Food Preferences of the Brushtail Possum (*Trichosurus vulpecula*)

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The common brushtail possum (*Trichosurus vulpecula*) has been reported to eat vegetation, fruit, invertebrates, and occasionally fungi, eggs and meat. The relative preference between food types found in the wild, however, has not been investigated systematically in a controlled laboratory study. This research investigated captive possums' food choice using two different methods of preference assessment. The first experiment involved a single stimulus assessment of possums' (*n* = 20) consumption of individually presented food items. More than 75% of possums consumed berries, locusts and mushrooms but fewer than 50% of possums consumed fivefinger, raw chicken and eggs. The second experiment that used a paired stimulus assessment to establish *relative preference* for those foods revealed that no single food was preferred by all possums. Overall locusts were the most preferred food, followed in order of preference by berries, egg, mushrooms, chicken and foliage. The single stimulus preference assessment confirmed the palatability of foods. The paired stimulus assessment provided a rank order of food preferences.

The common brushtail possum (*Trichosurus vulpecula*) is predominantly a folivore that has been reported to consume over 150 species of native and exotic tree and plant species in New Zealand (DeGabriel, Foley, & Wallis, 2002; Henderson, O'Connor, & Morgan, 1999; Nugent, Sweetapple, Coleman, & Suisted, 2000), but will often consume 'higher quality' foods such as invertebrates, fruit, and seeds when available, in preference to foliage (Nugent et al., 2000). They have become a major pest species in New Zealand after being introduced from Australia because of their detrimental impact on native flora and fauna (e.g., Cowan, 1990), and their negative economic effect on agriculture (e.g., Warburton, Cowan, & Shepherd, 2009). In their native Australia, possums consume a wide variety of foods, with the bulk of their diet being made up by different species of foliage, including species of *Eucalyptus* (e.g., Marsh, Wallis, Cowling, & Foley, 2003).

Possums also consume fungi (Cochrane, Norton, Miller, & Allen, 2003; Sweetapple, Fraser, & Knightbridge, 2004; Rogers, 1997), invertebrates (e.g., Cowan & Moeed, 1987; Owen & Norton, 1995), birds (e.g., Morgan, 1981) and eggs (e.g., Brown, Innes, & Shorten, 1993) when available. Possums are reported to eat a variety of invertebrates including: stick insects (*Phasmatodea* spp.), cicadas (*Hemiptera* spp.), wetas (*Orthoptera* spp.), beetles (*Coleoptera* spp.), fly larvae (*Diptera* spp.) and mites (*Acari* spp.). Invertebrates may make up 28% of the diet of possums at times of year when insect species are widely available (Owen & Norton, 1995).

Observational studies of captive possums found that some will eat birds and eggs (Brown et al., 1993; Brown, Moller, & Innes, 1996; Morgan, 1981). Analyses of the contents of over 2000 wild possums' stomachs, however, did not identify meat or egg remnants definitively (e.g.,

Clout, 1977; Cochrane et al., 2003; Gilmore, 1965, 1967; Harvie, 1973; Mason, 1958; Purchas, 1975; Warburton, 1978); thus, the preference for these foods by possums is unclear.

In field studies possums' preference for different food types has been determined by estimating a preference index (PI) for available foods - usually foliage - by calculating a ratio of the amount of food consumed and it's estimated availability in the environment (Nugent, 1990). The majority of studies assessing possums' food preference are field studies, which are limited because they do not control food availability. Additionally, field studies do not assess the food preferences of individual possums or the stability of those preferences over time. To accurately determine relative food preferences assessments need to be conducted in the laboratory where food availability is controlled. The present study was conducted to systematically assess, in controlled experiments, which food types typically available in the wild, possums will consume and their relative preference for these foods.

Two different preference assessment methods were used; single and paired stimulus. The *single stimulus* method was used to determine which foods possums would consume, and it involves presenting one food at a time (e.g., Weiner & Stellar, 1950; Pace, Ivancic, Edwards, Iwata, & Page, 1985). Using this method, Morgan (1990) found that possums consumed orange flavored barley more frequently than other flavors. This method has also proved useful for identifying foods that are effective lures for use in pest control (e.g., Ogilvie, Thomas, Morriss, Morgan, & Eason, 2000). This method gives an indication of food preference based on the frequency and the amount of food consumed, however, it may overestimate preference as foods selected when offered singly, may not be chosen when another choice is present (Fisher et al., 1992).

