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CAPTURING HUMBOLDT PENGUINS *SPHENISCUS HUMBOLDTI* WITH THE USE OF AN ANAESTHETIC

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With the development of new technologies such as satellite transmitters (Davis & Miller 1992), data-loggers (Wilson *et al.* 1993) and radio-telemetry (Heath & Randall 1989), the capture of live specimens prior to the attachment of such equipment plays a very important role. It has been shown that the attachment of any device may have a deleterious effect on the normal behaviour of wild birds (Wilson & Culik 1992), but this may be at least partially due to the capture techniques employed.

The most widely used techniques for catching birds (such as mist nets, cannon nets, cages, traps or catching by hand) have shown to be viable, but unfortunately have a strong stress component which is further exacerbated by human presence and manipulation. For example, Culik & Wilson (1991) established that the cardiac frequencies in nesting Adélie Penguins *Pygoscelis adeliae* increased due to human approach alone.

Recently, we started ecophysiological studies on the Humboldt Penguin *Spheniscus humboldti* at sea. For that purpose we employ data-loggers that are able to record information on swimming speed, foraging range and dive depth. Before using these instruments we carried out an experiment with four adult Humboldt Penguins to which dummy instruments were attached in order to assess: 1) responses of the penguins to Ketamine hydrochloride; 2) the best dose of Ketamine hydrochloride for Humboldt Penguins; and 3) responses of the penguins to capture, manipulation, and attachment of the dummy instruments. Following this, we began our study with authentic instruments. In all cases we registered the dose of the anaesthetic and the symptoms associated with it. In this contribution we report the methods used to inject the anaesthetic and the responses of the penguins.

We built a simple injection-device made of a 1.1-m-long aluminium holder painted black with a rectangular cross section (1×1 cm) and one of its sides open. We inserted a syringe (1 ml with needle 16-mm long × 0.05-mm external diameter) at one end of this holder. In order to hold the syringe and its needle, we made a transverse cut in order to obtain a 2.5-mm channel in the walls of the holder 8 cm from the end. At the end of the holder we attached a rigid plastic cylinder (1-cm length), through which we introduced the needle. To press the piston of the syringe we used a rod (0.75-cm diameter) with the same length of the aluminium holder, that was slid inside the holder (Fig. 1).

We tested the system and doses of tranquilizer on breeding adult Humboldt Penguins at Pan de Azúcar Island (26°09'S), northern Chile, between 12–14 December 1993 and 25 January 1994 with dummies and real instruments. Between 10 and 26 November 1995 we fitted authentic instruments (Table 2). We used doses of 2–7.5 mg/kg BM (penguin body mass) of Ketamine hydrochloride (100 mg/ml) (Ketavet, Parke-Davis GmbH, Berlin-Germany). Prior to injection of the anaesthetic, the system was assembled out of view of the penguins. We loaded the syringe with the requisite dose and inserted it into the aluminium holder. The operator then approached the nest slowly. When he was in front of the adults, *c.* 1 m away, he slid the system along the ground until it reached the nest, while at the same time distracting the attention of the adult, with a hand moving in the opposite direction. Once the holder with the needle was close to the penguin's chest, the operator pushed the holder firmly, introducing the needle into the pectoralis muscle. After needle penetration, the rod was pressed gently until the full dose was evacuated from the syringe. In order to avoid infection and disease transmission we used disposable syringes and needles.

The data-logger dummies were made of the same material as the authentic loggers, with the same hydrodynamic and mass characteristics. For more detailed information see Culik *et al.* (1994). Authentic devices and dummies were attached to the backs of penguins using methods described by Wilson & Wilson (1989a).

We obtained the best results with doses of 5 mg/kg BM (n=22, which includes cases where equipped penguins were injected a second time to recover the devices or dummies). With this dose, the animals did not fall asleep and the fleeing response was reduced. In all cases in which we used doses equal to 5 mg/kg BM, a sedative effect was observed after 5–10 min, with total recovery after 40–45 min. With doses greater than 5 mg/kg BM, the penguins salivated, showed muscular rigidity and had some difficulty maintaining body position, and recovery time took 50–60 min. With doses of 7.5 mg/kg BM total recovery was achieved after 60–70 min. With doses less than 5 mg/kg BM, the birds reacted very strongly to our manipulation and attachment of the dummy-instruments to their back (Table 1). In a preliminary study, two birds were injected with 1.5 mg/kg BM Ketavet. After attachment of the dummy instrument, the birds were returned to the nest site. However, they subsequently abandoned the nest and the dummy instruments could not be recovered.

