who participated, e.g. prepared well for class

Figure 18.5 The p
The Tungara frog
male. http://upload.w
Author: This file is lice
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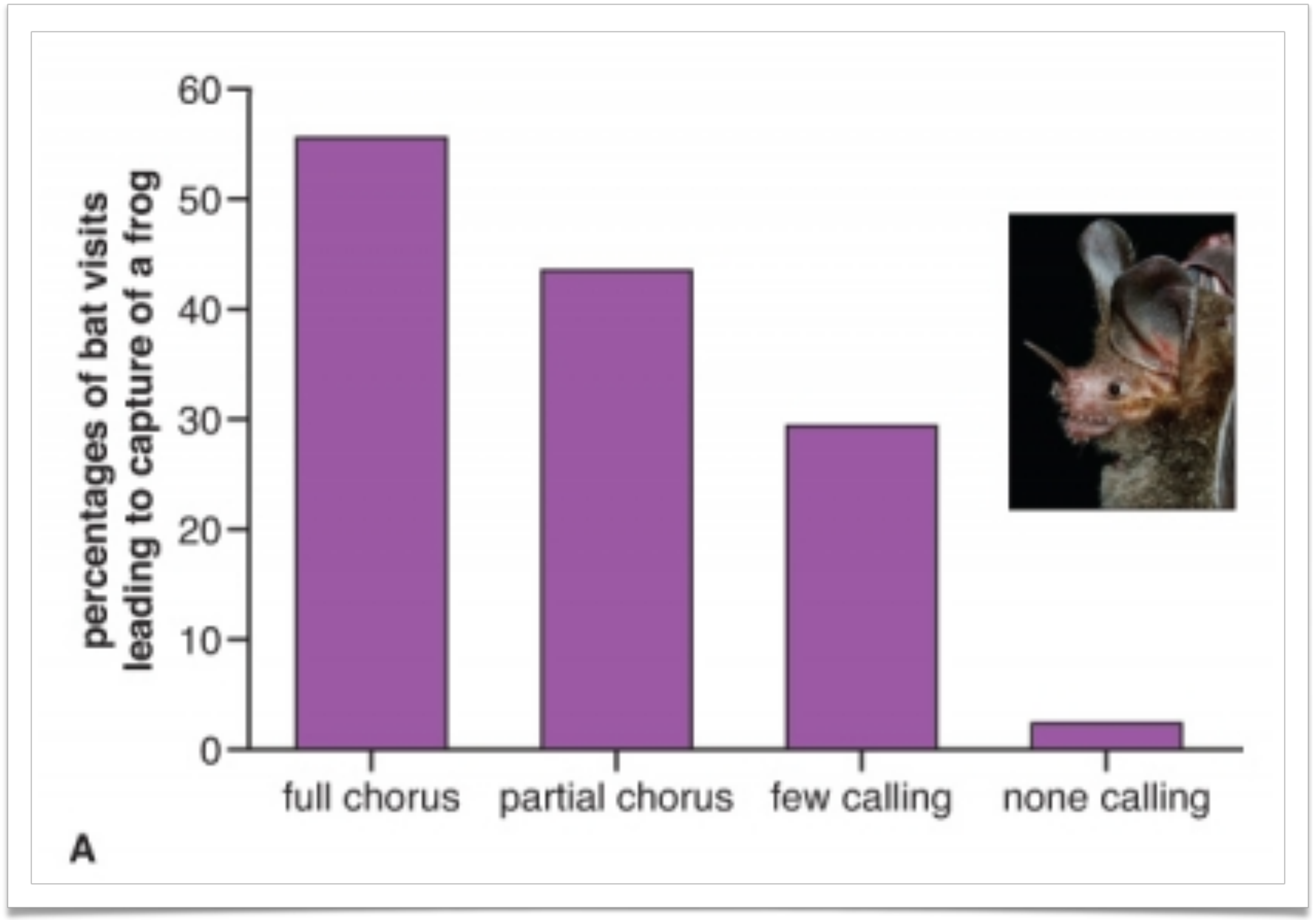
http://upload.wikimedi
pustulosus%29_Callir
the Creative Common

What’s the story with these two animals (which is Correct)?

a) The bats are predators that eat both of them
b) The opossum doesn’t eat Tungara frog because is poisonous
c) Both animals live near water and eat bugs and worms
d) The opossum eats small animals and is nocturnal
e) The Tungara frog displays inflatable cheeks to attract females



Might this data simply be explained by more frogs are caught <u>because</u> more frogs are there?

