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# DIY your captures when everything else fails: Description of an artisanal dart launcher with an assessment of the medium-term response in a primate

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## Abstract

When our dart guns failed in Morocco, we devised an artisanal pressurised air launcher to replace them. The effective shooting range was between 12 and 20m, which made it possible to capture wild Barbary macaques (*Macaca sylvanus*), from groups that would not allow for a closer approach or enter any trap. To assess the effect of that method of capture, we monitored the groups on foot before and after the captures. We looked for evidence of a change in risk perception after the captures. We did not uncover any such evidence in the step lengths, turning angles, home range area, frequency of rest while on the ground or frequency of social interactions. We conclude that for the study animals, being captured with our artisanal dart launcher, had a similar effect to being darted with a professional gun, and we intend this note as an inspiration to other field operators finding themselves in a similar predicament.

## KEYWORDS

behaviour sampling, capture technique, dart launcher, field study, *Macaca*, risk perception

## Résumé

Lorsque nos pistolets à fléchettes sont tombés en panne au Maroc, nous avons conçu un lanceur artisanal à air comprimé pour les remplacer. La distance de tir effective était comprise entre 12 et 20 m, ce qui a permis de capturer des macaques de Barbarie (*Macaca sylvanus*) sauvages, issus de groupes qui ne permettaient pas de s'approcher plus près ou ne tombaient dans aucun piège. Pour évaluer l'effet de cette méthode de capture, nous avons suivi les groupes à pied avant et après les captures. Nous avons cherché des preuves d'un changement dans la perception des risques après les captures. Nous n'avons trouvé aucune preuve de ce type dans les longueurs de pas, les angles de rotation, la zone du domaine vital, la fréquence de repos au sol ou la fréquence des interactions sociales. Nous concluons que pour les animaux étudiés, le fait d'être capturé avec notre lanceur de fléchettes artisanal a eu un effet similaire à celui d'être transpercé avec un fusil professionnel, et nous voulons que cette note soit une source d'inspiration pour d'autres opérateurs de terrain se trouvant dans une situation similaire.

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## 1 | INTRODUCTION

Geotracking and biologging have become major tools in ecology and conservation (Kays et al., 2015) but each new capture still represents a significant challenge. Sophisticated dart guns are now available when animals need to be anaesthetised before capture rather than captured before anaesthesia, but these guns require specific spare parts such as pressurised gas cartridges and washers. Clearing these spare parts through customs in a timely manner can be a challenge. Faced with such a situation in Morocco, we resorted to building an artisanal pressurised air launcher.

In this note, we first described the build and the supplies we sourced from local retail shops. Then, we assessed the medium-term effect of this unusual method of capture in Barbary macaques (*Macaca sylvanus*). We used before-and-after data collected from habituated groups as part of an ongoing study into the increased reliance of the macaques on anthropogenic food sources and the conflicts that arise with local stakeholders.

If the macaques' risk perception and foraging ecology had changed in response to the captures (Nowak et al., 2016), we expected a drop in social interactions, in the time spent resting when on the ground and concomitant changes in step lengths, home range size, proportion of time spent moving, searching for food and processing it.

## 2 | MATERIALS AND METHODS

### 2.1 | Study site and species

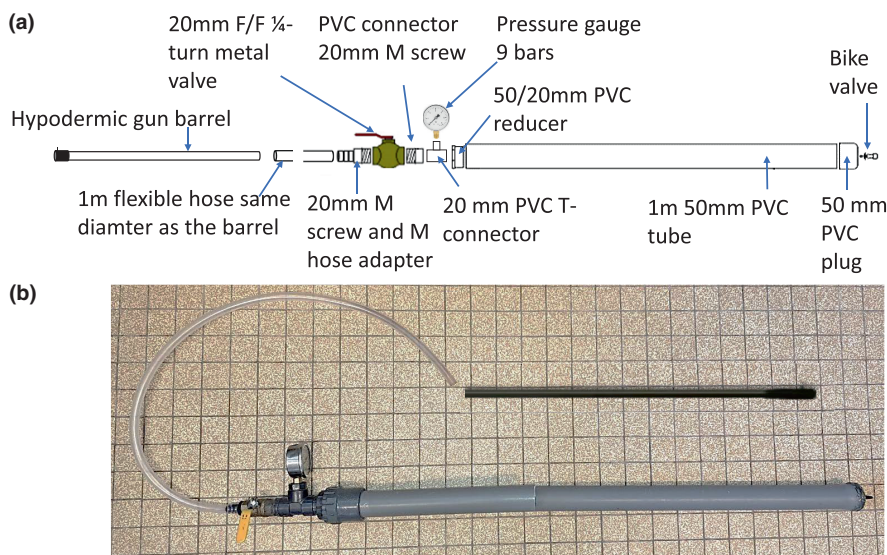
We worked in and around Ifrane National Park, near the town of Azrou, Morocco, in open, sheep-grazed forest of Atlantic cedar (*Cedrus atlantica*) and live oak (*Qercus ilex*), plus the adjacent small-holder commercial orchards (cherry and walnut) and large clearings that featured hawthorn (*Crataegus laciniata*) pollards.