After sedation of the penguin, we removed it from its nest, and installed the dummy or the data-logger. The animal was relaxed, which allowed us to work quickly and safely. The time needed for the entire manipulation varied between 10 and 15 minutes. The animals were kept in the shade for the complete time they were off their nests. After installation of the units, the animals were put back onto their nests. There, they did not attempt to escape or leave their chicks, and we did not observed aggressive behaviour directed to us. None of the animals was observed to vomit. All the penguins stayed for 1–2 days on the nest after being fitted with devices, and subsequently returned

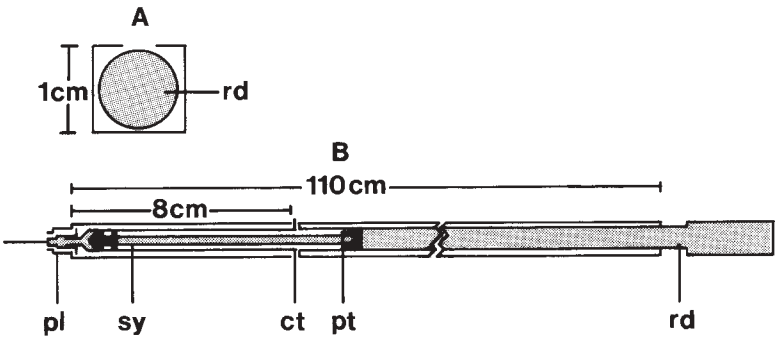

Fig. 1. **A** *Cross section of the aluminium holder.* **B** *Sketch of the system used to anaesthetize penguins: pl = plastic cylinder; sy = syringe: ct = transverse cut; pt = piston of syringe; rd = rod.*

to the nest after 12–24 hours at sea (Table 2). This behaviour is typical of Humboldt Penguins (Wilson & Wilson 1990).

According to our results, Ketavet acted as an effective tranquilizer, and with the exception of the one nest that was abandoned, the birds behaved normally subsequent to their handling. It remains to be proven whether birds calmed by Ketavet and equipped with external devices display a reduced stress response to handling and have a better breeding outcome than non-tranquilized birds used in similar investigations, but this seems likely. The dose considered optimal for Humboldt Penguin (5 mg/kg BM) coincides with the results obtained by Wilson & Wilson (1989b) on the African or Jackass Penguin *S. demersus* and other seabirds.

The determination of a dose that does not produce anaesthesia is important because if the adults are unconscious their chicks might be defenceless to predators and to environmental factors, such as high temperatures and high radiation. This is especially critical when the chicks are still unable to thermoregulate. During this phase, the chicks depend completely on the parents' protection (Montevecchi & Vaughan 1989). However, this is specially relevant to surface-nesting more than to burrow-nesting species. Another reason why anaesthesia should be avoided is that small chicks could be suffocated by the adult. In addition, unconscious birds may suffer from vomiting and increased body temperature (Hector 1984). In agreement with Wilson & Wilson (1989b), we recommend research to test study animals by initially administering small doses of sedative and then gradually increasing the dose. In the event that Ketavet proves unacceptable, other sedatives, such as alphaxalone and aldaphalone, have been shown to allow excellent recovery (Hector 1984).

The use of the methodology described here has advantages over other capture methods. These advantages and their modification according to species would be useful in the capture of birds for morphometric studies, studies of moult, banding and for the installation of telemetric systems. Furthermore, the technique described seems to have particular application for burrow-nesting seabirds, which may not be easily accessible without potentially breaking eggs or disturbing chicks. Intramuscular injection of the sedative does not seem to affect the birds' behaviour, although more studies are necessary to determine the effects of sedatives on physiological parameters. Although a third of the injected penguins left their nests for a period of some hours, in only one case was the nest abandoned (Table 2). Subsequent visits to the study area showed that chicks from all the other manipulated nests fledged. The major advantages of the system described here are low cost and ease of assembly and handling of the system. The total cost of the system is not more than US$ 5 and only 2–3 hours are necessary to build it.

Wilson & Wilson (1989b) proposed a more complex and expensive system with an electric motor and a remote control. These units allow a sedative to be injected by an observer up to 500 m away from the nest, reducing disturbance even further. This has been shown ideal for birds that are very sensitive to human presence and depart before workers can approach close enough to operate our system. However, the remote control system must be previously placed close to the nest and it is necessary to wait until the bird is in the right position to be injected. This system would be difficult to implement on Humboldt Penguins because normally their nests are excavated in the ground or are in cavities between large rocks. These conditions are, however, ideal for the use of our system because the topography reduces the possibility that the parents will escape when someone approaches the nest to inject the sedative. In our method the operator does not need to be near the nest more than once. After injecting the sedative the investigator can wait, at an appropriate distance, for the appearance of symptoms.

