Week 2

(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 18.1 part 2 Frog Choruses

- natural enemies may exploit communication signals -> prey.

Mike Ryan studied frogs in Panama (tungara frog) 1981->

. Male frogs vocalize to attract mates - shores of ponds

benefit/pro - get mate, cost/risk - get predator

- studied two predators : philander opossum, fringe-lipped bat

Methods#1: Use night vision scope to observe at night. Recorded 35 captures

Findings#1: observed opossum go to pond ~~edge~~, stop, then turn toward vocalizing frogs. As opossum got closer to prey, stopped again, turned head side to side rotating ears. Then pounced.

Methods#2: Playback experiment, tungara frog vocalizations, 2 meters from pond (frogs not normally found there).

Played recordings only when opossum nearby, facing away and no frogs vocalizing. ~~5/5 times opossum~~

Findings#2: 5 out of 5 times, opposum turned toward speaker, did head tilting + ear rotating, then approached speaker + pounced on speaker 3 out of 5 times. In 2 times did not pounce had seen researchers + left.

IQ: Acoustic OR visual cues used? Ryan et al data suggest?

[illegible]

Reading 18.1 (cont.)

Bat experiments - while most bats use echolocation (sonar) to locate prey, the fringe-lipped bat uses sound + eat frogs.

Methods#1: Researchers visit frog breeding ponds Jan-June.

Half ponds were tungara frogs. Amount of vocalizations varied at different times - recorded that: full chorus, partial, few, none

Recorded # bats visiting + how successful at capturing frogs

M#2: Also later compared caged vs wild bats response to playback of 'edible' vs 'poisonous', or 'small' vs 'too large' frogs.

Findings: Fig 18.6 A. more frogs joining chorus -> high % capture

B. Caged + wild bats avoided approaching 'poisonous' toad + too large frog

IQ: 11. ~~Read~~ Data from 18.6 A suggests what is hunting method of bat?

12. Can bats discriminate among prey types? what data = evidence?

13. Why test cages vs fields, were there differences?

-> Surprise of Ryan's findings was discriminate prey (to the literature)

-> lab studies are important, control more variables

2006 Movie Ryan et al Rachel Page

Purpose How do bats learn to avoid poisonous prey?

hypothesis - bats live in social groups -> learn from others?

In lab used vocalizations of cane toads - too large + poisonous

Methods : 1. test caged bats, none attracted to cane toad call.

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.

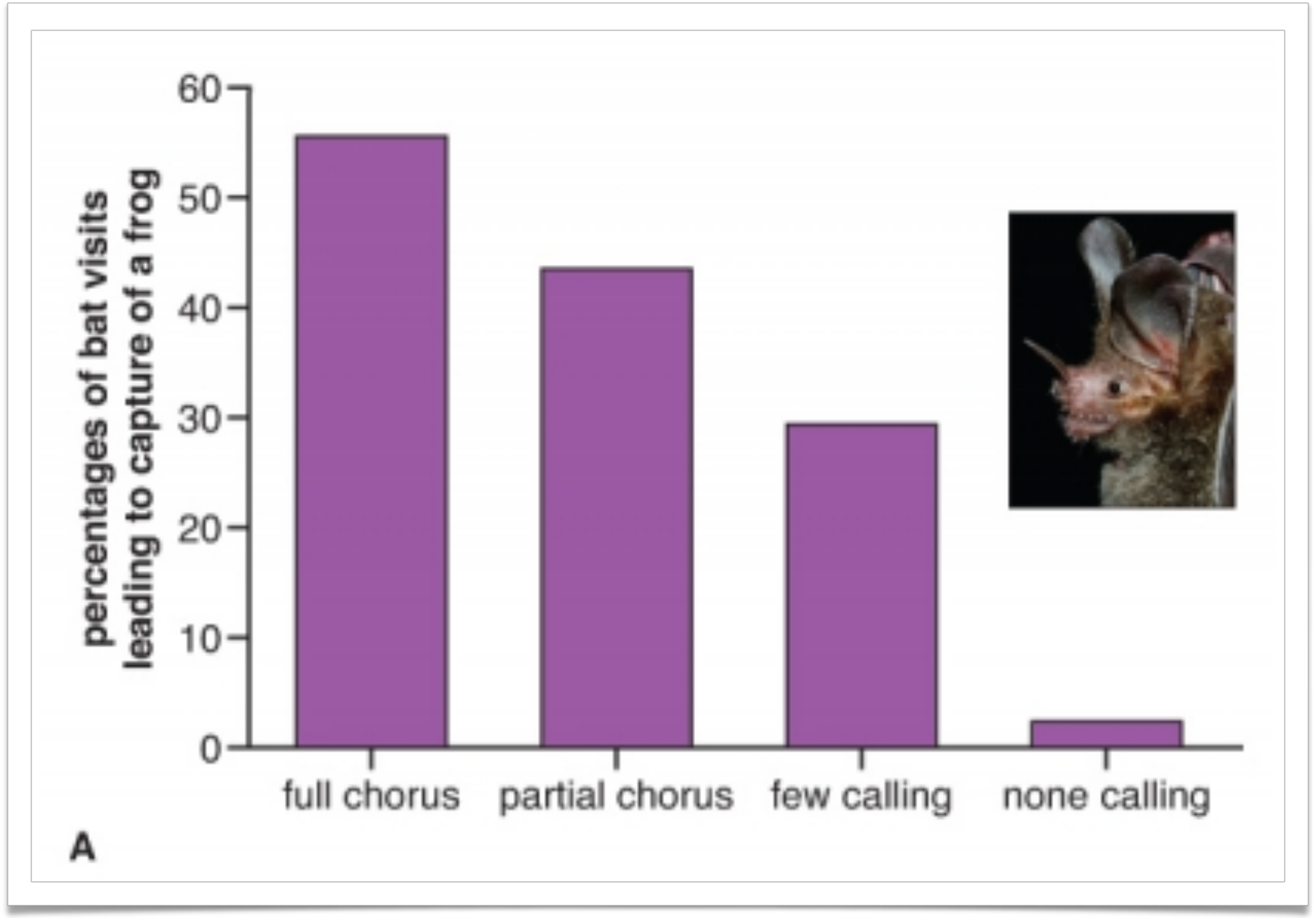
Section 18.1: What did you find the most interesting from today's reading (how might these readings help you)?

Test your knowledge

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

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?