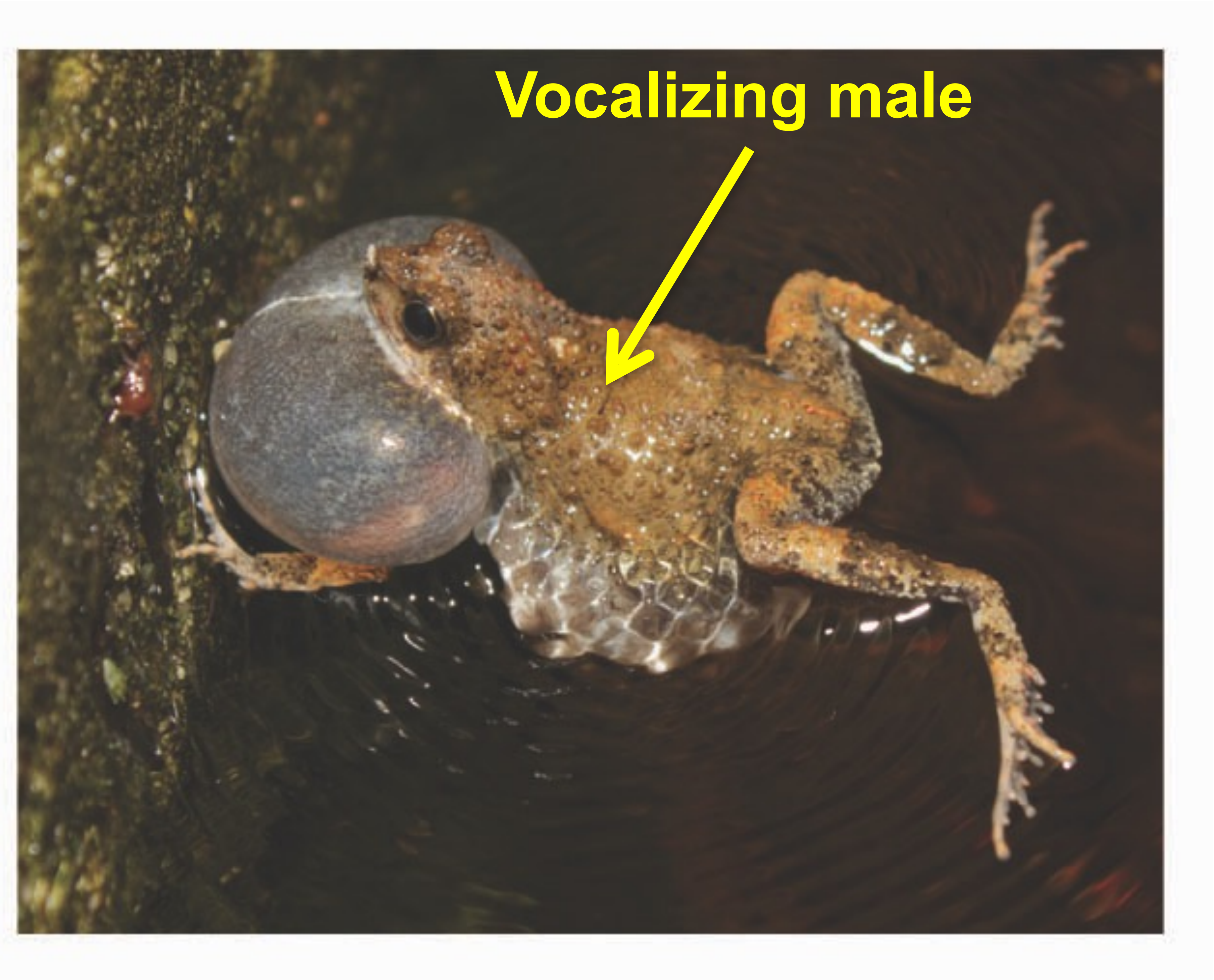
a) Nope, there was a speaker with no sounds
b) Yes, the speaker was nearest to bunch of frogs
c) Nope, these are not counts of frogs captured
d) Yes, a full chorus has more frogs, so it makes sense bats would have a better chance of catching more frogs.

Pop-quiz over

The philander opossum

Figure 18.5

The Tungara frog



http://www.youtube.com/watch?feature=endscreen&v=5S-RAgudnww&NR=1

Figure 18.5

Ryan & Tuttle Methods: opossums observed near a pond that contained breeding male Tungara frogs

Study #1 (purely observational experiment)

- M: Observed 2 hs/night; night vision scope, saw 39 captures
- F: Typical behavior recorded: describe?

Study #2 (audio playback experiment)

- M: Recordings played if opossum near & facing away from speaker when no frogs vocalizing (Q: speaker placed 2m from pond?!)
- F: **5/5 trials**: opossum turned toward speaker, tilted head and rotated ears, approached the speaker, **3/5 trials**: pounced on the speaker, continued to circle the speaker if the playback was on.

  (2 trials: opossum spotted the researchers, and it left)

Integrating Questions

10. Do you think the philander opossum relies more on acoustic signals or visual cues to locate its prey? What do the observations of Ryan and colleagues indicate about the ability of the philander opossum to intercept communication between frogs?

Prepare for **Trifecta**

(purpose, methods, findings)

