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RESEARCH NOTE

THE USE OF TARTAR EMETIC TO STUDY THE DIET OF INSECTIVOROUS BIRDS IN BORNEO

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Obligate insectivorous birds (insectivores) such as babblers and flycatchers and partial insectivores such as bulbuls are abundant in various types of habitats in Borneo (Myers, 2009; Phillipps and Phillipps, 2009) and serve as suitable subjects to study the diet of insectivores. Various methods have been used to determine birds' diets. Observation of what birds eat (Mizutani & Hijii, 2002; Anthal & Sahi, 2013; Mohd-Azlan *et al.,* 2014; Mansor *et al*., 2015; Styring *et al.,* 2016), examination of fecal samples (Ralph *et al.,* 1985; Parrish *et al.,* 1994; Burger *et al.,* 1999), analysis of stomach contents (Ballarini *et al.,* 2013; Bettycopa *et al.,* 2015), stomach flushing (Gionfriddo *et al.,* 1995; Barrett *et al.*, 2007; Fijn *et al.,* 2012) and examination of regurgitated samples (Poulin *et al.*, 1994; Poulin & Lefebvre, 1995; Valera *et al.,* 1997; Mallet-Rodrigues, 2001; Durães & Marini, 2003; Zduniak, 2005; Carlisle & Holberton, 2006; Ceresa *et al.,* 2014) have all been used. Stable isotope techniques have also been used to study the trophic position of babblers (Hamer *et al*., 2015) but require sophisticated equipment that may not be available.

The usage of regurgitated samples to determine birds' diets has an advantage over several other methods. The food items in the sample have not been subjected to extensive digestion so the samples have a higher chance of yielding intact prey bodies thus facilitating enumeration of both prey species and abundance. Previous studies have shown that regurgitated samples obtained by using emetics such as antimony potassium tartrate (APT) (tartar) or apomorphine (AM) provided useful information about the diets of birds ranging from small-bodied nectarivores to large carnivores (Lederer & Crane, 1978; Poulin *et al*., 1994; Valera *et al*., 1997; Mallet-Rodrigues, 2001; Durães & Marini, 2003; Zduniak, 2005; Carlisle & Holberton, 2006; Ceresa *et al*., 2014). The downside of this method is that it can be lethal if improper volumes and concentrations of emetic are administrated (Carlisle & Holberton, 2006). Proper administration of the emetic solution includes making sure that it does not enter the trachea (causing the bird to drown) and identifying the appropriate dosage - enough to elicit regurgitation but not to cause the bird discomfort. In this communication, we report the results of a study comparing two different dosages of tartar emetic to collect regurgitated samples from small insectivorous birds.

The study was carried out in regenerated secondary forests and a nearby primary forest at Pelagus National Park, Kapit Division, Sarawak, Malaysia (Borneo). Mist nets (9 m long, 2.5 m high, with 3 shelves and 20 mm mesh size) were deployed to capture small insectivorous birds over the period December 2014 to November 2015. The nets were checked every two hours daily during sampling between 06:00 and 18:00 hours. All captured birds were ringed, identified with reference to Phillipps and Phillipps (2009), measured and released. Birds from the target groups (babblers, flycatchers and bulbuls) were retained to be dosed with tartar emetic solution (1%) prepared by diluting 5 g antimony potassium tartrate (APT) in 500 ml of distilled water.

We initially chose to administer a dose of 0.2 ml of 1% APT per individual (dosage 1) (Mallet-Rodrigues, 2001) because the body size and feeding pattern of the babblers, bulbuls and flycatchers in our study were similar to those of the gleaners

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reported by Mallet-Rodrigues (2001). However, the dosage was later modified to 1 ml of 1% APT per 100 g bird body weight (dosage 2) as the initial dosage caused relatively high mortality in babblers and was not very effective in eliciting regurgitated samples from bulbuls. The APT solution was administered orally, slowly and steadily in order not to harm the birds and this was facilitated by using a syringe fitted with a short catheter at the tip. No emetic was given to individuals captured twice or more often on the same day. Each bird was then put into a cylindrical collection chamber with holes for ventilation and placed in a dark area to allow it to calm down. After 10 minutes the birds were released as done by Mallet-Rodrigues (2001) and Poulin *et al.* (1994), irrespective of whether they had regurgitated or not. In our study the emetic was only administered to birds caught between 10:00 to 18:00 hrs, giving the birds the opportunity to digest food taken in the early morning or to keep food foraged late in the afternoon in their stomachs for the night. After regurgitation, some of the birds were very weak so prior to release they were given some commercial glucose solution to help them recover.