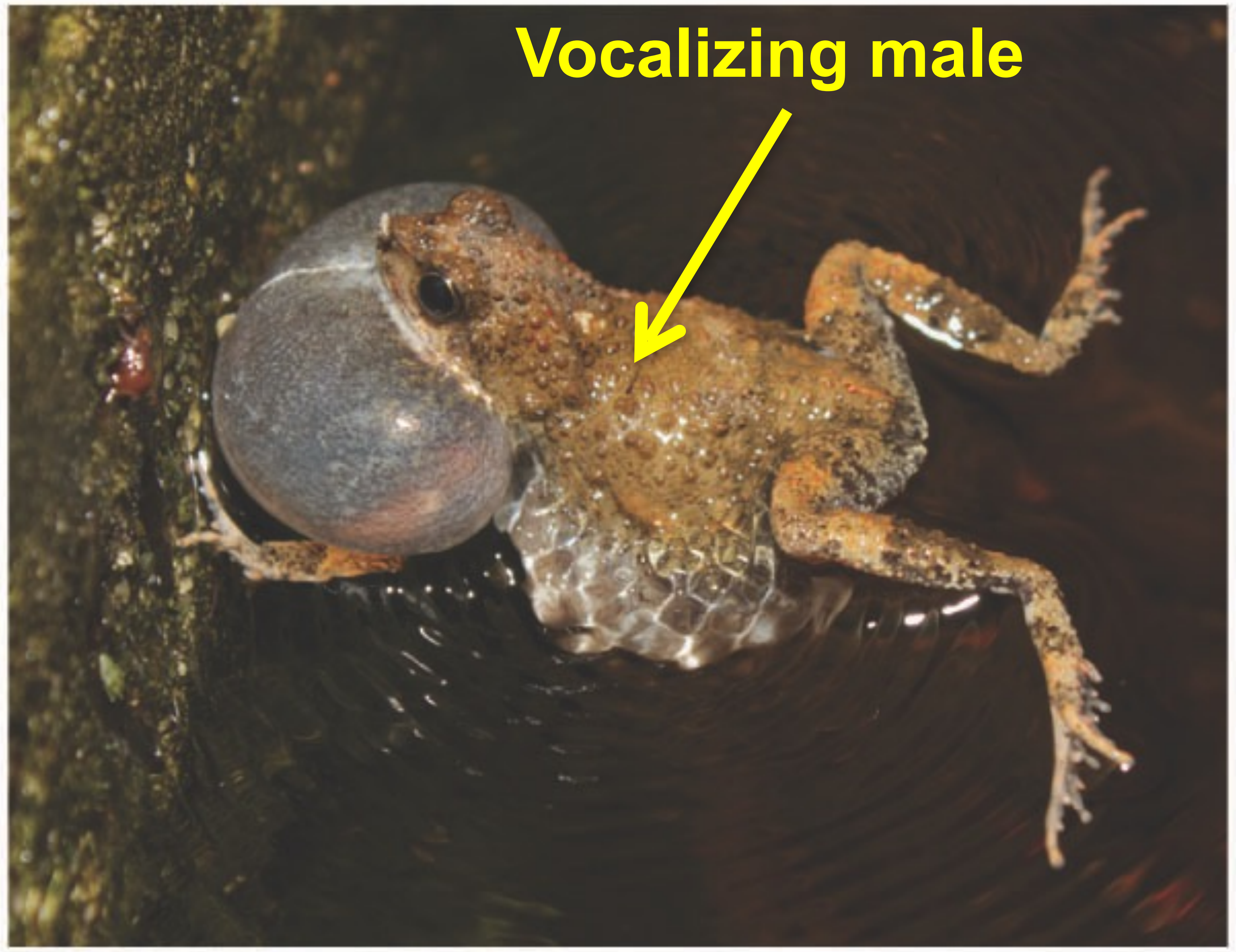
a) Nope, there was a speaker with no sounds
b) Yes, the speaker was nearest to bunch of frogs
c) Nope, these are not counts of frogs captured
d) Yes, a full chorus has more frogs, so it makes sense bats would have a better chance of catching more frogs.

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

Methods: Philander opossums observed near a pond that contained breeding male Tungara frogs

- Observed about 2 hours/night; recorded 39 captures
- Typical behavior recorded: describe
- Playback experiment: Recordings played when opossum was near but facing away from the speaker and no frogs vocalizing (Q: speaker placed 2 meters from pond edge?!)
- 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. 2/5 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?

