Heart rate of disturbed penguins

SIR — It is important to measure the degree to which breeding birds in Antarctica are disturbed by human intervention, both for Antarctic Treaty legislators concerned with the regulation of tourism and other human activities[1], and for researchers concerned to minimize the adverse effects of their studies[2].

Culik and Wilson[3] have suggested that a 10–20% decrease in populations of Adélie penguins *Pygoscelis adeliae* and chinstrap penguins *P. antarctica* at Admiralty Bay, King George Island, South Shetland Islands, ascribed by Trivelpiece[4] to overfishing of krill, may be attributed to human disturbance alone. Monitoring behaviour and heart rate[5,6] (the latter regarded as "a good indicator of stress"[3]) at a colony close to a busy research station, Culik and Wilson reported that breeding penguins showed dramatic avoidance reactions to pedestrians and aircraft, and that an approach by only one human caused substantial increases in heart rate when no stress was manifest externally[6].

We do not know which interpretation of the decrease in the Admiralty Bay colonies is more correct, because penguin breeding numbers in colonies fluctuate according to climate and ecosystem-related factors but can also be influenced by aircraft operations and other human activities[7,8]. But we do question the conclusion[3] that ". . . tourism does adversely affect breeding penguins, almost irrespective of how 'well-behaved' the tourists are".

Culik and Wilson removed ten Adélie penguins from their nests, and fitted them either with external ECG devices, or surgically implanted heart-rate transmitters. However carefully and humanely undertaken, such procedures are likely to induce associative learning and predispose birds to extreme reaction on subsequent sighting of humans — the heart rate of one penguin studied increased at the sight of a human 30 m away[5].

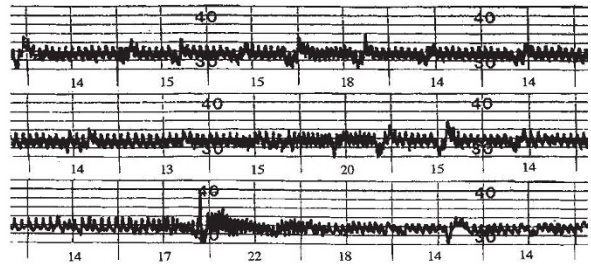
As most tourists and scientists visit colonies on foot, we are investigating responses of incubating penguins to walking visitors, using an artificial egg containing an infrared heartbeat sensor placed in a normally incubated nest[9]. Placement takes on average 2.5 min: the incubating bird is neither removed nor restrained, but is identified with a paint mark applied with a long-handled brush. The nesting pair thereafter includes one marked bird subjected to this mild procedure, and an unmarked partner unaffected by it. Heart rate is transmitted by cable to a hide 50–100 m from the nests, where it is recorded continuously. It is well known that attaching devices to animals can affect their natural behaviour: our technique avoids all such attachments and effects on behaviour should be minimal.

The experimental protocol is for a 'visitor' (modelling the behaviour of a well-briefed scientist or tourist) to appear at a distance of 15–20 m and approach the incubating penguin to a distance of 3 m from the nest, pausing at 5-m intervals and taking approximately 3 min overall. The observer then sits quietly for 5 min and finally stands and withdraws.

From a mean rate of 83.8 (± 7.5) beats per minute (b.p.m.) before the appearance of the visitor (see table), heart rates vary during the approach, in some cases increasing rapidly for spells of about 10 s (in one extreme instance to 132 b.p.m. for 10 s), then reverting to the non-disturbed rate (see figure). Rates varied more when the visitor was close (for example at 3 m) than when distant or absent, but mean rate during the approach and observation (84.3 ± 8.6 b.p.m.) did not differ significantly from mean non-disturbed rate ($t = -0.41$, d.f. = 12, $P = 0.692$). Initial results from other kinds of approaches to the same birds indicate, for example, that heart rates increased by 45–110% when they were approached rapidly up to 1 m from the nest, and remained as high while the visitor continued standing above the nest.

Although these results were obtained from only one of the four penguin species breeding on the Antarctic Peninsula, we believe that the great difference between our findings and those obtained from Adélie penguins can be explained by the use of our new unstressful, non-obtrusive technique.

Heart-rate changes do not reflect all potential detrimental effects of human visitors on penguins, nor do increases necessarily represent detrimental effects. Increases seen in laboratory animals in situations described as stressful are also seen in response to any change in their surroundings, such as the delivery of food[10]. However, they do indicate changes in an animal's awareness or alertness to its surroundings when overt behaviour does not change.



Three traces of penguin heart rate showing rapid increase during approach by a human, followed by quick recovery of former rates. Each column (1 cm wide on the original trace) represents 5 s. Figures below each trace give number of beats per 10-s period: average rate per period was derived by multiplying the number of beats by six.

We conclude that the reactions of nesting penguins to visiting humans depend on the visitors' behaviour, and the presence of a well-behaved visitor changes, only momentarily if at all, the awareness of a penguin with no prior, adverse experience of humans. Thus, efforts by tour operators, Antarctic Treaty authorities and others to encourage non-disruptive behaviour in visitors are not misplaced.

Amanda J. Nimon
Robert C. Schroter*
Bernard Stonehouse
Scott Polar Research Institute,
University of Cambridge,
Lensfield Road,
Cambridge CB2 1ER, UK
**Centre for Biological and Medical Technology and Medicine,*
Exhibition Road,
London SW7 2AZ, UK

MEAN PENGUIN HEART RATE IN ABSENCE AND PRESENCE OF HUMANS

Bird	Absent	Max.	Present	Max.
1*	91.3	114	91.7	96
2*	88.4	108	90.6	108
3*	89.2	105	91.8	103
4*	73.3	78	72.7	96
5*	84.1	96	89.4	132
6	82.4	108	78.5	84
7	82.6	90	79.9	90
8	81.6	96	80.4	90
9	85.1	102	82.3	96
10	88.1	96	89.6	108
11	83.3	96	87.2	120
12	83.6	102	83.5	90
13	74.0	90	73.6	84

Marked penguins (present during egg placement) are identified by an asterisk. Also shown are maximum rates measured in a 10-s period. Rates are in beats per minute.

1. *Protocol on Environmental Protection to the Antarctic Treaty* Cmd 1960 (HMSO, London, 1992).
2. Fraser, W. R. *Report on Workshop on Researcher-Seabird Interactions* (National Science Foundation, Washington DC, 1994).
3. Culik, B. & Wilson, R. *Nature* **351**, 340 (1991).
4. Anderson, C. *Nature* **350**, 294 (1991).
5. Culik, B., Adelung, D. & Woakes, A. J. in *Antarctic Ecosystems: Ecological Change and Conservation* (eds Kerry, K.R. & Hempel, G.) 177–182 (Springer, Berlin, 1990).
6. Wilson, R. P. *et. al. Polar Biol.* **11**, 363–370 (1991).
7. Fraser, W. R., Trivelpiece, W. Z., Ainley, D. G. & Trivelpiece, S. G. *Polar Biol.* **11**, 525–531 (1992).
8. *Antarctic Ecosystems: Ecological Change and Conservation* (eds Kerry, K. R. & Hempel, G.) 183–190 (Springer, Berlin, 1990).
9. Nimon, A. J., Oxenham, R. K. C., Schroter, R. C. & Stonehouse, B. *J. Physiol., Lond.* **481**, 57–58P (1994).
10. Jones, R. B., Duncan, I. J. H. & Hughes, B. O. *Behav. Processes* **6**, 121–134 (1981).