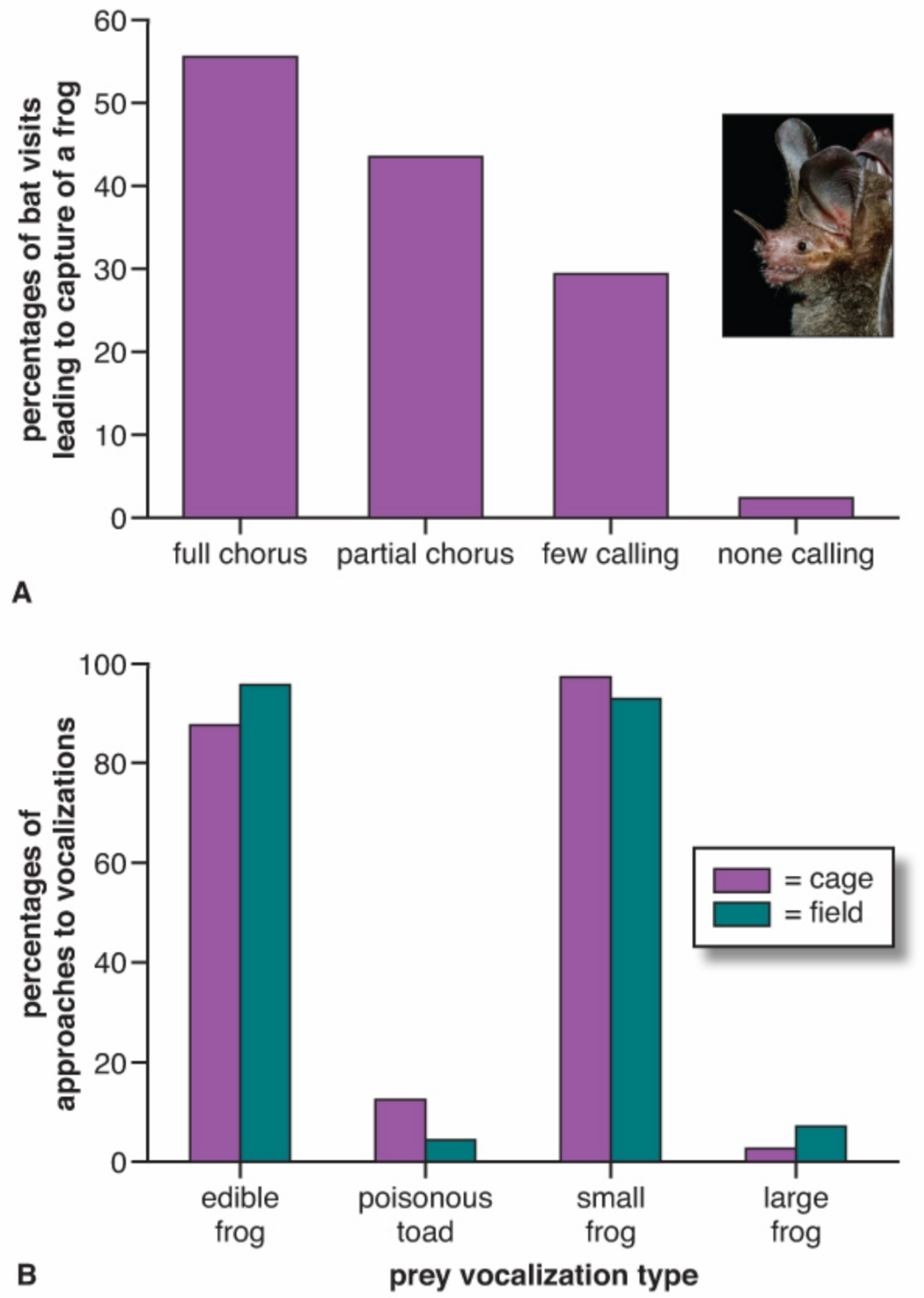
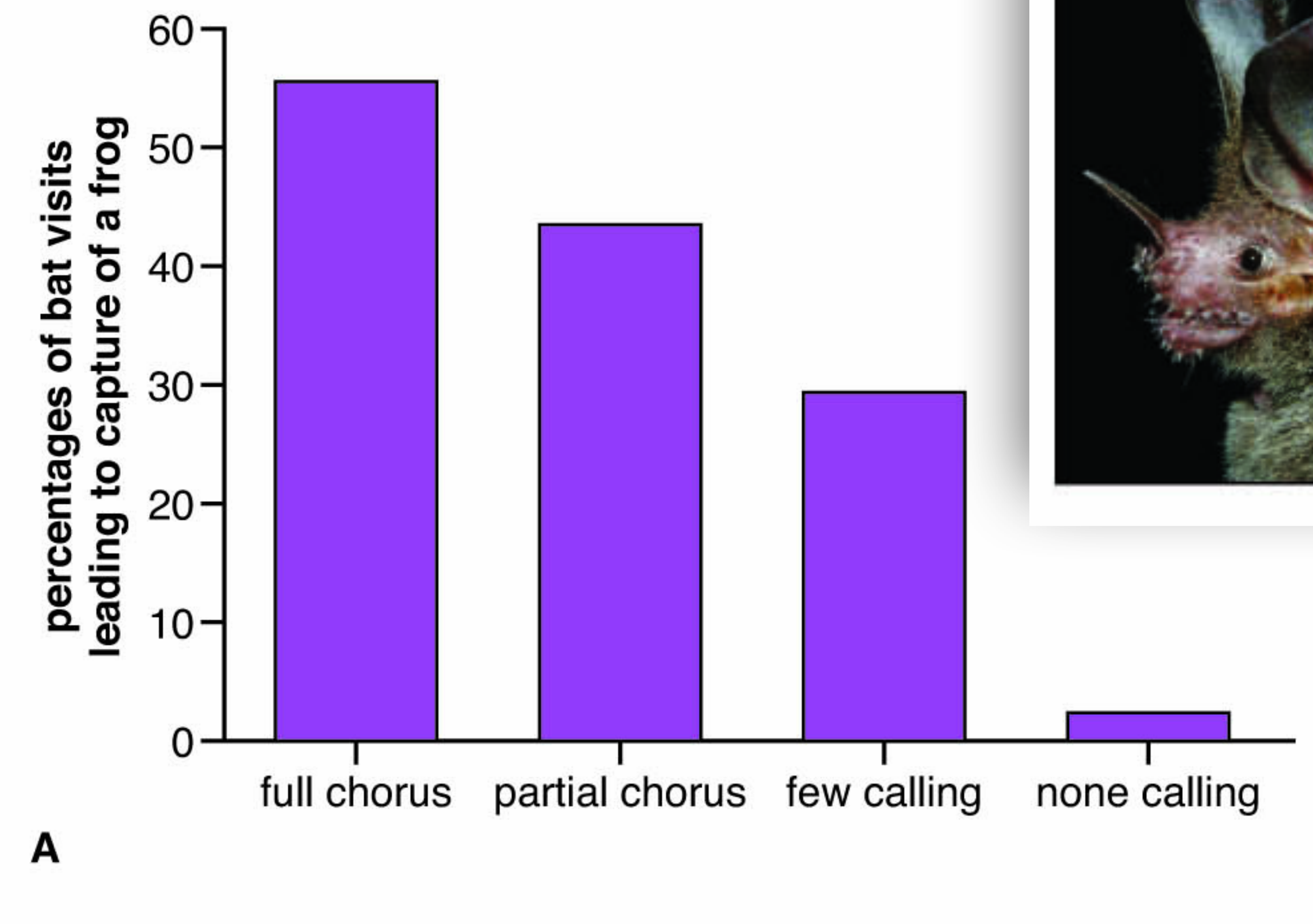
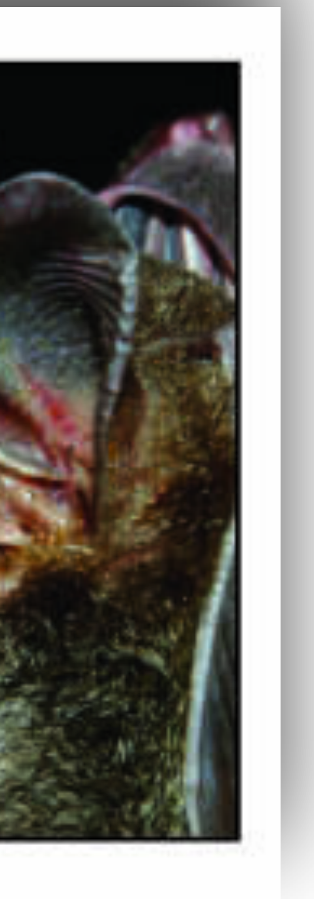