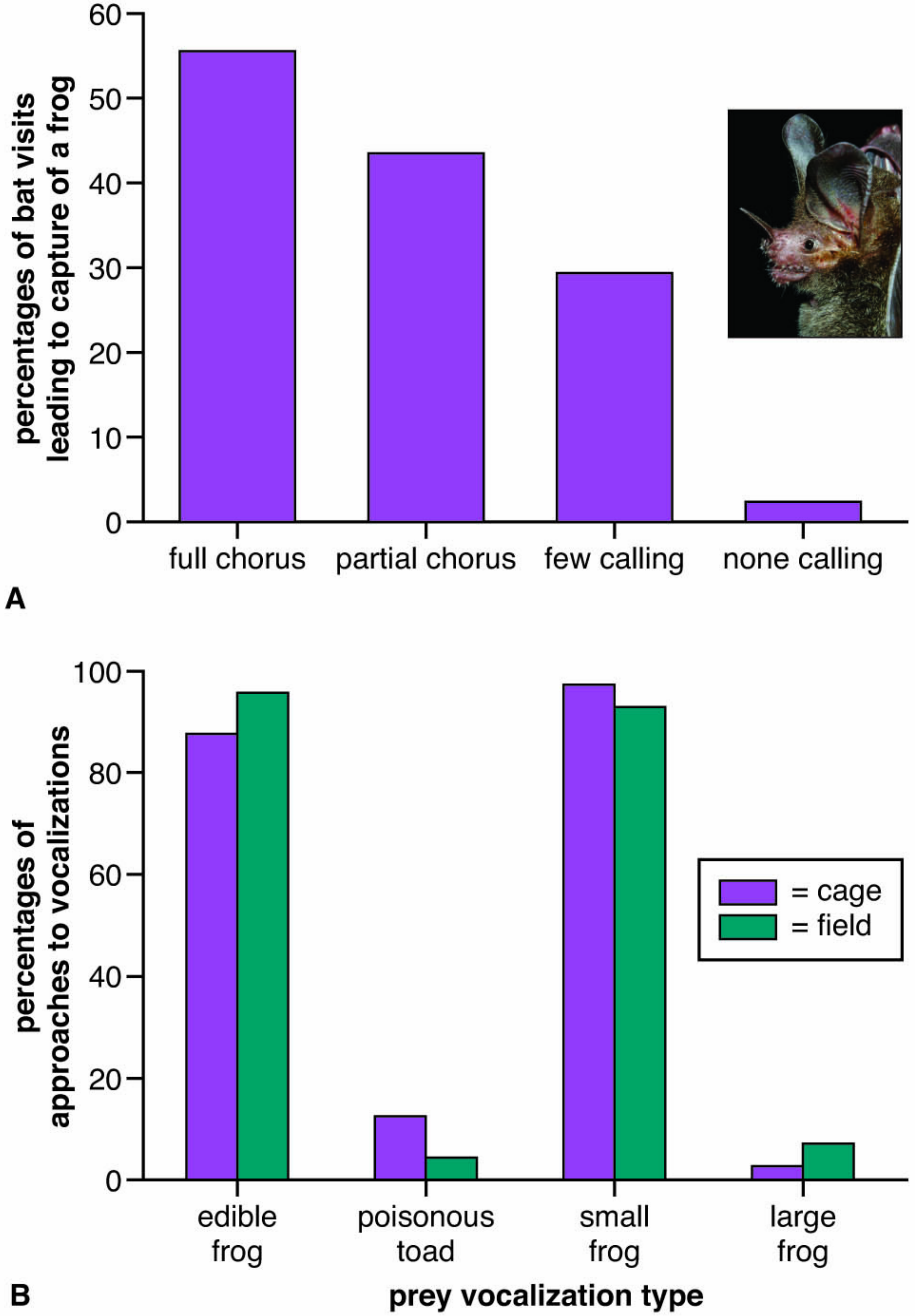


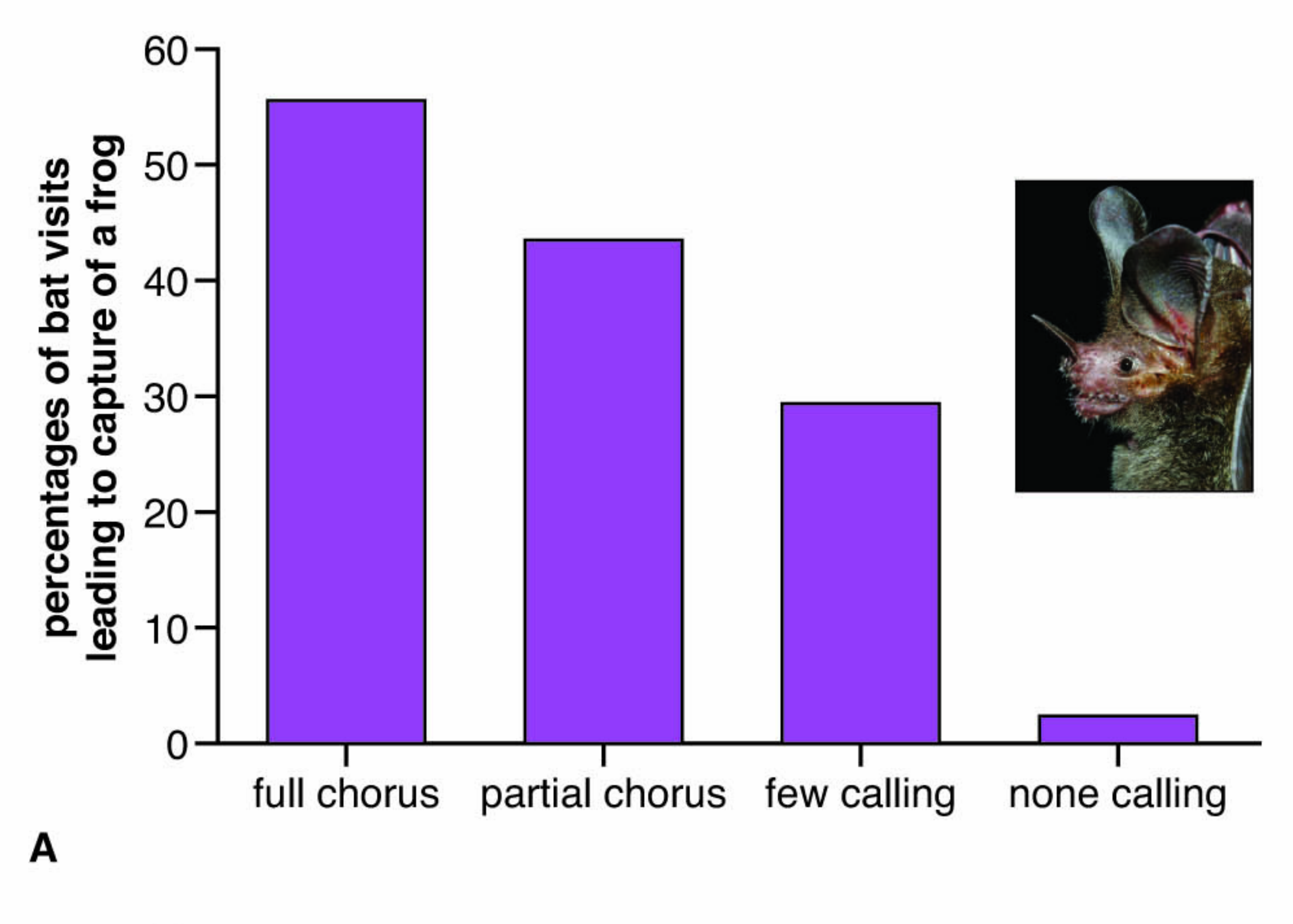
Figure 18.6

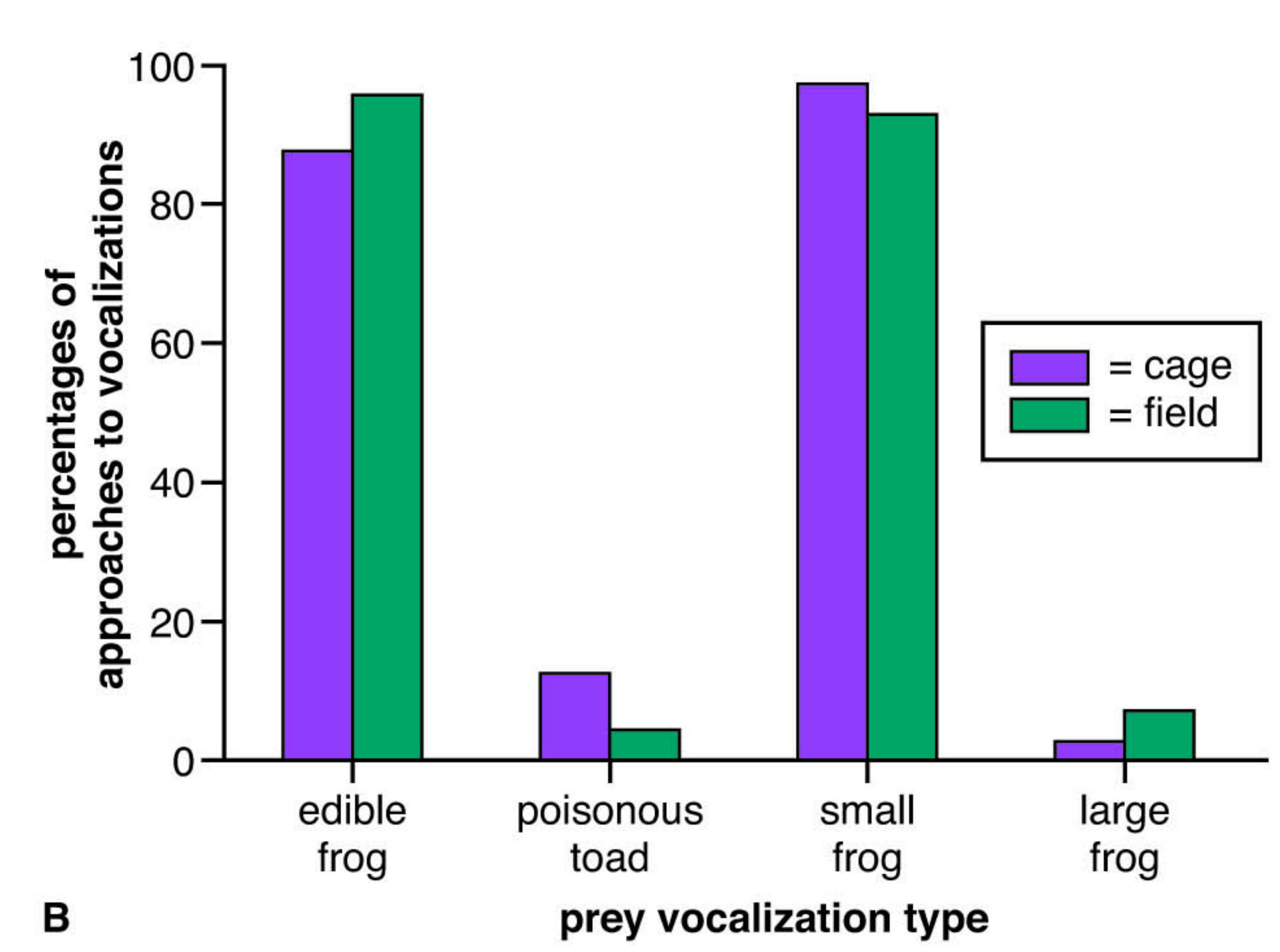
From Tuttle and Ryan, 1981, Table 1. Inset: Author: Karin Schneeberger. Creative Commons

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?