A *paired stimulus* assessment involves presenting two foods simultaneously and recording which food is consumed first, within a given time frame (e.g., Fisher et al., 1992; Gaalema, Perdue, & Kelling, 2011; Pace et al., 1985; Piazza, Fisher, Hagopian, Bowman, & Toole, 1996). This was used to provide a *relative preference* for different food types, where one stimulus is chosen over another (Young & Greene, 1953) and to provide a ranking of preferred items (e.g., DeLeon & Iwata, 1996; Pace et al., 1985). This method tends to identify preferences more accurately, and with greater differentiation between items than the single stimulus method (Fisher et al., 1992; Paclawskyj & Vollmer, 1995). Using this method, possums were found to select carob, dock leaves (*Rumex obtusifolius*), sultanas, and condensed milk most often, and lemon rind and apple least often (Hudson, Foster, & Temple, 1999). In a similar experiment, possums most preferred foods were barley, rolled oats and sunflower seeds (Martin, 2002).

The purpose of the present study was to assess possums' preference between food types that have been reported to be consumed in the wild. This study uses well established preference assessment methods in a laboratory environment, allowing control over food availability. The aim of Experiment 1 was to ascertain which test foods possums *will* eat using the single stimulus method. It was expected that as a group, the possums will consume most, if not all food types but not that *all* possums will eat *all* foods. Food preferences have been reported to be idiosyncratic in other species such as humans (e.g., Hoefling & Strack, 2010), pigtail macaques (*Macaca nemestrina*) (Laska, 2001), and possums (Martin, 2002). The aim of Experiment 2 was to determine the relative preference of the test foods using paired stimulus assessments, which ensures preference is determined based on active choices between concurrently available alternatives. The results from Experiment 1 and 2 will also allow a comparison of different preference assessment methods, and if preferences are stable within individual animals.

Experiment 1: Method

Animals

20 brushtail possums (9 females and 11 males) weighing between 2732 g and 4292 g ($\bar{X}$ = 3485 g, σ = 459 g) were used in the experiment. All possums were 'wild caught' and had been housed in captivity for 1 - 12 years ($\bar{X}$ = 4.5 years, σ = 3.5 years). At the start of the experiment eight of the possums were experimentally naïve; the remainder had participated in other behavioral experiments.

Possums were weighed every second non-experiment day (every eighth day). Supplementary feeds of dock leaves, sliced apple, and food pellets (Camtech Manufacturing Ltd, New Zealand) were provided at 14:00 h each day after experimental sessions were completed. Possums had constant access to water.

Housing

Fourteen possums were kept in laboratory built individual wire-netting cages (540 mm wide x 850 mm high x 470 mm deep) with a shelf halfway up the cage and a nest box (450 mm wide x 300 mm high sloping from 360 mm to 195 mm) on top of the cage. The remaining six possums were housed in slightly larger cages (540 mm wide x 1050 mm high and 470 mm deep) with a wire shelf 700 mm above the floor of the cage. The possums were housed in a laboratory with a 12:12 h reversed dark/light cycle (lights off at 09:45 h) with minimal illumination supplied by red lamps during the dark period. Cleaning and maintenance occurred during the light rotation at the same time each day.

The University of Waikato Animal Ethics Committee approved the use of animals for Experiments 1 and 2 (protocol number 787).

Apparatus

The home cage functioned as the experimental chamber with test foods presented in the same way as their standard diet. The front of each cage was designed to allow a small tray (70 mm wide x 130 mm long x 30 mm deep) to be slotted into the cage.

Test food choice. Test foods were chosen to represent the main food categories (foliage, fruit, fungi, invertebrates, meat and eggs) that possums eat in the wild. The specific foods were chosen based on availability, practicality and cost. Fivefinger (*Pseudopanax arboreus*) was selected as the foliage food type because it is eaten by possums in New Zealand (Fitzgerald, 1978; Kean & Pracy, 1953) and there was a guaranteed fresh supply of the plant available from the university campus. The fruit was a mixture of raspberries, blueberries and blackberries (Pams® Mixed Berries), which could be purchased year round from a local supermarket, field mushrooms and minced raw chicken were available from a local supermarket. Locusts (frozen) (*Locusta migratoria*) were purchased in bulk from a breeder, and quail eggs were sourced from a local poultry breeder. Table 1 gives an indicative guide to the nutritional content of the test foods.