Figure 18.6 Results of experiments on fringe-lipped bats preying on frogs. **A,** Percentage of bat visits resulting in a frog capture for four categories of Tungara frog vocalization frequency. **Inset,** A fringe-lipped bat. **B,** Responses of frog-eating bats to vocalizations of edible versus poisonous or small versus large frog or toad prey. From Tuttle and Ryan, 1981,





Trifecta?

(purpose, methods, findings)

Figure 18.6

From Tuttle and Ryan, 1981, Table 1. Inset: Author: Karin Schneeberger. Creative Commons

Trifecta?
(purpose, methods, findings)

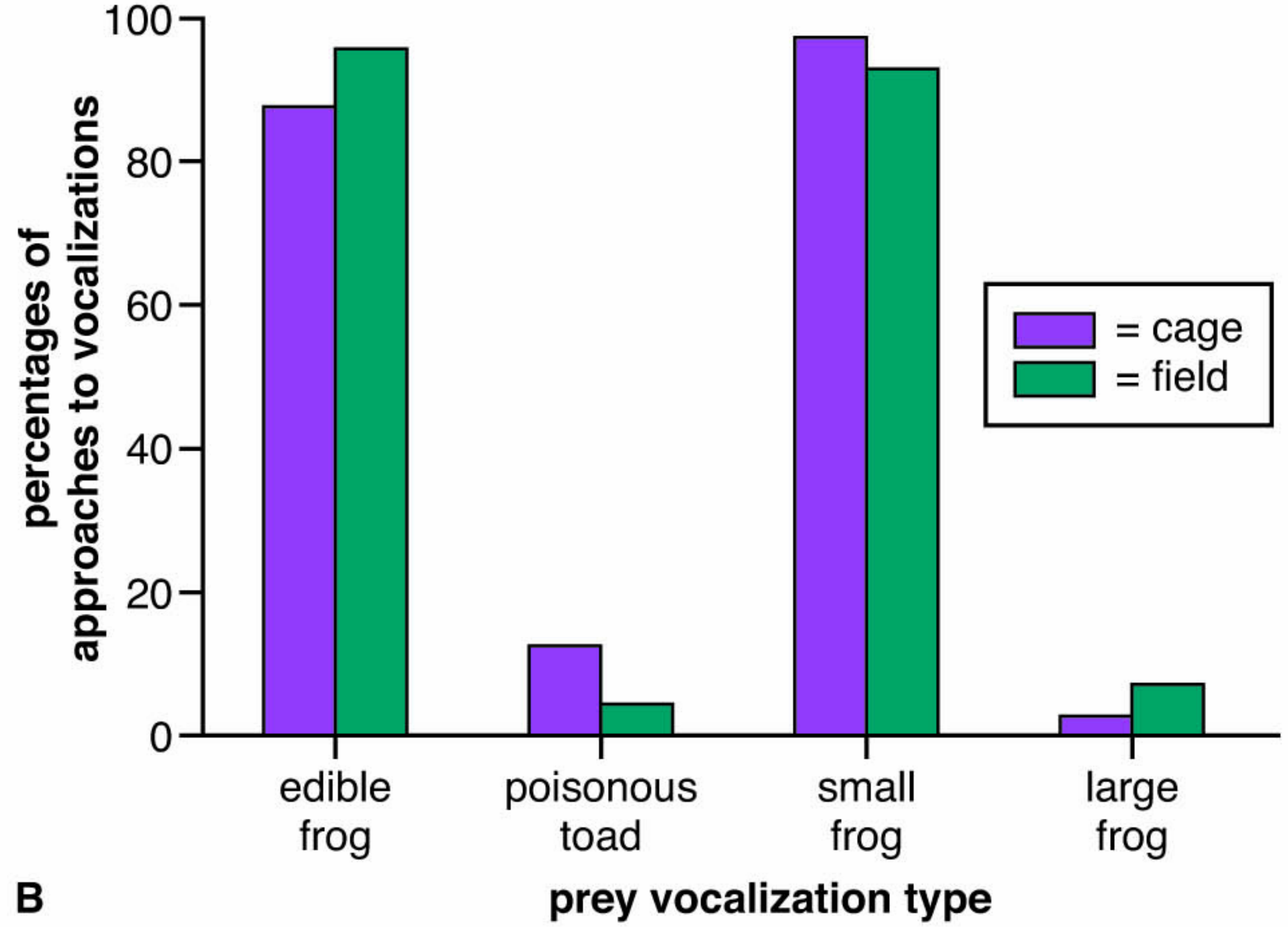


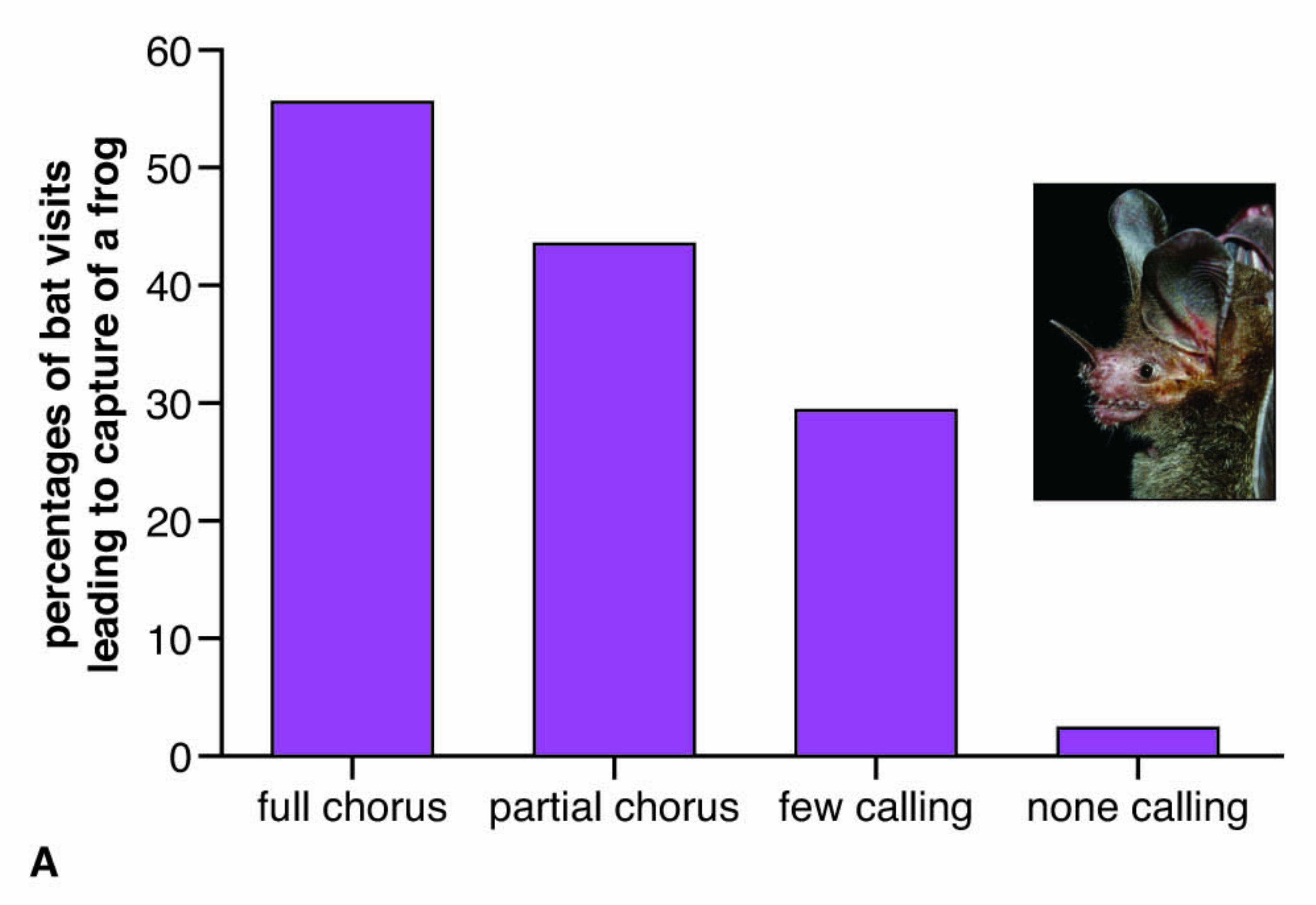
Figure 18.6

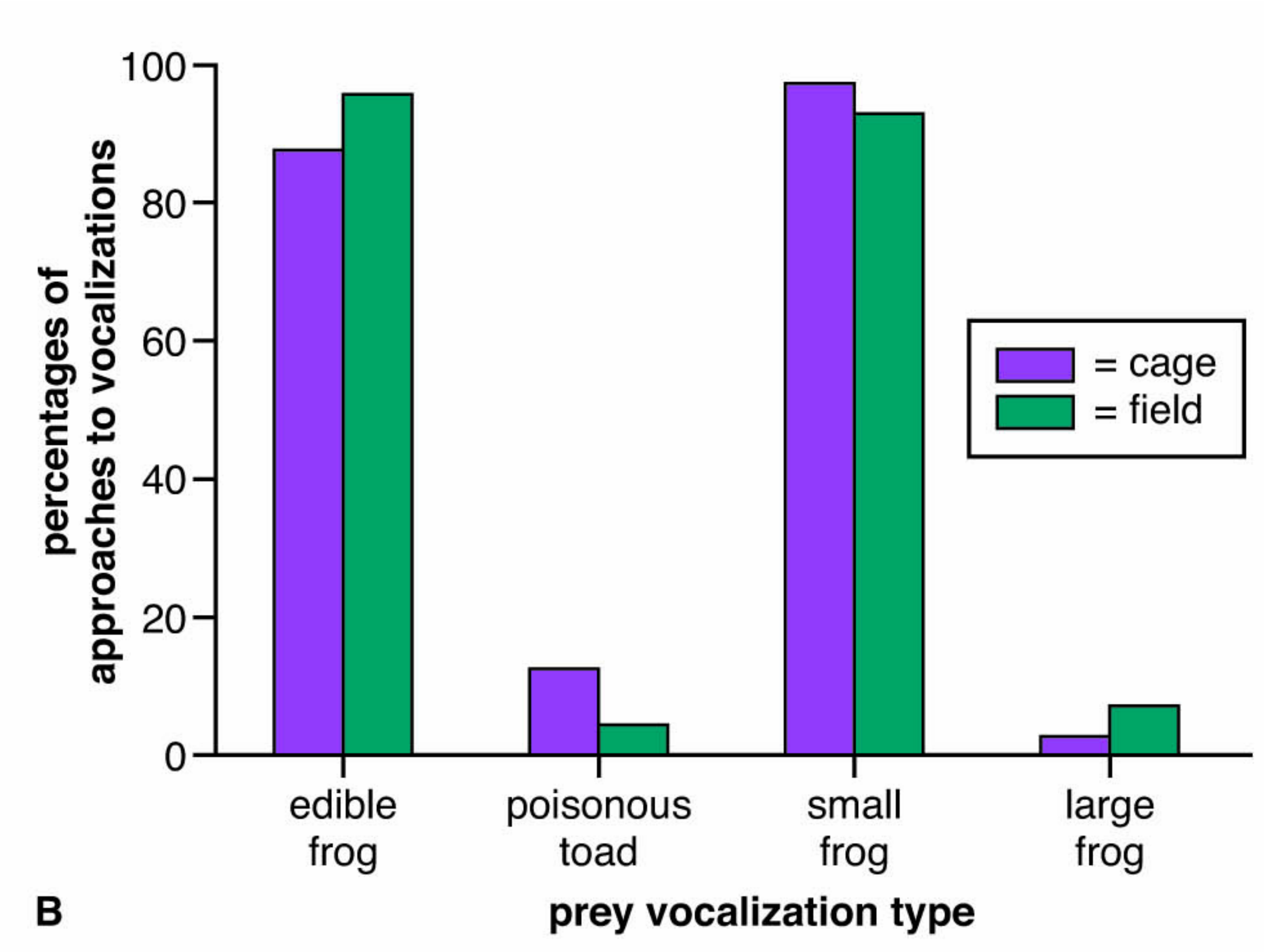
From Tuttle and Ryan, 1981, Table 1. Inset: Author: Karin Schneeberger. Creative Commons