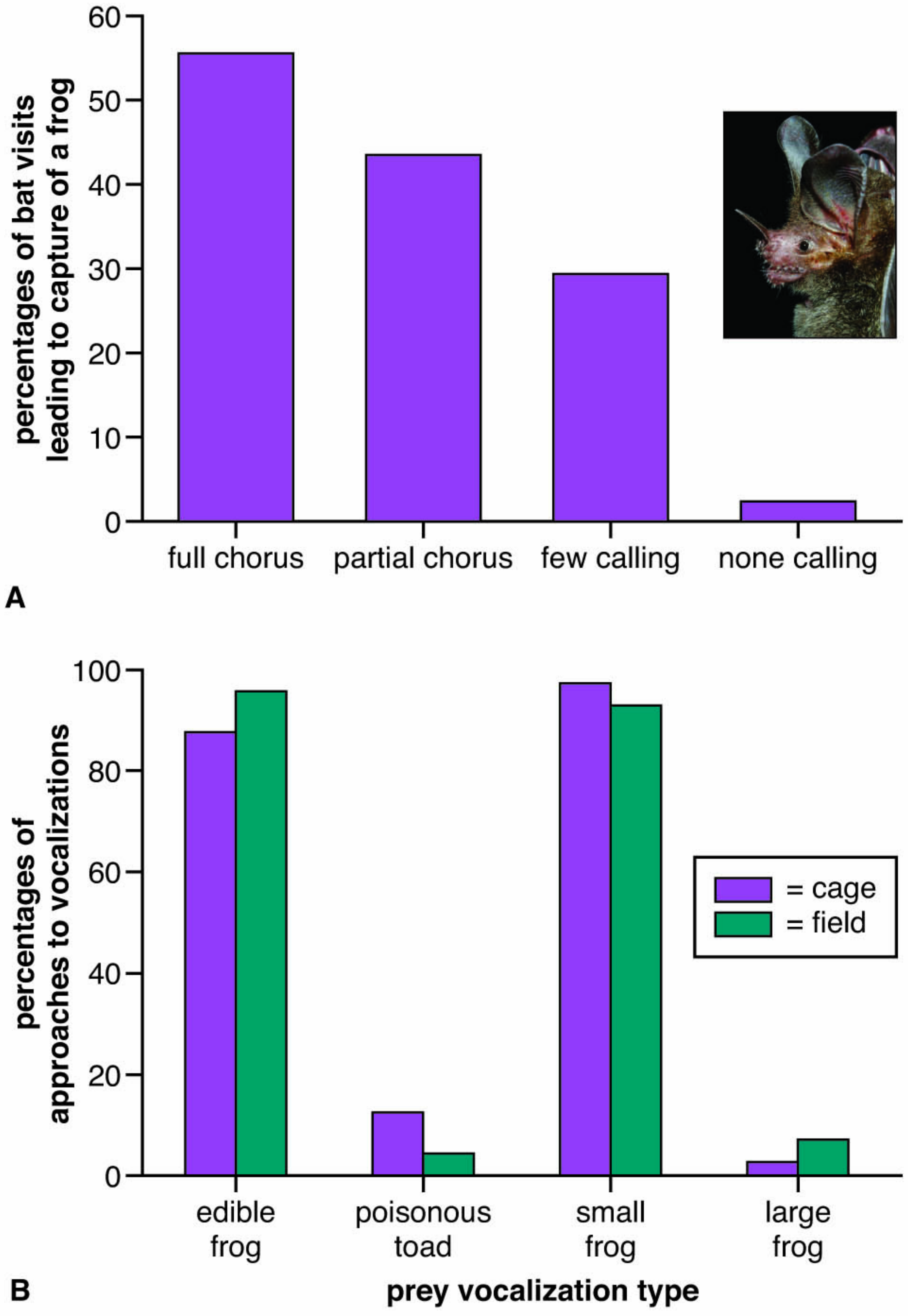

percentages of bat visits leading to capture of a frog
60
50
40
30
20
10
0
full chorus
partial chorus
few calling
none calling
A
percentages of approaches to vocalizations
100
80
60
40
20
0
= cage
= field
edible frog
poisonous toad
small frog
large frog
B
prey vocalization type

Figure 18.6

Percentage of bat visits leading to a frog capture for categories of frog vocalization frequency