As part of the aforementioned study, we captured adult male macaques to fit them with collar-mounted 245-g GPS/VHF/accelerometer devices (Litetrack Iridium 150 Loteck® with drop-off system). Barbary macaques live in polygynandrous multi-male multi-female groups with male-biased dispersal. They forage for mostly plant material and arthropods on the forest floor and in trees (Ménard & Qarro, 1999). They are relatively tolerant of human presence but their fleeing distance when encountering unfamiliar or threatening humans or dogs in Ifrane National Park has been reported to be up to 20m (Waterman, 2016), which in our case prevented the use of blowpipes. They are also neophobic towards trapping devices and unfamiliar bait (unpublished data).

### 2.2 | Build

We obtained all the supplies from local shops that cater to the agricultural/irrigation sector. All the elements were graded for 6-bar water pressure and all PVC connections were sealed with high-pressure glue. The central piece of the dart launcher (Figure 1) consisted of a 1-m section of 50mm PVC tube. At one end of the tube, we connected a 20mm female/female ¼ turn metal valve, using 50/20mm PVC reducers. This valve functioned as the trigger. At the other end of the tube, we mounted the valve of a bicycle tyre into a 50mm threaded PVC cap and cast the mount in epoxy glue. This valve allowed us to adapt a standard bicycle pump to increase the air pressure. Between the tube and the metal valve, we also installed a bypass-mounted 9-bar pressure gauge, making it possible to monitor the air pressure at all times. At the exit of the metal valve, we adapted a flexible hose of the same inner diameter as the external diameter of the barrel of the faulty gun (Figure 1). The whole build cost less than 35€. Lastly, we used a handheld rangefinder to measure the distance to the targets.

One of the weaknesses of this DIY build was that the final product required two people to operate it: one aiming and one triggering. The advantage was that it was possible to maintain a precise aim



**FIGURE 1** The build of the DIY dart launcher (a) schematics and (b) picture. In the picture, the PVC tube was cut in half.

while pulling the trigger, which would have been challenging in a one-person setup. We noted that the air pressure tended to drop over a few hours, which we attributed to the epoxy glue (either porous/unsuited for high air pressure applications, subject to cracks or bubbles, or maybe requiring a longer time to cure than we could afford). We used Telinject © (France) 3 mL, 11-mm-diameter syringes combined with 1.5-mm-diameter, 20-mm-long needles. We filled these darts with 1.8 mL of a solution of 100 mg/mL ketamine and 20 mg/mL xylazine, prepared in advance and stored at 4°C for less than 48 h.

### 2.3 | Assessing the medium-term effect of the captures

Two of the study groups (groups A and B hereafter) had been habituated and were monitored on foot both before and after the captures, as part of the ongoing study. Group A was composed of 9 adults (>4-year-old), 1 sub-adult (3- to 4-year-old), 2 juveniles (1- to 2-year-old) and 1 infant (<1-year-old). Group B was composed of 11 adults, three sub-adults, six juveniles and five infants.

The observers (mostly E.M. and C.T.) recorded the estimated group centroid position using a hand-held GPS every 30 min. We also performed instantaneous scans of the activity of the groups every 15 min, consisting of categorising the behaviour and activity type of group members into the following categories: resting, moving, looking for food, processing food, social interactions and other activities. To make sure that the scan remained as close to instantaneous as possible while still being representative, we included five individuals in each scan (sometimes less depending on visibility, but never more). Lastly, we recorded the height above ground (on the ground, 0–9, 10–19 and >20 m).

For group A, the capture operations spanned over a 9-day period so we divided the 65-day study period into three blocks: before, during and after the capture operations. We collected data on four separate days before, 8 days during and 13 after. For group B, we were successful on the first try. We collected data on eight separate days before the capture, and 13 after. In total, the assessment was based on 695 location records and 5651 individual activity records.

