

## *Myotis daubentonii* is able to catch small fish

BJÖRN M. SIEMERS, CHRISTIAN DIETZ, DIETMAR NILL, and  
HANS-ULRICH SCHNITZLER

*Department of Animal Physiology, Zoological Institute, University of Tübingen,  
Auf der Morgenstelle 28, 72076 Tübingen, Germany; E-mail of BMS: bjoern.siemers@uni-tuebingen.de*

We experimentally showed that Daubenton's bat (*Myotis daubentonii*), a Palearctic vespertilionid species hunting for insects floating on or flying close to water surfaces, can take a small fish for prey if the fish penetrates a smooth water surface. The bat in our experiments was able to lift small fish and other big prey items out of the water by using its large feet. The bat readily fed on the fish we offered.

*Key words:* piscivory, *Myotis*, preadaptation, trawling, prey capture

### INTRODUCTION

Field observations, faecal analyses and feeding experiments had suggested that *Myotis daubentonii* may occasionally capture small fish (Brosset and Delamare Deboutteville, 1966; Brosset, 1975; Terrasse, 1975). Several authors interpreted the foraging strategy and morphology of the so called 'trawling *Myotis*' as possible preadaptations for piscivory (Brosset and Delamare Deboutteville, 1966; Dwyer, 1970; Novick and Dale, 1971; Brosset, 1975; Jones and Rayner, 1988). Recent behavioural experiments showed that all three European species of 'trawling *Myotis*', i.e., *M. capaccinii*, *M. daubentonii* and *M. dasycneme*, take isolated objects on smooth water surfaces for prey. These could be arthropods, debris or prey-dummies positioned on the surface or insects

flying close to it. The bats' search image is matched by isolated acoustic glints that are reflected off those objects (B. M. Siemers, P. Stilz, H.-U. Schnitzler, unpublished data).

From a sensory perspective it therefore would not be surprising that 'trawling *Myotis*' will also take a small fish for prey if it penetrates a smooth water surface. In order to investigate whether small fish indeed fit into the search image of 'trawling *Myotis*' and can be lifted out of the water by the bats, we presented small sunbleak (*Leucaspius delineatus*, Cyprinidae) to a *M. daubentonii* in an artificial pond in a flight room. Thereby we used close-up photos to clarify the role of feet and uropatagium during retrieval of fish and other big prey from the water surface. We analysed the bat's faeces to assess the amount of scales and fish bone that pass the gut.

## MATERIALS AND METHODS

We captured a male *M. daubentonii* at Klosterreichenbach (08°24'W, 38°32'N), Southern Germany in September 1998 under licence of the responsible regulatory authority (Regierungspräsidium Karlsruhe licence # 73c1-8852.15). The bat was released to the wild at the site of capture after the end of the experiments. Experiments were run in a 5 m × 3 m flight room. We used young sunbleak of about 2 cm body length as prey. The freshly killed fish were presented in an artificial pond (1.1 m × 1.6 m area, water depth 7 cm) with their head protruding 2 to 3 mm above the water surface. Live fish were kept swimming freely in the pond. Moths (Noctuidae and Arctiidae, Lepidoptera), crane flies (*Tipula* spp., Diptera), grasshoppers (Saltatoria) and mealworms (*Tenebrio molitor*, Coleoptera larvae) were also presented floating on the water surface.

To contribute to the understanding of the role of feet and uropatagium during capture of large prey from the water surfaces, we took close-up photos (60 mm × 60 mm slides) with a Zenza Bronica SQ-Am camera and a 3.5/105 mm Zenzanon-S lens. An infrared photoelectric barrier was used to trigger photos at different stages of the capture sequence. The photos were analysed under 8× magnification. Of 333 taken photos, 60 showed the bat exactly at the moment of capture or while transferring prey to the mouth and hence were used for further analysis.

After the bat had fed on about 30 fish, we collected its faeces from the box it roosted in. The droppings were treated overnight with alizarin red in 1% KOH solution to stain remains of fish bone and scales. We then dissected them under a stereo microscope in aqueous solution.

## RESULTS

Already in the first trial in that we offered young sunbleak to the Daubenton's bat, the fish was captured and eaten. The insects were also captured, but some of the Arctiidae and grasshoppers were then rejected (i.e., dropped) by the bat. In a four week period, the bat captured about 30 small fish. Fish were only captured when they penetrated the water surface; the fish that swam freely in the artificial pond were never attacked. The bat was able to find and capture prey in complete darkness; it was

constantly emitting echolocation calls during search and approach flight. The bat ate most of the fish and other prey on the wing while circling in the flight room. Only towards the end of a session, it tended to land at a perch and finish eating there.