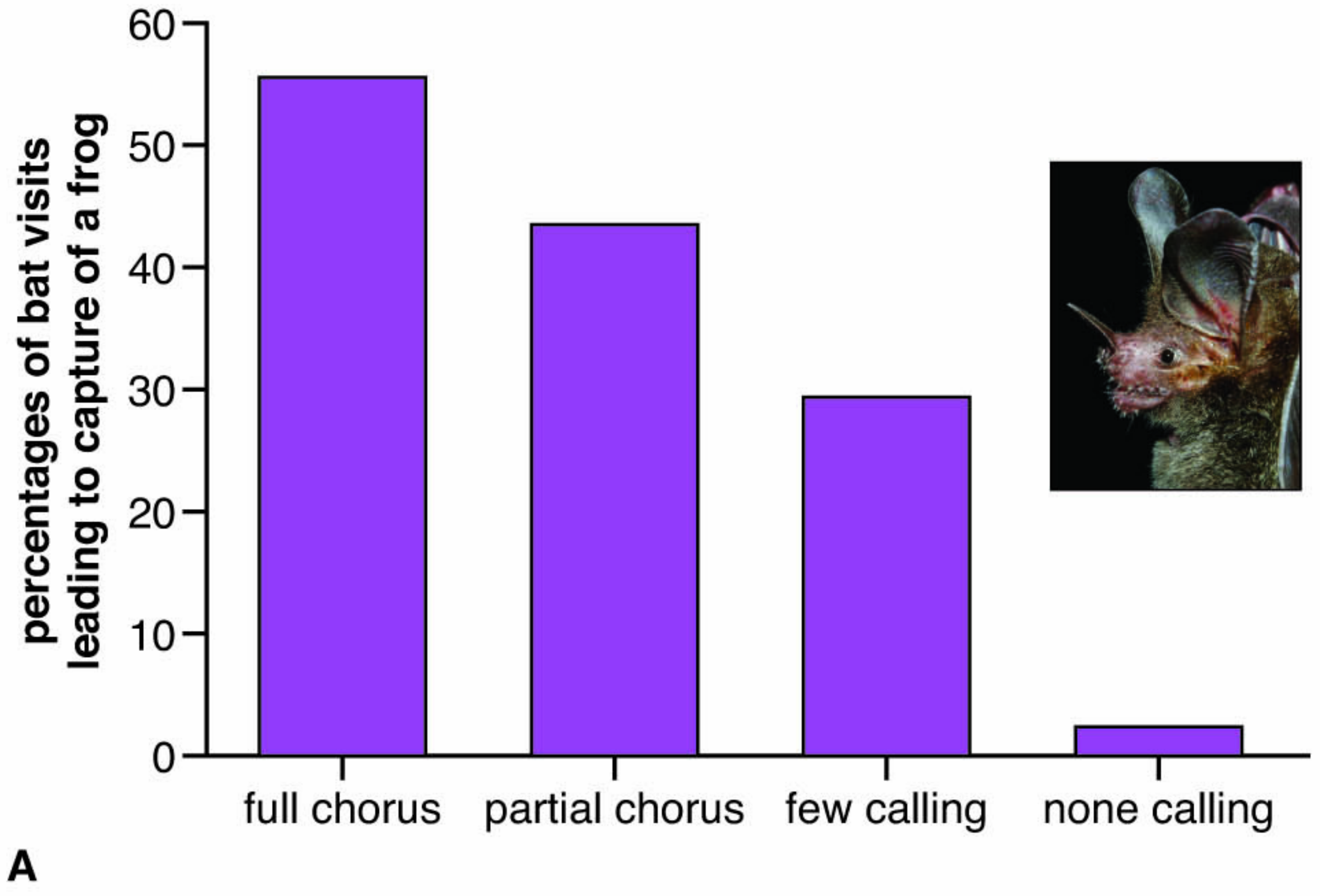
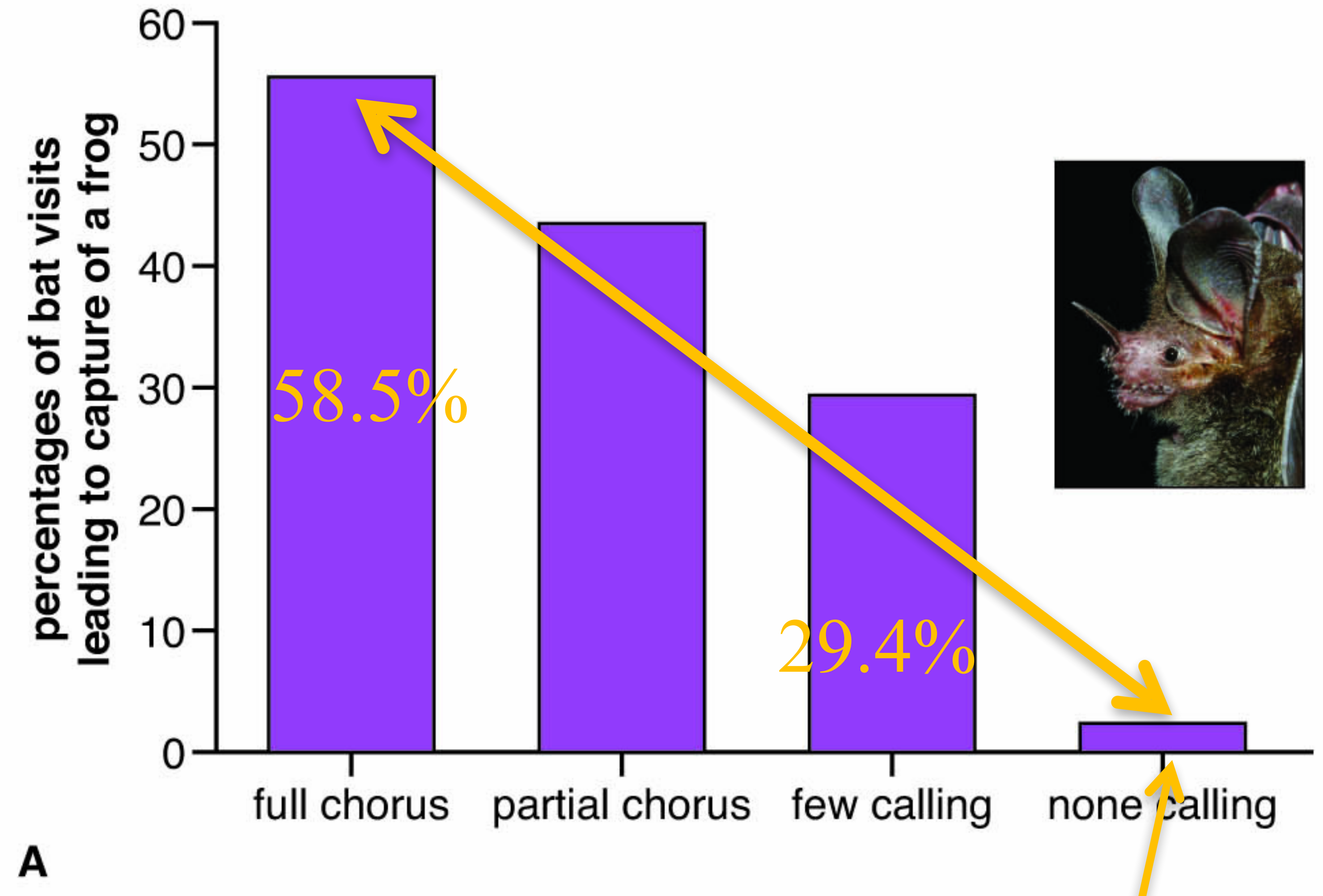


Figure 18.6

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

Percentage of bat visits leading to a frog capture for categories of frog vocalization frequency



2.3% success (1 in 42.7 visits)