Throughout, we assumed that the sampling variance associated with the change in the position of the observer relative to the group centroid was constant over time. In most tests, we ignored the temporal autocorrelation in the data and the day-to-day changes in weather because ignoring autocorrelation was conservative when our objective was to demonstrate the lack of difference between time blocks. Indeed, any difference that was not statistically significant when not correcting for autocorrelation would remain so if correcting for autocorrelation. The assessment was based on the following four questions:

1. Did the groups move away from the capture locations after the captures?

We computed the Euclidian distance to the capture location (NSD) and used linear models to estimate the effect of the time block (before, during or after the capture operations) in each group.

2. Did the ranging patterns change after the captures?

We used quasi-Poisson linear models to determine if step lengths (the shortest path between successive records) or turning angles (the change in direction between two successive 30-min intervals, in degrees) increased or decreased after the captures, and variance F-tests to determine if the variance in step length or turning angle changed after the captures.

We also used weighted autocorrelated kernel density estimators (Fleming & Calabrese, 2017) to estimate the home range area as the area inside the 95% isocline of probability of use. These estimators are designed to account for temporal autocorrelation (Fleming & Calabrese, 2017) and extrapolate comparable estimates despite the differences in sampling effort across time blocks (Péron, 2019). We used the overlap between the confidence intervals to determine the statistical significance of the change in home range area across time blocks.

3. Did the groups engage in fewer social activities?

We fitted multinomial models with the six-value activity data as dependent variable and the time block and the time of day (within 2 h of sunrise or sunset vs. more than 2 h) as predictors; the latter was a potential confounding factor. We used Z-tests to determine if the frequency of social interactions (both affiliative and agonistic) decreased after the captures. We used the R-package *nnet* (Venables & Ripley, 2002).

4. Did the groups spend less time resting when on the ground?

We used chi-squared tests to assess the change in the proportion of time spent resting when on the ground across time blocks. We did not correct for the time of day since we asked whether individuals chose to stay on the ground whenever they rested.

## 3 | RESULTS AND DISCUSSION

### 3.1 | Darting distance

We successfully darted targets between 12 and 20 m away, compared to a maximum of about 4 m with a blowpipe. The monkeys were darted while perched less than 6 m above the ground in a live oak or similar small tree, on relatively flat terrain, after an average of  $0.6 \pm \text{SD } 0.9$  missed attempts. We found that four of five target individuals descended to the ground by themselves before falling asleep. Nevertheless, to mitigate the risk of a fall, we recommend avoiding situations where the target individuals could climb higher than 7 m above ground before falling asleep (avoid large tree, cliff).

When the air pressure was high (near 2.2 bars) and the distance was close (near 12 m), the risk increased that the dart would cause a deeper wound than needed. To mitigate that risk, we fitted silicon muffers around the base of the cannula. The opposite issue was when the pressure was low (nearly 1.7 bars) and the distance was long (nearly 20 m), some of the content of the dart was not injected into the muscle. We used the rangefinder and pressure gauge to adjust the pressure to the distance or inversely.

Loss of consciousness occurred between 2 and 9 min after injection. Consciousness was regained between 110 and 180 min after the injection, but return to full motricity (ability to climb to a 5-m perch) required 4 to 5.5 h.

### 3.2 | Medium-term effect of the captures

1. Did the groups move away from the capture locations after the captures?

Group A actually stayed 165 m or 13% closer to the capture location, on average, after the capture (ANOVA  $p < 0.001$ ; Figure 2a). Group B did not exhibit any evidence of a change in the distance from the capture location ( $p = 0.28$ ; Figure 2a).

2. Did the ranging patterns change after the captures?

Group A performed shorter (ANOVA  $p < 0.001$ ; Figure 2b) and less variable step lengths ( $F$  test  $p < 0.001$ ; Figure 2b) after the capture operations. It also performed wider (ANOVA  $p = 0.002$ ; Figure 2c) and more variable ( $F$  test  $p = 0.01$ ) turns. The data contained no evidence of a change in the movement patterns of group B after the captures (all  $p > 0.05$ ; Figure 2b,c).