11. What do the success rate data (i.e., the percent of bat visits resulting in a capture) tell you about the hunting methods of the bats?

12. Are frog-eating bats able to discriminate among potential prey types? On what basis do you make that conclusion? Which frogs are best protected from predation, despite their vocalizations?

13. Why did the researchers perform the experiments both in the cages and in the field? Is there a significant difference in response for captive bats versus wild bats?





diminished during hypothyroidism in adult rats. The spontaneous discharge rate of Purkinje neurons is determined to a large extent by the tonic inhibitory noradrenergic afferents originating in the nucleus locus coeruleus (*13*). Thus, an increased spontaneous discharge in the Purkinje neurons of hypothyroid rats is consistent with the diminished responsiveness of such neurons to norepinephrine. A hypoactive afferent projection from the locus coeruleus is ruled out by several studies on the peripheral and central nervous systems (*5, 14, 15*) demonstrating an increased amount of norepinephrine discharged at the sympathetic nerve endings during hypothyroidism. Thus, alterations in postsynaptic function could conceivably lead to the electrophysiological changes reported here (*6, 15*). β-Receptors might be altered in number or in their affinity or functional coupling with adenylate cyclase. In fact, diminished β-receptor binding (with no change in affinity) during hypothyroidism has been demonstrated (*3, 15*). In peripheral tissues, parallel changes in adenylate cyclase activity have been reported (*16*). Our electrophysiological studies agree well with previous observations (*3, 6, 15, 16*). In another study (*2*), the activity of cyclic AMP phosphodiesterase (E.C. 3.1.4.17) did not change in the cortices of hypothyroid rats. The studies we report here suggest tha. the subsensitivity occurring

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19. Supported by USPHS grant DA-07043.

10 July 1981

Bat Predation and the Evolution of Frog Vocalizations in the Neotropics

Abstract. *Bat predation has probably had an important influence on the evolution of frog vocalizations in the Neotropics. The rate at which fringe-lipped bats capture frogs is significantly higher when the frogs are calling. These bats respond to a wide variety of calls from edible frogs, and, when simultaneously presented with a choice, choose the recorded call of a palatable species over that of a poisonous species and the call of a small species over that of one too large to capture. Thus the selective advantages of loud, rapid mating calls in anurans are balanced by an increased risk of predation.*

Many animals use conspicuous vocalization to attract mates. The benefits are obvious, but biologists have long suspected that this also leads to increased vulnerability to sound-responsive predators (*1, 2*). Although such counterselection is believed to influence the evolution of vocal advertisement (*3*), documentation is rare (*2*) and is entirely lacking for vertebrates. In this report we show that *sus*) uses acoustic cues to capture calling frogs, and we consider the possible role of call-responsive predators in the evolution of anuran calling and courtship behavior.

On 35 nights from January to June 1980 we visited 14 frog breeding sites on Barro Colorado Island, Panama (*4*). *Trachops cirrhosus* was observed hunting on each night. Seven of the nights were

Table 1. Responses of *T. cirrhosus* to playbacks of the advertisement calls of four anuran species.

Species	In cage		In field	
	Bats tested	Responses	Sites visited	Responses
Hyla boulengeri	5	35	6	66
Bufo typhonius	5	5	6	3
χ^2	42.81 (10), $P < .005$		70.63 (12), $P < .005$	
Physalaemus pustulosus	5	36	3	26
Leptodactylus pentadactylus	5	1	3	2
χ^2	47.15 (10), $P < .005$		31.52 (6), $P < .005$	

Table 2. Responses of *T. cirrhosus* to the recorded advertisement calls of two anuran species played at different repetition rates and volumes.

Species ''calling''	Bats tested	Responses
Physalaemus pustulosus		
1.6-second interval between calls	3	22
3.2-second interval between calls	3	2
χ^2		22.62 (6), $P < .005$
Centrolenella fleischmanni		
1.6-second interval between calls	3	18
6.4-second interval between calls	3	1
χ^2		22.19 (6), $P < .005$
Physalaemus pustulosus		
78 dB SPL	2	13
74 dB SPL	2	2
χ^2	14.14 (4), $P < .01$	


0:00 / 2:48

What was the next experiment?

treatment	mean number of trials	standard error	sample size
inexperienced bat with experienced bat	5.3	1.7	10
two inexperienced bats	96.8	3.2	5
one inexperienced bat	96.2	3.8	5

Table 18.2. Number of trials needed for fringe-lipped bats to learn to associate the cane toad vocalization with palatable prey. From Page and Ryan, 2006, Figure 2.