Figure 18.6

Responses of frog-eating bats to vocalizations of different prey

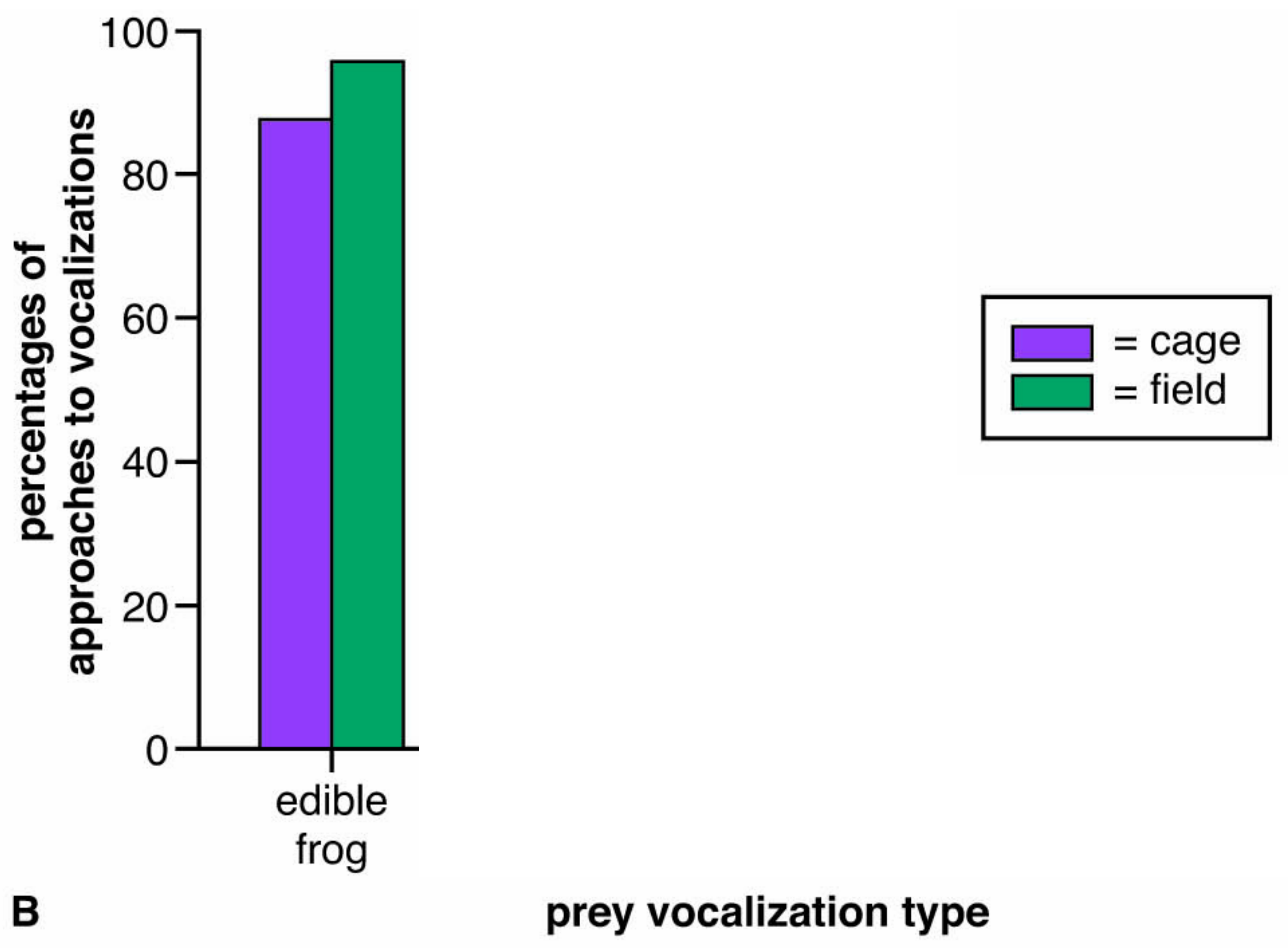


Figure 18.6

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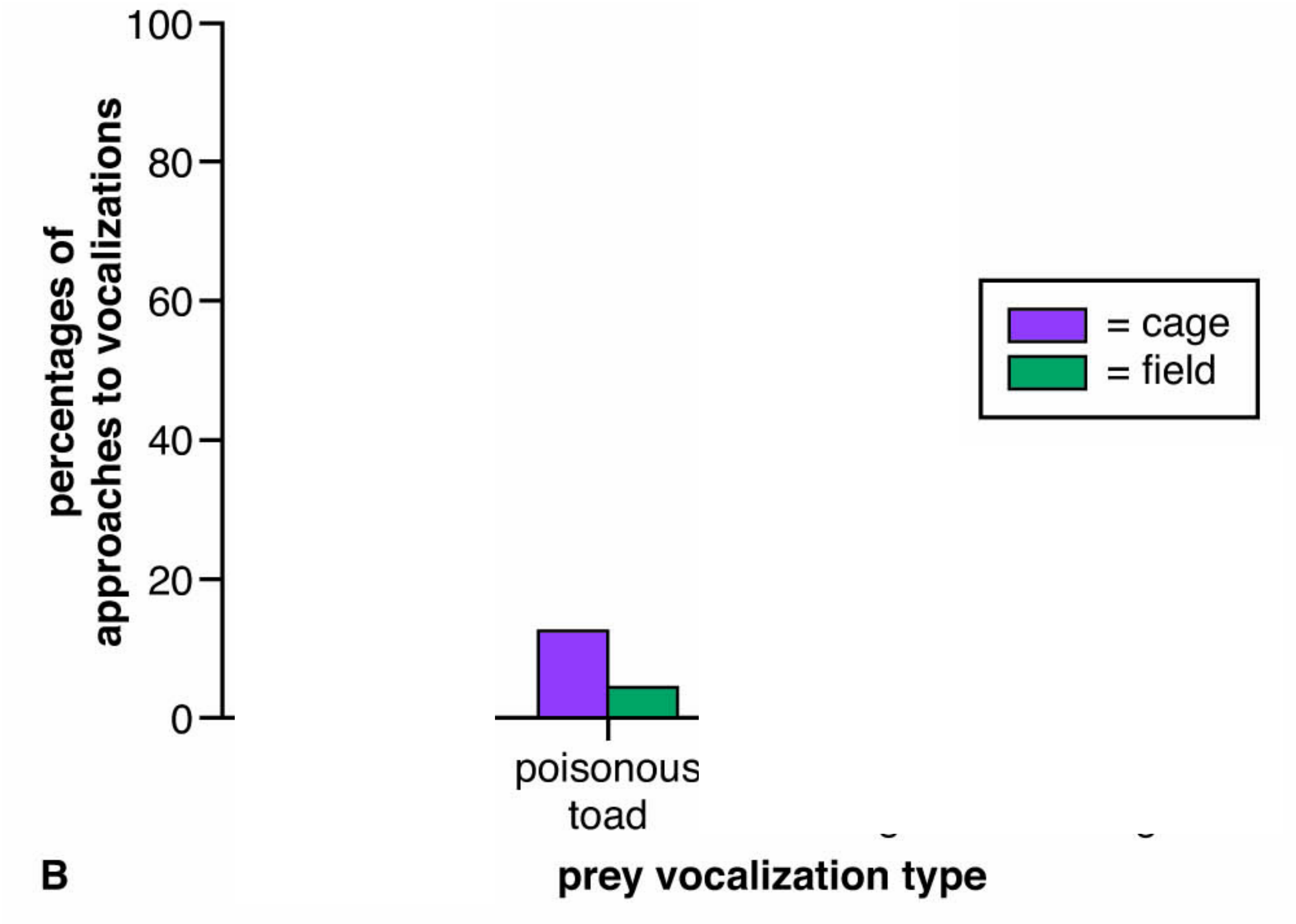