From the photos we could observe the following details of prey capture (example in Fig. 1). About 10 cm from the prey, the bat lowered its feet and tail membrane from a position trailing the body into a 'tail down' position (Kalko and Schnitzler 1989). Thereby, body, wings and tail membrane were brought into a vertical position, while the head and especially the ears were bent downward focussing on the prey object. The tail tip touched the water surface first and penetrated the surface about 1 or 2 mm deep. Then tail and tail membrane were deflected backwards ( $n = 23$ ) and the feet were lowered further. Roughly 3 cm before reaching the prey, the bat dipped its feet into the water about claw-deep and raked towards its target ( $n = 23$ ). The feet were brought together and the prey was either clutched with both feet or gaffed by the claws of one. The bat always grasped fish and other large prey with its feet ( $n = 17$ ) and never directly scooped it up with the tail membrane. Prey was taken with the mouth either directly from the claws ( $n = 11$ ) or from the tail membrane ( $n = 12$ ) where it had dropped into from the feet.

After the bat had fed on several species of insects and on approximately 30 small fish during a four week period, we found much insect material in its faeces, but only two fish scales and one fragment of fish bone.

## DISCUSSION

Small floating or jumping fish that protrude above the water are small echo-reflecting objects on an acoustically smooth surface and thus fit well into the

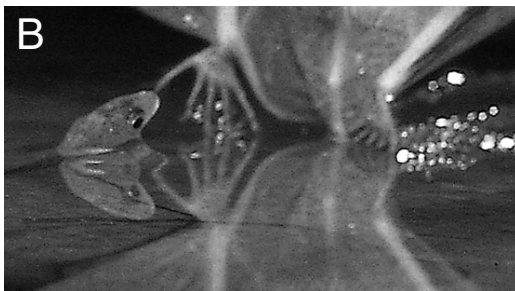
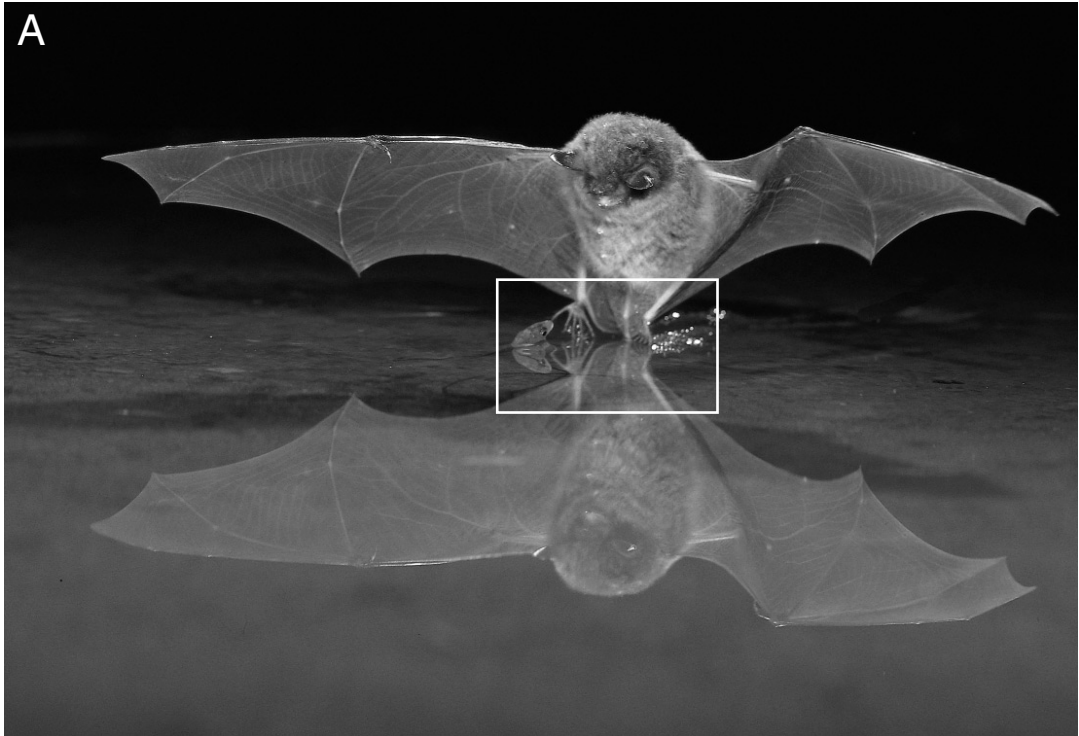


FIG. 1. Representative photograph of a *M. daubentonii* that is about to gaff a small fish with its feet. Fish were only attacked when part of their body was sticking out of the water. The bat's tail membrane is deflected backwards; one foot already penetrates the surface and rakes towards the prey object (white frame from Fig. 1A is shown enlarged in Fig. 1B).

Photo: D. Nill

search image of 'trawling *Myotis*'. It is hence not too surprising that the *M. daubentonii* male readily attacked the sun-bleak we offered. It ate the fish without hesitation, much like the captive *M. daubentonii* that fed deliberately on fish Brosset and Delamare Deboutteville (1966) offered to them. In contrast to Brosset's and Delamare Deboutteville's (1966) work, the bats in our study not just ate fish but captured it under semi-natural conditions. For the first time, the bat in our experiments clearly showed that *M. daubentonii* is able to lift small fish out of

the water. Evidence from the field and laboratory suggests that *M. daubentonii* sometimes uses its feet for grasping prey (Jones and Rayner, 1988; Kalko and Schnitzler, 1989; photos by Zomer Bruijn in Limpens *et al.*, 1997; Britton and Jones, 1999). The photos we took clearly confirm this for the capture of large prey objects, such as fish and floating moth. In this situation, the tail membrane was deflected backward actively or passively, thus not being deeply immersed and not producing much additional drag that would destabilise the bat's flight path.

