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SHORT COMMUNICATION

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# Bats in Kenyan pit latrines: Non-invasive sampling by photography

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Bats seek out a variety of daytime retreats such as caves, rock crevices and hollow trees, but there are also some that use anthropogenic structures such as buildings, bridges and culverts (Kunz, 1982). Some bats actually prefer buildings compared with 'natural' roosts. Such preferences are found both in temperate and tropical climates (López-Baucells et al., 2017; Michaelsen, 2014).

Bats are known to roost in many types and sizes of buildings, from churches and castles to bird boxes and potato cellars (Rydell et al., 2017; Vintulis & Pētersons, 2014). In Africa, bat colonies are often found under the roof tiles and roofing of houses (López-Baucells et al., 2017), but there are presumably other buildings that are suitable as well. For example, the lower part of pit latrines, the pit, may seem to provide suitable roosts for bats, but this has never been examined, as far as we know.

A pit latrine is a low-cost facility that allows for the safe storage of human waste and contributes to improved household and overall community sanitation. Faeces and urine enter the pit via an opening in the floor and collect in a large, sealed compartment underneath. Pit latrines reduce open defecation and thus minimise the potential transmission of disease (Orner et al., 2018; Strande & Brdjanovic, 2014). Nearly 2 billion people currently use pit latrines, mostly in Africa (Graham & Polizzotto, 2013), but almost half as many (nearly 900 million) still do not have access to a toilet and therefore defecate in the open (UNICEF & WHO, 2017).

Pit latrines are permanent and widespread structures and are expected to increase in abundance, particularly in Africa. They are potentially suitable for bats, because they are warm inside and provide protection from poor weather, disturbance and predation. They typically do not have any permanent lights installed, because this would attract flies and other potential disease carriers and would likely scare away bats. The absence of lights is an undisputed requirement of a functional bat roost (Rydell et al., 2019). A pit latrine can be used by bats that are able to hang free from the ceiling under the pit floor by their feet and take flight by releasing the grip and fall. This is in contrast to bats that prefer to roost in cracks or sit on vertical walls. To fly in the narrow space inside the latrine is, however, a challenge even for a bat. Any bat using a latrine as a roost would need extraordinary flight manoeuvrability and also a low-intensity broadband echolocation system, to avoid self-deafening from multiple echoes and also permit acoustic orientation in the concealed space (Aldridge et al., 1990; Fenton et al., 1995). Such features are the characteristics of the Old-World families Megadermatidae (large-eared bats) and Nycteridae (slit-faced bats) and are also found among several long-eared species of the Vespertilionidae (plain-nosed bats; Anderson & Racey, 1991). Some species of Phyllostomidae (leaf-nosed bats) have similar characteristics, but this family is confined to the New World.

In Kenya, we have observed three bat species using the lower part of pit latrines, the pit, for roosting and breeding. The bats were observed and photographed (see below) as they emerged from the pit to feed in the evening, and in one case, two individuals were captured in mist nets to confirm identification in the hand. The three species, the large-eared slit-faced bat *Nycteris macrotis*, the Egyptian slit-faced bat *Nycteris thebaica* (Nycteridae; Figure 1) and the heart-nosed bat *Cardioderma cor* (Megadermatidae; Figure 2), have exactly the characteristics expected; a wing form that permits extreme flight manoeuvrability and low intensity, broadband echolocation that allows manoeuvres in narrow spaces and detection of prey on surfaces (Aldridge et al., 1990; Kaňuch, et al., 2015). The eyes are different in size in the two species, indicating that the big-eyed *C. cor*, but probably not the small-eyed *Nycteris* spp., may also use vision to complement echolocation during hunting (Bell, 1985; Rydell & Eklöf, 2003). The situation is slightly reminiscent of the European vespertilionids, *Myotis emarginatus* and *M. nattereri*, both of which live in stables and feed on flies *Stomoxys calcitrans* and *Musca autumnalis* attracted to the livestock (Dekker et al., 2013; Kervyn et al., 2012; Siemers et al., 1999).

  

Our records were just occasional observations. We did not attempt a systematic search of toilets for bats. The roosts were encountered more or less by chance while we surveyed for other bats, as we were approached by people telling us that they had bats in their toilets. Our records are so far mostly from the relatively dry habitats of coastal and eastern Kenya, but we have one observation also in the more humid south-western part of the country (Table 1).