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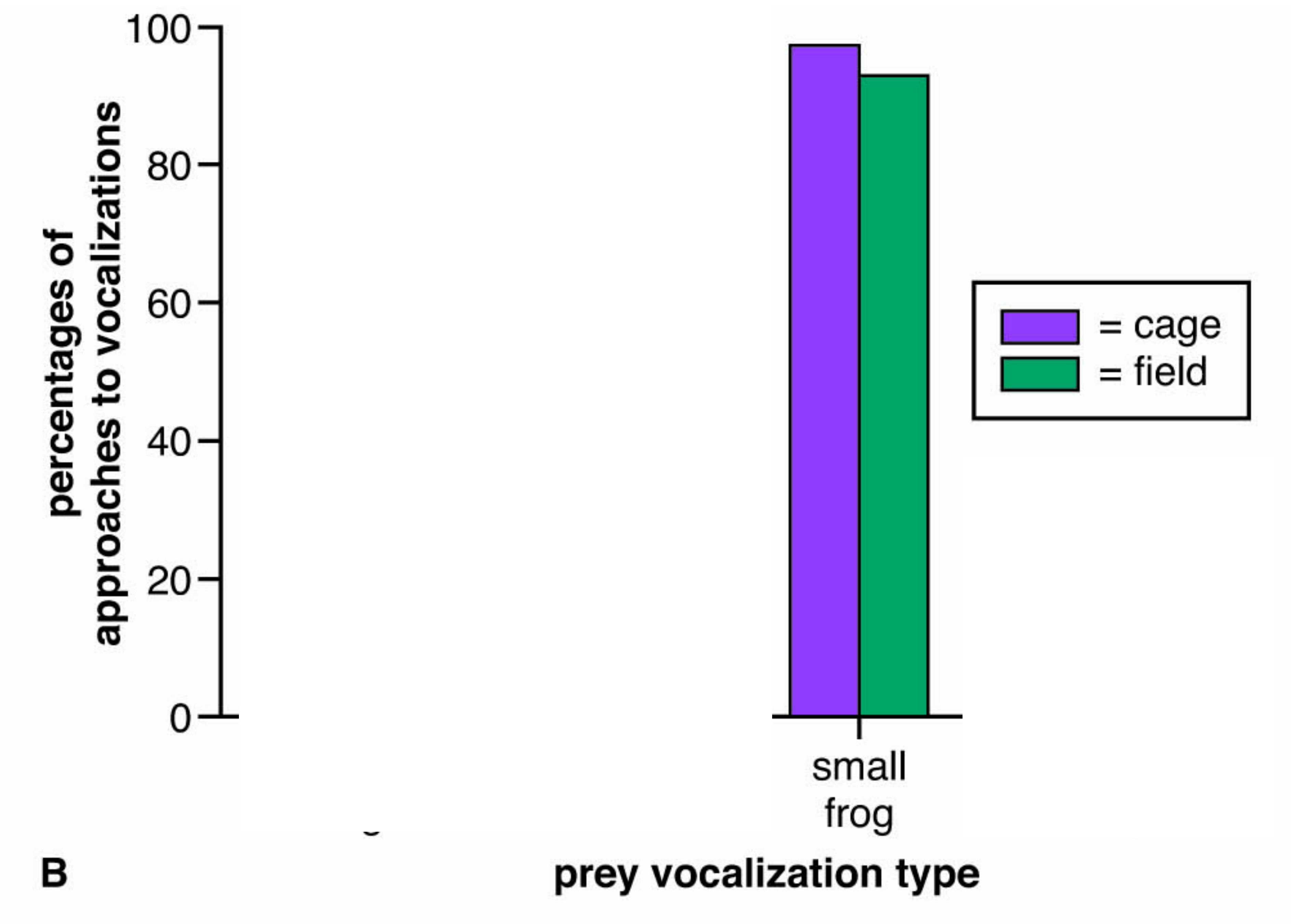