As the remains of the small fish were hardly detectable in faeces, probably because of demineralisation in the stomach, piscivory will be very difficult to assess quantitatively in the field for the European 'trawling *Myotis*'. The main bulk of their prey are clearly insects (reviewed for *M. daubentonii* in Vaughan, 1997; *M. dasycneme*: Britton *et al.*, 1997), but from a sensory perspective it is probable that they at least occasionally capture floating dead or jumping fish also in the wild. Small fish might try to capture insects that float on the water surface. If a bat accidentally aims at the same insect, chances are high and time is sufficient to grasp the emerging fish instead of the insect. If European 'trawling *Myotis*' at all capture fish in the wild, successful retrieval from water will probably be restricted to young and small fish of the minute size and weight that we used in our experiments. From an evolutionary perspective, we agree that the big feet and the ability to grasp prey from the water surfaces (Brosset and Delamare Deboutteville, 1966; Dwyer, 1970; Novick and Dale, 1971; Brosset, 1975; Jones and Rayner, 1988) and also the search image of 'trawling *Myotis*' (B. M. Siemers, P. Stilz, H.-U. Schnitzler, unpublished data) might be regarded as preadaptations that can favour the evolution of piscivory in bats, much like in a scenario proposed for the partly piscivorous *Noctilio leporinus* and the insectivorous *N. albiventris* (Schnitzler *et al.*, 1994; Kalko *et al.*, 1998). In this study we showed that, owing to these preadaptations and given certain circumstances, *M. daubentonii* is able to catch small fish. The presence and possible extent of piscivory in wild *M. daubentonii* populations of our days, however, remains enigmatic.

#### ACKNOWLEDGEMENTS

We thank Dr. Ralf Britz for advice with the

alizarin staining, and two anonymous referees for valuable comments on the manuscript.

#### LITERATURE CITED

- BRITTON, A. R. C., and G. JONES. 1999. Echolocation behaviour and prey-capture success in foraging bats: laboratory and field experiments on *Myotis daubentonii*. *Journal of Experimental Biology*, 202: 1793–1801.
- BRITTON, A. R. C., G. JONES, J. M. V. RAYNER, A. M. BOONMAN, and B. VERBOOM. 1997. Flight performance, echolocation and foraging behaviour in pond bats, *Myotis dasycneme* (Chiroptera: Vespertilionidae). *Journal of Zoology (London)*, 241: 503–522.
- BROSSET, A. 1975. Le régime alimentaire de *Myotis daubentoni*. *Commentaires sur l'observation de J. F. Terrasse. Mammalia*, 39: 148.
- BROSSET, A., and C. DELAMARE DEBOUTTEVILLE. 1966. Le régime alimentaire du vespertilion de Daubenton *Myotis daubentoni*. *Mammalia*, 30: 247–251.
- DWYER, P. D. 1970. Foraging behavior of the Australian large-footed *Myotis* (Chiroptera). *Mammalia*, 34: 76–80.
- JONES, G., and J. M. V. RAYNER. 1988. Flight performance, foraging tactics and echolocation in free-living Daubenton's bats *Myotis daubentoni* (Chiroptera: Vespertilionidae). *Journal of Zoology (London)*, 215: 113–132.
- KALKO, E. K. V., and H.-U. SCHNITZLER. 1989. The echolocation and hunting behavior of Daubenton's bat, *Myotis daubentoni*. *Behavioral Ecology and Sociobiology*, 24: 225–238.
- KALKO, E. K. V., H.-U. SCHNITZLER, I. KAIPF, and A. D. GRINNELL. 1998. Echolocation and foraging behavior of the lesser bulldog bat, *Noctilio albiventris*: preadaptations for piscivory? *Behavioral Ecology and Sociobiology*, 42: 305–319.
- LIMPENS, H., K. MOSTERT, and W. BONGERS (eds.). 1997. Atlas van de Nederlandse vleermuizen. KNNV Uitgeverij, Utrecht, 260 pp.
- NOVICK, A., and B. A. DALE. 1971. Foraging behavior in fishing bats and their insectivorous relatives. *Journal of Mammalogy*, 52: 817–818.
- SCHNITZLER, H.-U., E. K. V. KALKO, I. KAIPF, and A. D. GRINNELL. 1994. Fishing and echolocation behavior of the greater bulldog bat, *Noctilio leporinus*, in the field. *Behavioral Ecology and Sociobiology*, 35: 327–345.
- TERRASSE, J. F. 1975. Comportement de pêche d'une chauve-souris, probablement un vespertilion

de Daubenton (*Myotis daubentoni* Leisler).  
Mammalia, 39: 147.

VAUGHAN, N. 1997. The diets of British bats (Chiroptera). Mammal Reviews, 27: 77–94.

*Received 9 February 2001, accepted 28 March 2001*