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Original investigation

Have introduced fish initiated piscivory among the long-fingered bat?

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Abstract

During the winter of 2003–2004 feces were collected from a winter colony of the long-fingered bat (*Myotis capaccinii*) in the Hazorea cave (north-west Israel). Of the 1913 feces that were examined, 234 contained scales of *Gambusia affinis* – a small fish that had been introduced to Israel around 1920 in order to control mosquito larvae. The remains of spiders and five insect orders were also represented in the feces. This is the first report of a piscivorous bat in the Middle East and the first finding of fish remains in the feces of *M. capaccinii*. The findings show that in the north of Israel this species does not hibernate but remains active throughout the winter. It appears that the consumption of *G. affinis* reflects a change in the diet of these bats from insectivory to semi-piscivory.

Key words: *Myotis capaccinii*, *Gambusia affinis*, Israel, piscivory

Introduction

Piscivory as the main feeding pattern in bats is known from two species: *Noctilio leporinus* and *Myotis vivesi* (Bloedel 1955; Reeder and Norris 1954; Kalko et al. 1994). However, feeding partly on fish by insectivorous bats is known from several other species of the genus *Myotis*. Fish remains were found in *M. daubentoni* feces in France (Brosset and Delmare 1966), and this species is also known to pick up small fish from the water in captivity (Siemers et al. 2001a). Fecal analysis of *M. ricketti* from China confirms that this species too feeds partly on fish (Ma et al. 2003). Behavioral experiments suggest that the three species of European trawling *Myotis* (i.e. *M. capaccinii, M. daubentoni* and *M. dasycneme*) can take objects from smooth surfaces (Siemers et al. 2001b). Finally, fish scales were recently found in the feces of four free-living *M. capaccinii* females in Spain, but the fish were never identified (Aihartza et al. 2003).

The long-fingered bat, *M. capaccinii* (Vespertilionidae) is a common bat near aquatic environments in the northern part of Israel (Shalmon et al. 1993). This small insectivorous bat (6–10 g) is found in the Mediterranean region of Europe and northwest Africa, in Asia Minor, and in the Middle East from Israel and Lebanon to Iran and Uzbekistan

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(Corbet 1978). *M. capaccinii* is known as a 'trawling' bat that forages close to the water surface, seizing insects from both above and off the water surface, similar to other trawling bats in its subgenus (Kalko 1990; Siemers et al. 2001b).

The aim of this study was to investigate the diet of a winter colony of *M. capaccinii*, in order to determine whether piscivory exists in this species in Israel. Should such a phenomenon be found, our secondary objective was to estimate the proportion of fish and its species in the bats' diet during winter.

Material and methods

Study site

The study was conducted in the Hazorea cave (Kibbutz Hazorea, north-west Israel 32°40N 35°05E, about 50 m a.s.l.). This man-made cave is located 800 m from the Kibbutz Hazorea fisheries ponds. *M. capaccinii* exclusively inhabited the cave from the second week of November 2003 to the third week of January 2004. During this period we visited the cave six times. Twice (in November and January) bats were captured by hand net, sexed, weighed (by Pesola spring balance to an accuracy of 0.1 g), forearm measured (to an accuracy of 1 mm), and released. In order to estimate colony size, we counted the bats emerging from the cave entrance at dusk, at the beginning, middle and end of the research period.

Ambient temperature and humidity inside the cave were recorded throughout the study period every 16 min using an HOBO data logger (Onset Computer Corporation), and meteorological data were received from Ein Hashofet meteorological station (http://www.mop-zafon.org.il/).

Feces collection and analysis

Four times during the study period we positioned a polyethylene sheet (1.5 × 1.2 m) on the cave floor under the bat colony in order to collect feces. The sheet was placed one afternoon, removed 7–25 days later and replaced by a new one. Feces were dried at room temperature for 24 h and each one was later examined under a binocular microscope for identification of fish scales. Feces that contained fish scales were separated from those that contained only insect remains. For scale analysis, we softened the feces with 70% ethanol and separated the scales and bones. We found only a few fish bones, which could not be identified because of their small size and bad condition. The feces that contained fish scales had almost no insect parts. The fish scales were compared under a microscope to scales taken from fish caught in the Hazorea fisheries ponds and identified to species level (during winter the ponds are densely inhabited by several different species of small Cyprinids, as well as by *Gambusia affinis*).

For insect remains, we analyzed the contents of 200 feces, 50 feces from each visit, studying each individually under a binocular microscope (× 10, × 20) and identifying its contents to order, family or genus level. We calculated the frequency of insects found in the feces and the volume of each order in them (Whitaker 1988). Feces that contained fragments too small for identification or just digested material were marked as unidentified.

Results

Colony size

Mean colony size was 280 bats (SD = 58). Sex ratio among the 20 bats caught and sexed was 1:1. Mean body mass decreased significantly from 9.1 g (SD = 0.55, $n = 7$) in November to 7.4 g (SD = 0.69, $n = 13$) in January (*t*-test $P < 0.001$, $t = 5.477$), and there was no significant difference in mass between males and females (*t*-test $P = 0.95$, $t = 0.063$). Temperature decreased gradually during the study period from minimum of 13.2 °C outside and 15.2 °C inside the cave in mid-November until reaching a minimum of 5 °C outside and 10 °C inside the cave during the last part of December, but bats remained active throughout this period and emerged each night. None were found hibernating in the cave.

Fecal content

Of the 1913 feces examined from four periods during the research, 234 contained fish scales and bones (Tab. 1). All the samples had a strong fish odor. All of the fish scales belonged to *Gambusia affinis*. This fish was introduced into Israel from North America around 1920 in order to control mosquitoes, since it preys on mosquito larva (Goren and Ortal 1999). Today, *Gambusia* is very common in fisheries ponds, lakes and cisterns in