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CORRESPONDENCE

No evidence for hibernation in rockwrens

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We write this because we are concerned about problems with scientific rigor in a paper recently published by McNab and Weston (2020). The paper is based on a limited, poor-quality dataset, lacks statistical analysis, focuses on out-dated literature and makes conclusions that are not related to the data presented.

The title asks whether a passerine bird, the New Zealand rockwren (*Xenicus gilviventris*), can hibernate. This seems reasonable given that these birds are small and largely sedentary, eat invertebrates and live at high elevation, where they apparently can nest in snow banks. However, the Introduction does not provide a coherent rationale for asking this question and, in the Results, there are no data addressing the question. Instead, much of the Introduction is devoted to Woods et al.'s (2019) evidence that an unrelated non-passerine, the common poorwill (*Phalaenoptilus nuttallii*), hibernates, with some discussion of a few passerines that enter shallow torpor. The rationale leading to the main question of the paper is weak and in the Introduction, the text on whether poorwills hibernate is contradictory. The argument in the Introduction that hibernation can only occur under constant cold thermal conditions has been refuted in many recent papers reporting data on free-ranging individuals (Stawski et al., 2014; Woods et al., 2019; Nowack et al., 2020). More alarmingly, though, the data that follow provide no evidence to support the paper's title or conclusions.

One rockwren reduced body temperature (T_b) from a normothermic, resting level of 36.4°C, to a minimum of 33.1°C, a drop of 3.3°C. Dehydrated camels (*Camelus dromedarius*) and other large mammals reduce their T_b more than this (Hetem et al., 2016) and, clearly, they are not hibernators. Based on most thresholds in the literature used to define torpor in endotherms, a drop of only 3.3°C or a minimum T_b of 33.1°C would barely qualify as shallow torpor, let alone provide evidence of hibernation. Hibernating mammals and birds reduce T_b by vastly more than this, often by 35 to 40°C below normothermia to approximately 5°C on average (McKechnie and Lovegrove, 2002; Ruf and Geiser, 2015).

McNab and Weston (2020) report that metabolism in two rockwrens during single measurements was somewhat reduced, ostensibly by 30–35%. The authors note that birds did not settle in the chamber, so this result is unreliable but, in any case, this reduction is not sufficient evidence for hibernation, when hibernators often reduce metabolism by 99% or more. As for T_b, based on the metabolic data reported, there is no evidence that the rockwrens hibernated, and it is questionable whether they even entered torpor. Metabolism and T_b data are shown in Fig. 1, but the figure is uninterpretable. There is no explanation for how 'regression' lines were derived, only three of six individuals are identified and no statistical analysis is described in the paper.

The authors' claim that thermal energetics of rockwrens differ from those of other passerines is also incorrect. In general, passerines seem to be homeothermic or do not express deep torpor, but reductions in resting T_b by 5 to 15°C from approximately 40°C have been commonly reported (e.g. McKechnie and Lovegrove, 2002; Schleucher, 2004). Tits (*Parus* spp.), even though they express shallow torpor, reduce T_b by approximately twice as much (by 5–10°C) as rockwrens. The authors contend that rockwrens spontaneously rewarmed from 33.1 to 36.0°C and, therefore, conclude that the T_b reduction was controlled. However, as clearly shown in Fig. 2, this 'arousal' only occurred after exposure to an ambient temperature of 30.1°C, not the 9.4°C at which minimum T_b was recorded. Given this, it is just as likely that the birds exhibited shallow, uncontrolled hypothermia in response to cold exposure, and rewarming was aided by the rise in ambient temperature.