Prepare for **Trifecta**

(purpose, methods, findings)

Trifecta

(purpose, methods, findings)

treatment	mean number of trials	standard error	sample size
inexperienced bat with experienced bat	5.3	1.7	10
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one inexperienced bat	96.2	3.8	5

14. What can you conclude from the data in Table 18.2? Do the data support what you expected?

15. Identify the controls that Rachel Page and Mike Ryan used in their experiment and what the controls were for.

Report

Social Transmission of Novel Foraging Behavior in Bats: Frog Calls and Their Referents

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Summary

The fringe-lipped bat, *Trachops cirrhosus*, uses prey-emitted acoustic cues (frog calls) to assess prey palatability [1]. Previous experiments show that wild *T. cirrhosus* brought into the laboratory are flexible in their ability to reverse the associations they form between prey cues and prey quality [2]. Here we asked how this flexibility can be achieved in nature. We quantified the rate at which bats learned to associate the calls of a poisonous toad species with palatable prey by placing bats in three groups: (a) social learning, in which a bat inexperienced with the novel association was allowed to observe an experienced bat; (b) social facilitation, in which two inexperienced bats were presented with the experimental task together; and (c)

prey palatability [2]. Using a fading-conditioning paradigm [6], we were able to rapidly reverse the bats' assessment of palatable and poisonous prey.

Here we ask whether this flexibility is part of the bats' natural foraging repertoire and to what degree novel associations between prey cue and prey quality can be culturally transmitted. To address these questions, we quantified the rate of acquisition of a novel foraging behavior in three learning groups: (a) a social-learning group, (b) a social-facilitation group, and (c) a trial-and-error group. The target foraging behavior was the bats' ability to learn to associate the calls of the sympatric cane toad, *Bufo marinus*, with a palatable food reward. *B. marinus* is both highly poisonous and far too large for a *T. cirrhosus* to eat, so on two accounts it should be an unsuitable prey item. The criterion for task acquisition was flying to and landing on a speaker broadcasting toad calls in three consecutive trials.

We first conducted baseline tests with all bats to determine initial responses to *B. marinus* calls. None of the bats showed any initial response to *B. marinus* calls. We then tested for social learning by allowing an inexperienced bat to observe the foraging behavior of an experienced bat (tutor) that had already acquired the novel association. The first tutor learned to associate toad calls with a palatable food reward via a fading-conditioning technique (for methods, see [2]). Subsequent tustrate that mothers and their daughters shared foraging grounds, sometimes for years [27, 28]. Thus, the vertical transfer of foraging-site location from mother to pup could be playing a large role in the foraging dynamics of these bat communities. Although the learning we document in our study is likely entirely opportunistic (the result of one bat eavesdropping on the successful foraging behavior of another), the study of social learning in highly related groups, and especially in mother-pup pairs, should prove an interesting area for further research.

Our study is not designed to distinguish among the mechanisms of social learning [29–32]; however, it is likely that these bats are learning by either stimulus enhancement or observational conditioning. In stimulus enhancement the activity of the tutor draws the observer's attention to the test stimulus [31, 33]—in our experiment, to the toad calls. The observer then forms an association between the stimulus and the reward via individual, trial-and-error learning. Because we altered the speaker location for each trial, we can rule out the possibility that the bats are learning to associate a food reward with a particular spatial location (local enhancement).

In observational conditioning, a type of higher-order conditioning, the observer associates the stimulus with the outcome experienced by the tutor and thus responds more readily to the stimulus itself [31, 34]. In our social-learning treatment, the test bat did not initially attend to the toad calls or to the flight of the tutor bat. In the initial trials, the test bat typically would commence responding with ear motions and head orientation only

Experimental Procedures

Experiments were conducted at the Smithsonian Tropical Research Institute field station on Barro Colorado Island (BCI), Panama, from February to June 2004 and 2005. We captured the bats in mist nets and tested them in a 4.5 m × 4.5 m × 2.5 m outdoor flight cage. We illuminated the flight cage with a 25 watt red light bulb to facilitate our observations of the bats. This light level was within the range of illuminations in which the bats forage. We used a Sony NightShot DCR-TRV340 camera equipped with a Sony HVL-IRH2 infrared light to record all initial and final tests, all social learning trials, and a subset of the social-facilitation and trial-and-error learning trials. Each bat was marked with a passive integrated transponder (PIT tag) and released at its site of capture after testing. All experiments were licensed by the Smithsonian Tropical Research Institute and the University of Texas at Austin (IACUC #04113002).

Stimulus Presentation

We broadcast calls of *B. marinus* from a Dell Inspiron 8100 computer, a SA-150 Realistic amplifier, and 40-1040 Radio Shack speakers. To approximate the natural call intensity of *B. marinus* in the wild, we broadcast the calls at an amplitude of 75 dB SPL (re. 20 μP) measured at a distance of 1 m from the speaker. Most of the energy in *B. marinus* calls falls between 548 and 708 Hz; the frequency response of these speakers is flat for these frequencies. To ensure that the bats responded to the acoustic stimulus broadcast and not to the speaker itself, we concealed one to five speakers beneath a 1.5 m × 1.5 m screen covered with leaf litter and randomly repositioned the speakers between trials. To ensure that the bats were responding to the toad calls per se and not to other noises associated with the speaker, in a subset of the trials we turned on one of the control speakers and broadcast a sound file of silence. The bats never approached control speakers. Toad calls were broadcast for 60 s or until the test bat landed on the speaker, whichever came first. Trials were conducted in approximately 10 to 15 min