**FIGURE 1** Lactating slit-faced bat *Nycteris thebaica* returning to the roost in a pit latrine after feeding. Sokoke-Arabuko, Kilifi County, Kenya. Photograph J. Rydell 2014 with owner´s permission

**FIGURE 2** Female heart-nosed bat *Cardioderma cor* carrying a baby and another individual of the same species in a disused pit latrine in Nuu, Kitui County, Kenya. Photograph J. Rydell 2017 with owner´s permission

Following Rydell and Russo (2014), we used a non-invasive method based on flash photography, with the system triggered by a photoelectric switch with the beam set across the opening to the pit, to identify the bat species and estimate the numbers of bats in the toilets. The camera was used only during emergence exits as the bats left the pit at dusk for foraging and stayed active until we felt the last bat had left the pit. This lasted for approximately one to two hours. There is a need for non-invasive research and survey methods when working with bats, due to the risk of transmitting disease among them. This is realised following the devastating white-nosed syndrome (WNS) and other infectious diseases, most recently the COVID-19 pandemic, and has resulted in a reduction in field studies of bats as well as restrictions on research, involving capture and handling them (Melber et al., 2020). However, in the case of the colony from western Kenya, we captured two individuals in mist nets, as they came up from the pit at dusk, to identify them in the hand. As there are several species of *Nycteris* in that area, there was a clear risk of confusion. The bats were released immediately after identification.

The destruction of important bat roosts in caves, churches, temples and monuments worldwide is increasing in frequency and impact (Umadi et al., 2019). Particularly, the introduction of LED lights has a devastating effect on bats, when applied on or near roosts (Rydell et al., 2017). If our observations are indicative of a real trend, pit latrines are a rare case of the opposite, as it may increase the availability of high-quality roosts for bats.

We did not encounter any negative comments about the bats from the owners of the latrines, and it seems like the bats do not cause any serious inconveniences. Observation and counts of bats in pit latrines are easiest at dusk, when they emerge to forage, or in the morning, when they return to the roost. To see the bats in the daytime is difficult and requires special viewing equipment such as mirrors. They typically hide quietly under the floor in corners of the pit, where they cannot be spotted from above.

The latrines contained cockroaches, mostly American cockroach *Periplaneta americana*, and other insects and sometimes also insect predators such as geckoes *Hemidactylus* spp. It seems

**TABLE 1** Observations of bat colonies in pit latrines in Kenya January-March 2014–2021

| County | Locality | Year | Coordinates | Species | Number of bats | Type of roost |
|---|---|---|---|---|---|---|
| Kwale | Shimba Hills, KWS HQ | 2014 | −4.2152, 39.4513 | *Nycteris thebaica* | 30 | Day roost |
| Kilifi | Arabuko-Sokoke | 2014 | −3.3000, 39.9951 | *Nycteris thebaica* | ca 30+young | Maternity |
| Kitui | Mikuyuni, Mutito | 2020 | −1.2024, 38.1669 | *Nycteris thebaica* | 4 | Day roost |
| Kitui | Mikuyuni, Mutito | 2020 | −1.2042, 38.1688 | *Nycteris thebaica* | 5 | Night roost? |
| Kitui | Mutulu Village | 2020 | −2.1278, 38.1988 | *Nycteris thebaica* | 15 | Day roost |
| Kitui | Nuu Hills | 2017 | −0.9921, 38.3302 | *Cardioderma cor* | ca 10+young | Maternity |
| Siaya | Ukwala Village | 2021 | 0.1954, 34.1893 | *Nycteris macrotis* | ca 15 | Day roost |

likely that the bats take advantage of this food. In other habitats, the diet of *Cardioderma cor* consists of small vertebrates and large insects, including lizards, katydids and beetles, which sometimes are gleaned from the ground (Csada, 1996; Vaughan, 1976). The diet and feeding behaviour of *Nycteris thebaica* and *N. macrotis* are similar in the sense that large insects are sometimes gleaned from surfaces. The diet of *N. thebaica* is known to include cockroaches (Aldridge et al., 1990; Grey et al., 1999; LaVal & LaVal, 1980; Seamark & Bogdanowicz, 2002) and that of *N. macrotis* includes katydids, beetles and termites (Findley & Black, 1983). It seems likely that *C. cor* would also eat cockroaches if the opportunity arises. Cockroaches like katydids emit sounds during courtship, just like the flies mentioned above, and also in defence (Bell et al., 2007). Hence, it seems possible that they may reveal themselves to bats by their sounds. We may speculate that the bats in the toilets provide ecosystem services by feeding on potentially disease-carrying insects, thereby reducing the risk of reinfection in humans (Reiskind & Wund, 2009; Roth & Willis, 1957).

As agriculture, human settlements and urbanisation become more widespread and severe, natural roosts for bats are likely to disappear, especially in the tropics, making alternative roosts critical for the persistence of bats. It, therefore, becomes increasingly important to know what specific habitats or biotic and structural features in habitats are important for maintaining particular bat populations. Pit latrines, where they exist, provide important alternative roost sites for *Cardioderma cor* and Nycterid bats in Kenya. In these roosts, bats typically exit by only one route, the pit. This permits the visual counting directly or via photography of individuals or, potentially, electronic counting by using photoelectric beam splitters or ultrasonic detectors. However, these counts are labour-intensive and must necessarily be confined to known roosts, which can be determined from surveys or via interviewing of members of the public.

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## DATA AVAILABILITY STATEMENT

The data, mainly photographs, that support the findings of this study are available from the corresponding author upon reasonable request.

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