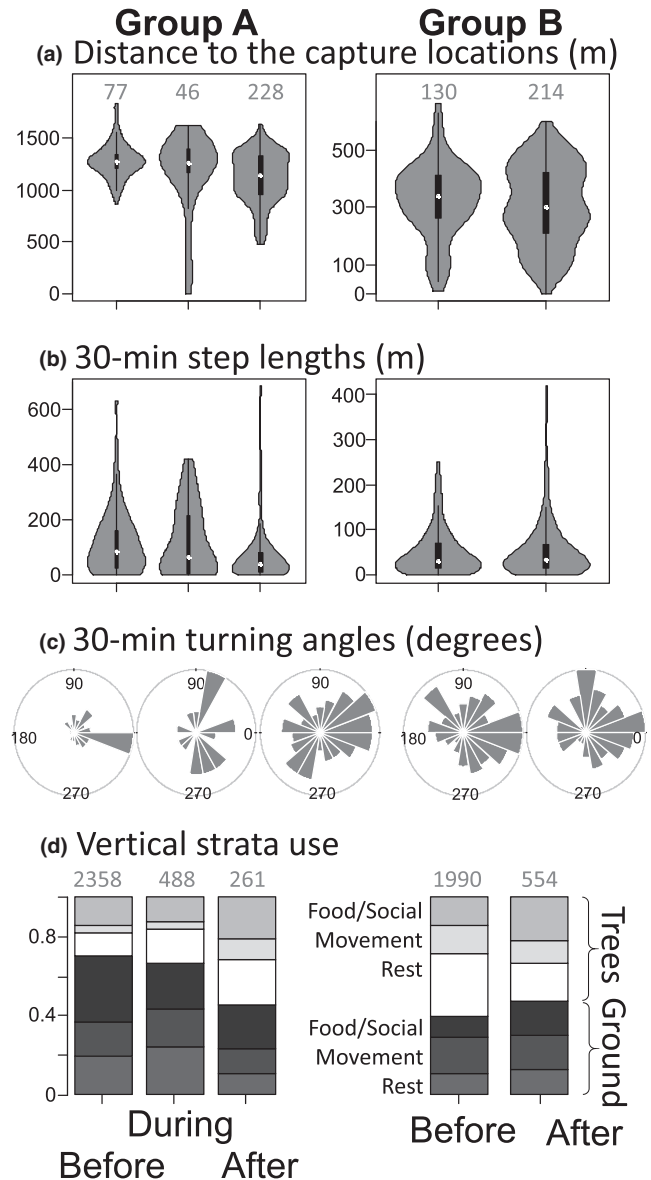
Despite the above changes in group A, the home range analysis did not yield any evidence of a change in home range area after the captures in either group. We estimated the asymptotic home range of group A between 51 and 138 ha before the capture operations and between 47 and 105 ha after the capture. For group B, the asymptotic home range was between 10 and 92 ha before the capture and between 49 and 132 ha after the capture.

3. Did the groups engage in fewer social activities?

In group B, social interactions actually increased after the capture, from 7% to 10% of the time budget (Z-test  $p = 0.004$ ). In group A, the data contained no evidence of a change in the frequency of social interactions ( $p > 0.25$ ).

4. Did the groups spend less time resting when on the ground?

In group B, individuals actually spent more time resting when on the ground after the capture (chi-squared  $p = 0.007$ ; Figure 2c). In



**FIGURE 2** Before-and-after assessment of the medium-term effect of the captures on (a) the Euclidian distance to the capture location; (b) the step lengths over 30-min intervals; (c) the turning angles over 30-min intervals; and (d) the frequency of three categories of activity in two strata of the vegetation. The numbers in grey font indicate the sample sizes.

group A, the data contained no such evidence ( $p > 0.25$ ) but group A spent 15% less time on the ground after than before the capture operations (Z-test  $p < 0.001$ ; Figure 2c).

Both groups also spent more time processing food after the captures (Z-test  $p = 0.07$  and  $< 0.001$ , respectively), but the data contained strong evidence of a compensatory decrease in the time looking for food in group A and the time moving in group B (both  $p < 0.001$ ).

Overall, the before-and-after comparison of the distance to the capture location, step lengths, turning angles, home range area, resting patterns, and frequency of social interactions yielded little evidence for a change in risk perception. The differences we uncovered were more congruent with seasonal changes in resource use than with a

change in risk perception. In particular, the availability of young shoots in the herbaceous strata increased towards the end of the study period as the autumn season set in. Young shoots require more processing but less searching and moving, which could explain some of our results.

## 4 | CONCLUSION

In this technical note, we reported on the successful capture of five wild adult male Barbary macaques with a DIY pressurised air dart launcher, built from supplies that we readily sourced from shops that cater to the agricultural sector. These animals would have been nearly impossible to capture otherwise.

We did not find any evidence that this technique changed the risk perception of the target groups, at least not more than a professional dart gun would have caused (Nowak et al., 2016; Wasserman et al., 2013). Therefore, we intend this note as an inspiration for anyone finding themselves in the same predicament as we did. However, we do recommend the same best practices as when handling professional dart guns, including regular training and the careful assessment of the balance between the costs paid by individual animals, and the benefits received by populations and ecosystems (Nowak et al., 2016; Wasserman et al., 2013).

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## CONFLICT OF INTEREST STATEMENT

No conflicts of interest.

## DATA AVAILABILITY STATEMENT

Data will be uploaded to Dryad or similar upon acceptance.

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