Figure 18.6

Responses of frog-eating bats to vocalizations of different prey

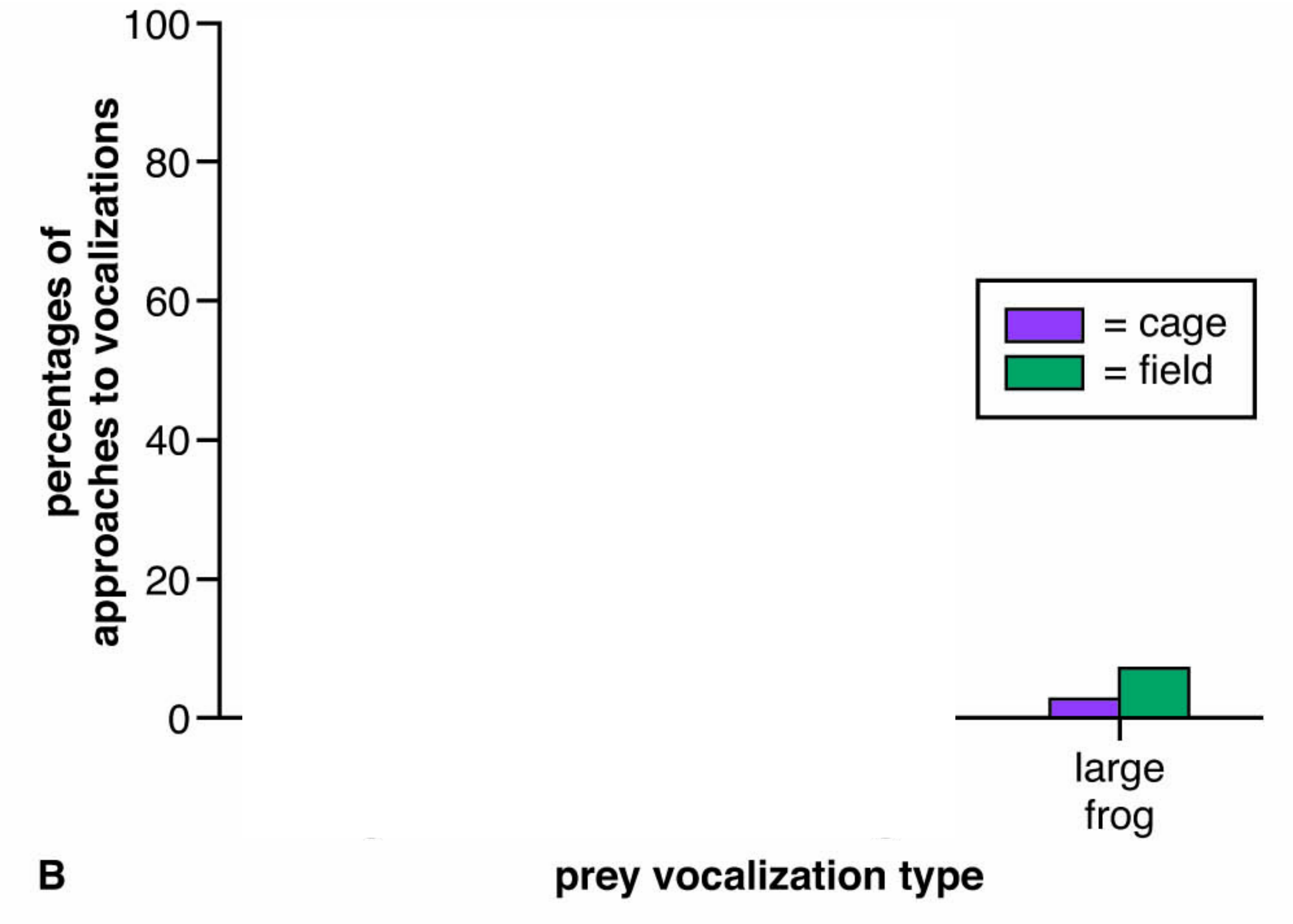


Figure 18.6

Responses of frog-eating bats to vocalizations of different prey

Compare responses within boxes

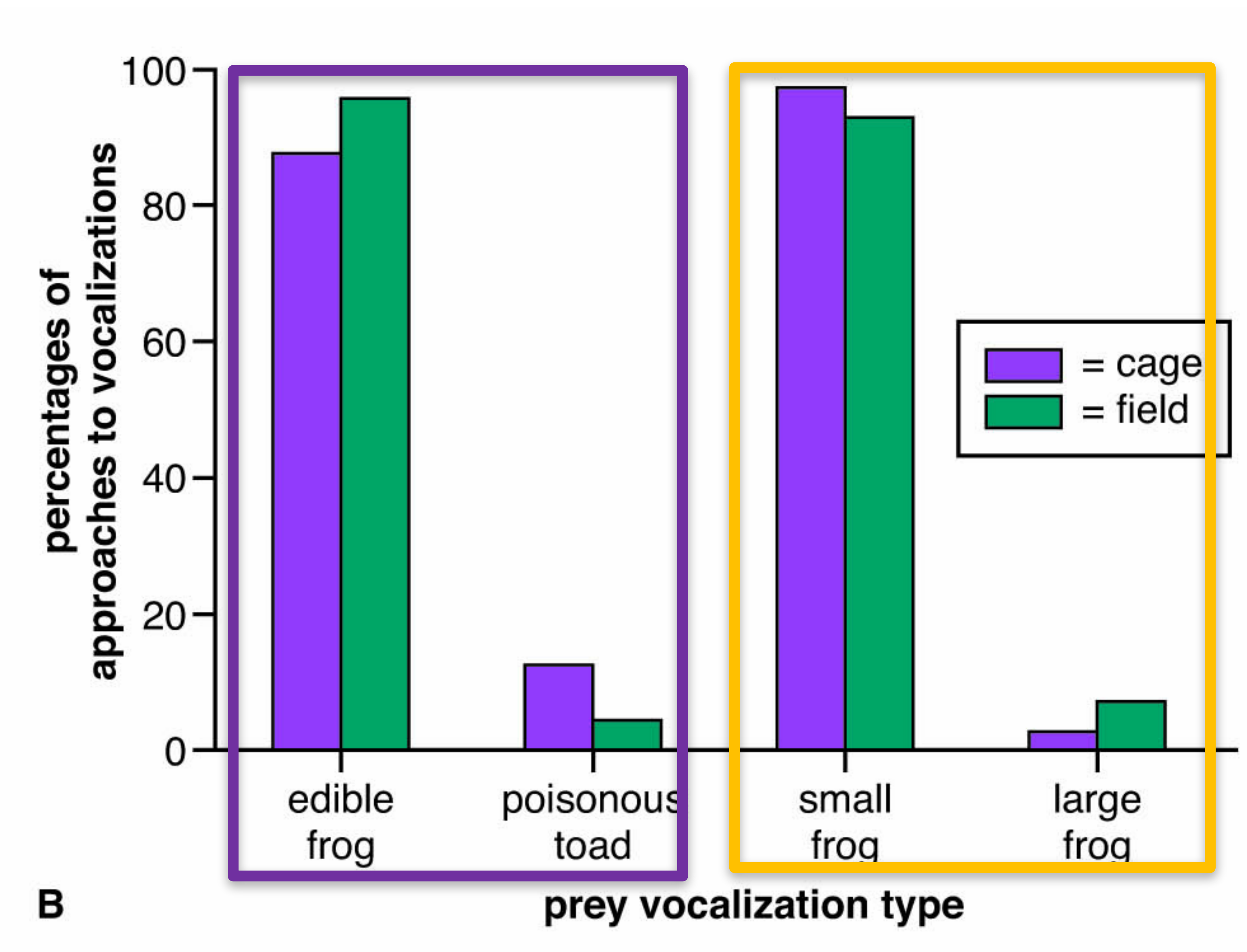
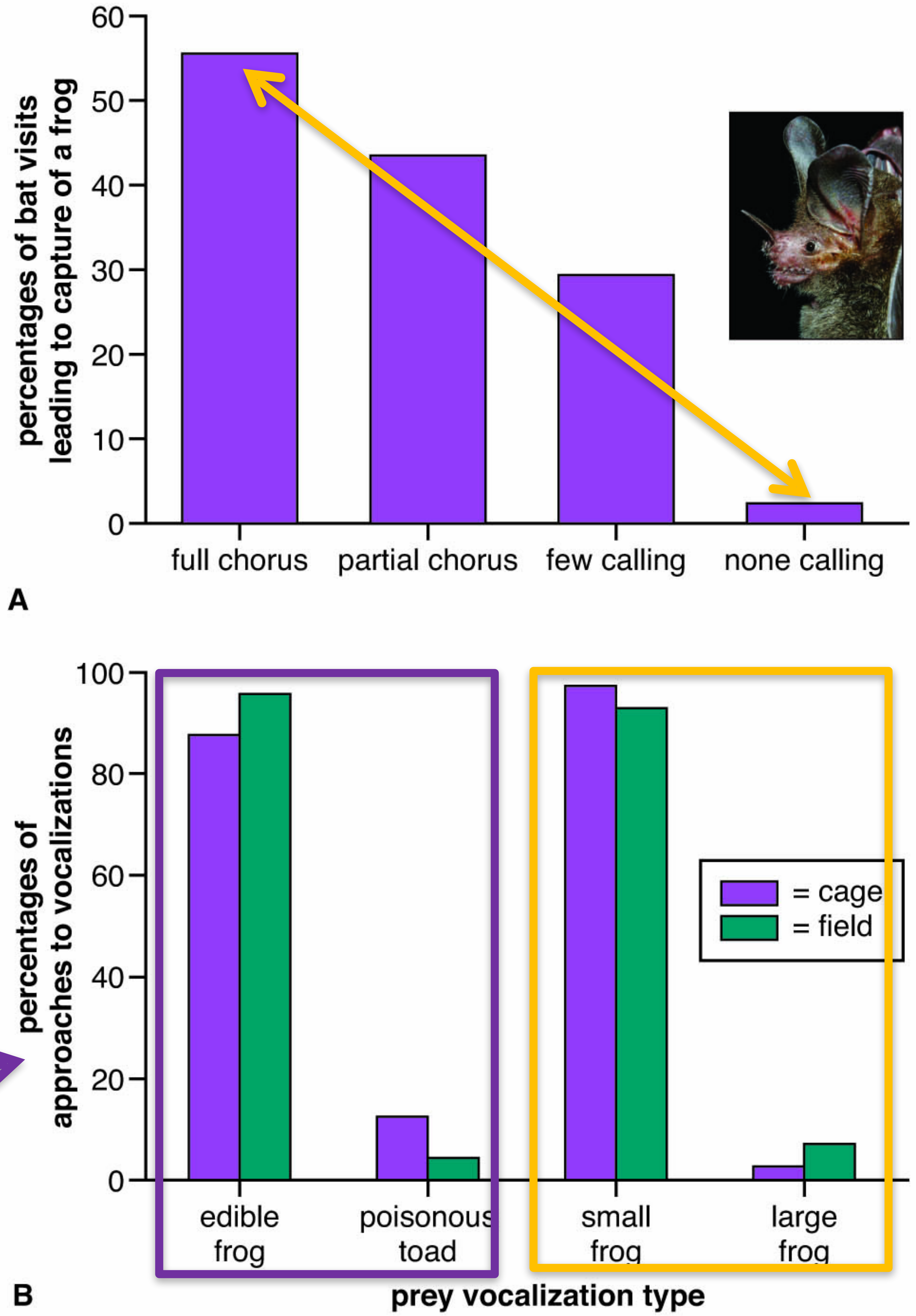


Figure 18.6

Results of experiments on fringe-lipped bats preying on frogs



"IQ: Is there a significant difference caged vs wild?"

Figure 18.6

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

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

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

15. Identify the controls that Ryan and his colleague used in their experiment and what the controls were designed for.

Trials needed for fringe-lipped bats to learn to associate cane toad vocalization with palatable prey

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

Table 18.2

From Page and Ryan, 2006, Figure 2

Trials needed for fringe-lipped bats to learn to associate cane toad vocalization with palatable prey

treatment	mean number of trials	standard error	sample size
two inexperienced bats	96.8	3.2	5

Table 18.2

From Page and Ryan, 2006, Figure 2

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Table 18.2

From Page and Ryan, 2006, Figure 2

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