A total of 307 babblers, 236 bulbuls and 114 flycatchers was netted during the study and body weight ranged from 7 to 48 g. Of these, 43 babblers, 65 bulbuls and 10 flycatchers were not dosed with APT because they were captured before 10:00 hrs or after 18:00 hrs or escaped during handling. APT was administered to the remaining 264 babblers, 171 bulbuls and 104 flycatchers and of these, 99 babblers, 86 bulbuls and 26 flycatchers regurgitated.

The overall success rate of eliciting regurgitated samples was 36.9% at dosage 1 and 41.1% at dosage 2 (Table 1). Although a slightly higher percentage of babblers and flycatchers regurgitated when given dosage 1 than when given dosage 2, the difference was not significant (p value = 0.378). In contrast, significantly more ($p < 0.01$) bulbuls regurgitated when given dosage 2 (65.6%) than when given dosage 1 (29.2%). The Akaike Information Criterion (AIC) value from generalized linear models in R shows that dosage applied in accordance with body weight was the best attributor to the success rate of regurgitation (AIC: 658.134) compared to dosage alone (AIC: 661.723) or the weight of the birds (AIC: 672.094).

No mortality has so far been reported from the administration of apomorphine via eye drops (Valera *et al.*, 1997; Ceresa *et al.*, 2014). Oral, administration of APT resulted in zero mortality (Zduniak 2005) or mortality rates of up to 94% (Carlisle & Holberton, 2006) suggesting that oral administration of APT is stressful to the treated birds making them more vulnerable. The mortality rates in this study were 11% and 3% of dosed individuals for dosages 1 and 2, respectively (Table 1). These figures are higher than those of reported in the past (in spite of being given glucose solution to help them recover). Only Poulin *et al.* (1994) reported mortality for a wide range of bird groups, including babblers, bulbuls and flycatchers, while the other

Table 1. Dosages of emetic solution used to obtain regurgitated samples and results obtained

Study	Lederer & Crane, 1978	Poulin *et al.*, 1994	Valera *et al.*, 1997	Mallet-Rodrigues, 2001	Durães & Marini 2003	Zduniak, 2005	Carlisle & Holberton, 2006	Ceresa *et al.*, 2014	Current study (Dose 1)	Current study (Dose 2)
Solution	APT	APT	AM	APT	APT	APT	APT	AM	APT	APT
Concentration	0.5%	1.5%	4%	1%	1.2%	1.5%	1.5%	4%	1%	1%
Dose / individual or unit body weight	0.5 cc / ind.	0.8 ml / 100 g	0.03 – 0.05 ml	0.2 ml / p ind.	0.8 ml / 100 g	2 cm^3 / 100g	0.8 ml / 100 g	2 drops each eye	0.2 ml per ind.	1 ml / 100 g
Bird group	Sparrows	All birds caught	Finches	Black-capped Foliage-gleaner	All birds caught	Nestlings of Hooded crow	Idaho migrants and captive juncos	Warblers	Babblers, Bulbuls and Flycatchers	
Results										
Success rate	100%	88%	57.8 – 77.9%	96.6%	70%	82.6%	>70%	76.6%	36.9%	41.1%
Mortality rate	2%	2%	–	9.1%	10%	0%	1.5% and 94.4%	0%	13.0%	4.87%

researchers' samples did not include the bird groups targeted in this study.

We recorded a success rate for percentage of birds yielding regurgitated samples of 36.9% at dosage 1 (0.2 ml / individual) and 41.1% at dosage 2 (1.0 ml / 100 g body weight). These success rates are lower than those recorded by previous researchers (over 50%) (Table 1). This could be due to the dosage of APT used being insufficient to produce regurgitation. Dosage 2 seems to work better on bulbuls, which are considerably heavier than babblers and flycatchers. In this case the weight of individual birds may play a role since the effectiveness of many physiologically active compounds is dependent on body weight, as reported in previous studies (Poulin *et al*., 1994; Durães & Marini, 2003; Zduniak, 2005; Ceresa *et al*., 2014). Babblers and flycatchers have similar weight ranges (9–32 g and 9–29 g respectively) and both are significantly lighter than bulbuls (weight range 11–60 g). Dosage 1 (0.2 ml / individual) may be more effective on babblers and flycatchers while dosage 2 (1 ml / 100 g body weight) seems to work better with slightly larger birds such as bulbuls.

Our results confirmed earlier reports (Poulin & Lefebvre, 1995; Zduniak, 2005) that the effectiveness of tartar emetic depends on body weight and species. It appears that increasing the effectiveness of tartar emetic in obtaining regurgitated samples for the study of avian diets requires manipulation of both volumes and concentrations to suit birds of different weights and species.

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