There are also problems with the methodology and reporting of it. The Materials and Methods state that metabolic rates were recorded for 6 h from 19:00 to 01:00 h and T_b was measured (using a device and procedure never identified) in intervals of 1.5 to 2 h. Therefore, it is of no surprise that birds did not enter torpor as they were prevented from doing so because they were frequently disturbed. Entry into avian torpor can take many hours, almost never occurs within 1–2 h of the start of measurements or after a disturbance, and usually requires a calm, undisturbed animal. The respirometry protocol is also problematic. The authors used 1.5 liter chambers to measure metabolism and the lowest flow rate was 105 ml min^{-1}, meaning that 66 min would be needed to reach 99% equilibrium (Withers, 2001). Thus, oxygen consumption values averaged over only 20 min are not accurate.

Although less serious than problems of methodology and inference, most of the thermal energetics citations are out of date and recent thermal biology studies on free-ranging passerines are missed. For example, Romano et al. (2019) reported that Australian fairy-wrens (*Malurus cyaneus*) reduce skin temperature by approximately 14°C from 41 to 27°C, followed by endogenous rewarming. The one recent study on babblers (*Pomatostomus superciliosus*) that is cited is misreported. Although these birds reduce T_b at night similar to rockwrens, Douglas et al. (2017) emphasize that babblers do not express torpor, but rather use huddling to save energy.

We were motivated to point out the issues with this paper not only to inform non-specialist readers but also as mentors of students whom we are trying to train to be critical of the peer-review process.

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Response to 'No evidence for hibernation in rockwrens'

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The recently published results from our experimental study describing the thermal flexibility of the rockwren (*Xenicus gilviventris*), combined with the unique alpine ecology of this species, led us to raise the question, as the title of our article clearly indicates, 'Does the New Zealand rockwren (*Xenicus gilviventris*) hibernate?'.

The study of the rockwren is of special importance. This species combines having a small mass and largely insectivorous diet with living above the climatic timberline in the mountains of the South Island of New Zealand year-round. The response of this species to the challenging alpine conditions is of great interest. Within the Introduction of our article (McNab and Weston, 2020), we critically define the difference between a period of short-term torpor and hibernation. Although caprimulgids exhibit a range in observed torpor period lengths, there is no clear evidence that one of them, the common poorwill (*Phalaenoptilus nuttalli*), goes into hibernation. We introduce the characteristics of the rockwrens' alpine ecology, which provides the rationale for the hypothesis of a unique thermal behavior in this species.

As Geiser et al. (2020) state, our results are based on a limited data set of six individuals. We showed that this species enters shallow torpor at ambient temperatures well above those encountered in their natural environment. We were not able to demonstrate the length of the period of torpor, which is required to separate short-term torpor from hibernation along a temperature continuum. For that to be demonstrated, it must be done in the field. We do not claim to have answered the question within our study whether rockwrens hibernate; rather, we state that 'evidence of an extended period of torpor is required to conclude that the rockwren hibernates…' (p. 4, McNab and Weston, 2020). We do, however, leave the reader with the enduring question of whether it may be possible that this unique alpine passerine species hibernates. This should encourage further research on the species. Geiser et al. (2020) also agree this question 'seems reasonable, given that these birds are small and largely sedentary, eat invertebrates and live at high altitudes, where they apparently can nest in snowbanks'.

Unfortunately, some misunderstandings of our article were present in the analysis of Geiser et al. (2020). The statement that the birds 'did not settle in the chamber' is incorrect: this occurred only in one individual (p. 3, McNab and Weston, 2020). The limited amount of data that we have reflects the highly endangered status of the New Zealand rockwren and the necessary restrictions around the time that individuals were held in captivity. With such a limited sample size, the application of robust statistical testing becomes irrelevant and therefore we have simply presented a summary of the raw data, always providing the variance around the data. We did not address torpor in other passerines because we were concerned with rockwrens; none of the other passerines face similar conditions. We could not expose the rockwrens to low ambient temperatures – they were neither available nor permissible for this study.

We are aware that the occurrence of hibernation in this species remains an open question, and believe if anything, that this study stands to demonstrate to students the difficulties of working with highly endangered species in remote mountainous locations. Above all, we hope that this study and the limitations that it presents motivate further research into determining the over-wintering strategy of this rare and unique alpine passerine.

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