Yuan et al. (1) sequenced the genomes of 17 marine mammals, providing an excellent basis to further elucidate mammalian aquatic evolution. Surprisingly, in their examination of the previously published Antarctic fur seal (Arctocephalus gazella) genome (2), Yuan et al. report the pseudogenization of uncoupling protein 1 (UCP1), the key driver of brown adipose tissue (BAT)-mediated nonshivering thermogenesis (NST) (3), concluding that this underscores the strategic importance of prioritizing insulation rather than heat production in aquatic marine mammals. Notably, the Antarctic fur seal is the most polar pinniped species examined in the dataset and, hence, most expected to rely on UCP1-mediated NST during cold exposure, all other factors set aside (allometry, insulation, etc.). Therefore, we aimed to verify this UCP1 pseudogenization by comprehensively examining the raw Sequence Read Archive (SRA) data of the Antarctic fur seal.

We contest that, while the assembled Antarctic fur seal genome does display seeming mutations in UCP1 exons 1 and 6 (Accession: UIRR01000066.1), these are not supported by SRA data. We retrieved 170 sequence reads from the SRA database (Accession: SRX1338453–SRX1338509) spanning these sites of contention, all of which reveal that the
Antarctic fur seal retains an intact highly conserved UCP1 locus (Fig. 1). The raw data strongly suggest genome misassemblies rather than authentic sites of inactivation. Thus, the intact Antarctic fur seal UCP1 remains under strong selective pressures likely due to the cold ecological niche exploited by the species.

Instead, we highlight that, if at all, the only pinnipeds exhibiting potential UCP1 pseudogenes are the northern and southern elephant seals (Mirounga angustirostris and Mirounga leonina, respectively), which have, unfortunately, not been examined by Yuan et al. (1). Both species share a frameshift deletion in exon 1 that may produce a nonsensical messenger RNA or at least a truncated open reading frame, and a unique 6-bp in-frame deletion in exon 3 (Fig. 2). Interestingly, elephant seals are the largest extant pinnipeds and carnivores, with males reaching up to ∼3,500 kg (despite massive body size sexual dimorphism) (4). Southern elephant seal pups are ∼38 kg at birth and, remarkably, gain over 3 kg/d before weaning at ∼22 d and ∼120 kg (5). Thus, we posit that UCP1 pseudogenization in pinnipeds is not linked to aquatic life but to the evolution of large body size.

While we generally agree with the conclusion that insulation rather than UCP1-mediated NST is prioritized in aquatic marine mammals given the high thermal conductivity of water (∼24.1 times higher than air) (6), we assert that only fully aquatic mammals (cetaceans and sirenians) support this conclusion. Indeed, several pinnipeds are known to display both BAT and UCP1 as neonates (7), presumably the most critical life stage for supplemental heat production. The overwhelming retention and conservation of UCP1 in this lineage of semiaquatic mammals, including the Antarctic fur seal, is instead an indicator of the importance of NST when birthing and rearing young on land, while UCP1 inactivation in elephant seals is linked to body size, as suggested previously for other terrestrial mammals (6, 8).

Acknowledgments
The M.J. laboratory is supported by the Ascending Investigator Grant of the Novo Nordisk Foundation (Grant 0059646), and was partially supported by the Swedish Research Council (Grant 2018-03472).

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Fig. 2. Alignment of the northern elephant seal (M. angustirostris; Accession: PITE01002540.1) and southern elephant seal (M. leonina; Accession: JAAMPH010000052.1) potential UCP1 pseudogenes displaying an early frameshift mutation (red) in exon 1 following the ATG start site (green) (A) and a 6-bp in-frame deletion in exon 3 (purple) (B) in comparison to the intact loci of the Hawaiian monk seal (Neomonachus schaaislandii; Accession: NINY01007775.1) and Weddell seal (Leptonychotes weddellii; Accession: APMU01141180.1 and APMU01115166.1) The consensus amino acid virtual translation is shown above the nucleotide alignment. (C) Phylogeny of pinnipeds (based on refs. 1 and 9), with adult male and female body weights (4). Lineages with black branches indicate intact UCP1, while red branches of the elephant seals denote apparent UCP1 pseudogenes.