The use of a stress-minimizing system for the capture of wild animals is an important issue. Capture and manipulation can

TABLE 1

SYMPTOMS ASSOCIATED WITH DIFFERENT DOSES OF KETAMINE HYDROCHLORIDE IN BREEDING HUMBOLDT PENGUINS *SPHENISCUS HUMBOLDTI*

Doses tested (mg/kg BM)	n	Symptoms	Recovery time (minutes)
2–3	4	No sedative effects were observed. Birds remained tense and alert and engaged actively in nest defence.	–
4	4	First symptoms of sedation appeared after 3–4 min. Birds appeared to have some difficulty maintaining head position.	30–40
5	22	As above, but birds remained in relaxed state. No signs of aggression.	40–45
7.5	3	Salivation, muscular rigidity. Birds appeared to have some difficulty maintaining body position. One bird became unconscious.	50–60

TABLE 2

THE TYPE OF DEVICES ATTACHED TO PENGUINS, THE DATE OF ATTACHMENT, THE DATE OF RECOVERY, THE DURATION OF THE FIRST FORAGING TRIP AFTER THE INJECTION AND THE EFFECTS OF MANIPULATION ON BREEDING SUCCESS OF BREEDING HUMBOLDT PENGUIN *SPHENISCUS HUMBOLDTI* AT PAN DE AZUCAR ISLAND, NORTHERN CHILE

Device	Date of attachment	Date of recovery	Duration of foraging trip (h)	Effect on breeding success
Dummy 1	12 Dec 1993	14 Dec 1994	10	N.A.
Dummy 2	12 Dec 1993	14 Dec 1994	10	N.A.
Dummy 3	12 Dec 1993	N.R.	?	T.A.; C.S.
Dummy 4	12 Dec 1993	N.R.	?	T.A.; C.S.
DKLOG 100	25 Jan 1994	N.R.	?	T.A.; C.S.
MK6 N. 5	10 Nov 1994	13 Nov 1994	8.15	N.A.
MK6 N. 2	10 Nov 1994	14 Dec 1994	8	N.A.
MK6 N. 3	10 Nov 1994	13 Nov 1994	8.15	N.A.
MK6 N. 4	19 Nov 1994	22 Nov 1994	13.9	N.A.
MK6 N. 1	19 Nov 1994	N.R.	?	A.; C.N.S.
MK6 N. 6	19 Nov 1994	26 Nov 1994	12.8	N.A.
MK6 N. 3	22 Nov 1994	N.R.	?	T.A.; C.S.
MK6 N. 2	22 Nov 1994	26 Nov 1994	14	N.A.
VHF N. 1	10 Nov 1994	N.I.	10.5	N.A.
VHF N. 2	10 Nov 1994	N.I.	10.5	N.A.
VHF N. 3	19 Nov 1994	N.I.	8	N.A.
VHF N. 4	22 Nov 1994	N.I.	6	N.A.
PTT N. 1	10 Nov 1994	N.I.	10.5	N.A.
PTT N. 2	10 Nov 1994	N.I.	9	N.A.

A. = Birds abandoned nest. **N.A.** = Birds did not abandon nest. **T.A.** = Birds temporarily absent. **C.S.** = Chicks or eggs survived. **C.N.S**. = Chicks or eggs did not survive. **N.R.** = Devices not recovered. **N.I.** = No attempt made to recover unit. **MK6** = Time-depth recorder from Wildlife Telemetry, USA. **VHF** = Very high frequency transmitter from Telonics, USA. **PTT** = Satellite transmitter from Telonics, USA. **DKLOG100** = Time-depth recorder from Driesen & Kern, Germany.

induce high levels of stress, which can be increased when birds are nesting, because the parents put extra effort into defending eggs or chicks (Wilson *et al.* 1991). Several studies of wild birds where loggers were used (Grémillet & Plös 1994) or where birds have been manipulated to study growth rates (Guerra *et al*. 1988) or ontogeny of thermoregulation (Montevecchi & Vaughan 1989) have required that birds be captured on the nest. Unfortunately, such studies do not give any information on the negative effects produced by the capture, manipulation and disturbance in the breeding colony. If the parents do not abandon the colony at the moment of disturbance, they might do so later. There is also a possibility that the adults will not return to the same nest site the following year. Although these factors may not significantly affect survivorship and juvenile recruitment in a population without conservation problems, they may have a significant impact on population size in an endangered species, such as the Humboldt Penguin (CONAF 1988, Guerra *et al.* 1986).

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