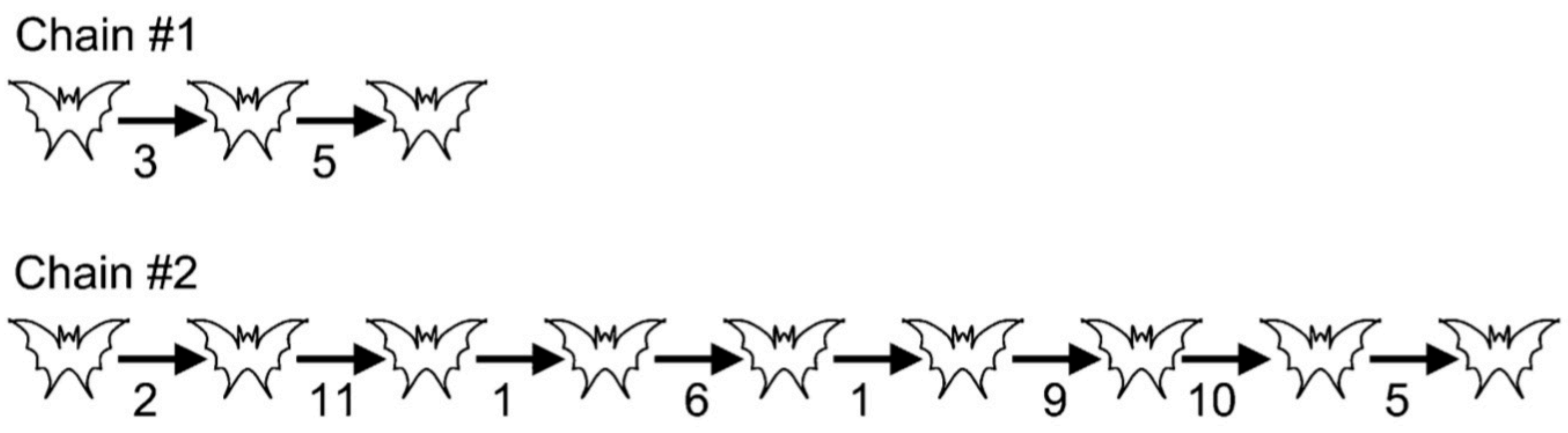

Figure 1. Chains of Transfer in the Social Learning Group

Arrows indicate the transmission of the novel foraging behavior; the numbers underneath the arrows indicate the number of trials required to reach acquisition criterion for each bat. After testing, the current test bat became the tutor for the next test bat.

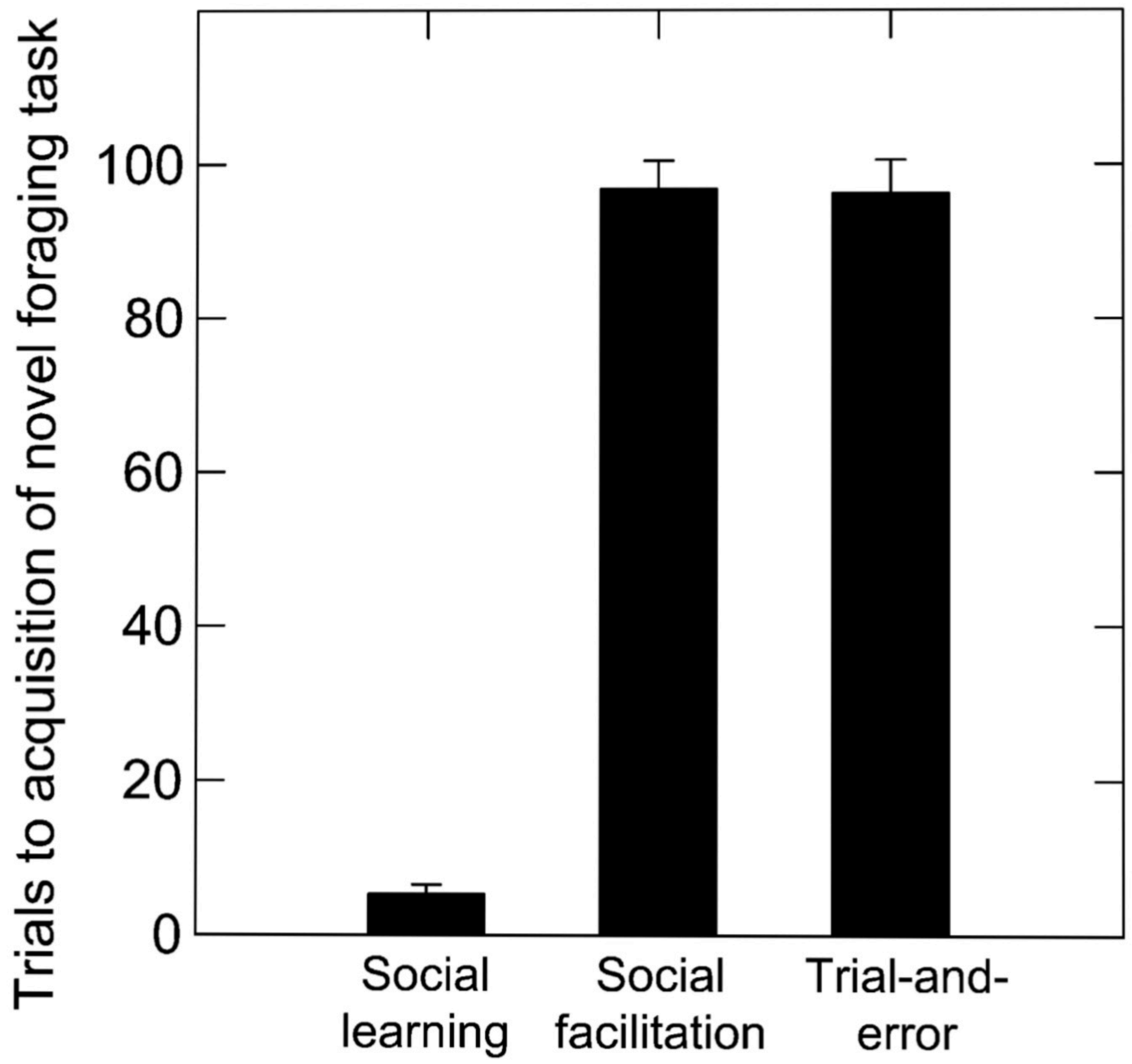

Figure 2. Mean Rates of Acquisition, ± SEM, of the Novel Foraging Task for the Three Learning Groups

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