The six test foods presented during the experimental sessions were; 20 g fresh fivefinger leaves (*Pseudopanax arboreus*), 20 g berries (defrosted and drained of juice), 20 g mushrooms, 3 locusts (defrosted), 20 g minced raw chicken, and 1 quail egg (approx. 15 g).

Design

Each possum received the same test food every day for three consecutive days at 10:00 h. All six test foods were given to each possum during the experimental period (18 presentations of food in total). The food was distributed between possums in a randomised order that was counterbalanced to avoid adjacent possums receiving the same test food concurrently. The fourth day was a rest day. The quantities of foods were not equated on weight; rather the amounts were determined such that each occupied approximately the same surface area on the bottom of the food dish. To guard against satiation the maximum amount of test food offered to each possum did not exceed 11% of their daily food intake (by weight). Additionally, the amount of supplementary feed provided for each possum was adjusted depending on how much of the test food they consumed.

Table 1

Approximate nutritional compositions of 1 gram of test foods, energy (kJ/g), protein (mg/g) and fat (mg/g). Berries (retrieved from Pams®), locusts (Oonincx & van der Poel, 2011), mushrooms, eggs and chicken (USDA food database (www.usda.gov), and fivefinger (Fitzgerald, 1978).

	Energy (kJ/g)	Protein (mg/g)	Fat (mg/g)
Berries	2.0	10.0	< 1.0
Locusts	21.3	65.0	19.0
Mushrooms	0.9	2.0	< 1.0
Egg (hen)	3.4	8.0	6.0
Fivefinger	22.5	-	-
Chicken	5.0	23.0	3.0

Procedure

A trial began during the second hour of the dark cycle. The sample of food was delivered in the food tray. The food tray was removed after 2 hours and any remaining food - in the tray and in and under the cage - was weighed and recorded. Instances where a food was disturbed, for example, if a quail egg was broken but not consumed, it was noted but not recorded as being 'consumed'. A food type was considered 'consumed' if less than 12.5% (by weight) remained at the end of the session, except for locusts which were considered consumed if one or part of one locust was left over. Unbroken eggs in the cage after day 1 were broken for the possum on days 2 and 3. Food trays were cleaned at the end of each experimental session.

Data Analysis

The food consumed by each possum was recorded after each presentation and the percentage of possums that consumed each food on each day was calculated. To allow comparison of food consumption across Experiments 1 and 2 the total number of times each food was consumed by each possum was aggregated across days, and then reported as a percentage of total trials.

Results and Discussion

The results from Experiment 1 showed that all food types were consumed by some possums across the three days. Figure 1 shows that berries were consumed on the greatest number of trials, followed by locust, mushroom, fivefinger, egg, and chicken the least. A repeated measures ANOVA revealed a significant difference in the mean percentage of trials when each food was chosen [$F(5, 95) = 15.69$, $p < 0.001$, $\eta_p^2 = 0.45$]. Pairwise comparisons confirmed that berries, locusts and mushrooms were consumed in a significantly higher percentage of trials than fivefinger, egg and chicken (all *p's* < 0.006). Nineteen possums consumed berries, 18 possums consumed locusts, 20 possums consumed mushrooms, 14 possums consumed fivefinger, 11 possums consumed egg and 8 possums consumed chicken. It should be noted, however, that while more animals might have tried a food such as mushrooms at least once, if it was only consumed on one of the three days that would result in a lower percentage of trials overall when mushrooms were consumed.

These findings reveal that all foods were consumed to some extent, supporting the findings of earlier field studies. These data show that possums consume a wide variety of foods and that the single stimulus preference assessment can identify palatable foods. A preference assessment, however, where there is a choice between foods is required to provide a measure of most and least preferred foods, or relative preference that is frequently lost in single stimulus preference assessments which tend to overestimate preference (Fisher et al., 1992). Sumpter,

Foster and Temple (2002) in reviewing different methods for assessing preference concluded that free choice or single stimulus methods provide limited information about preference (i.e., what animals will consume), but only those offering a discrete choice between two or more options can be used to indicate the *degree* of preference. Therefore, the aim of Experiment 2 was to determine the relative preference of test foods of the type used in Experiment 1 using a paired stimulus assessment. It was expected that foods that were consumed the most, or by the greatest number of possums in Experiment 1, would also be the most preferred foods when presented concurrently with foods that were consumed less frequently in Experiment 1.
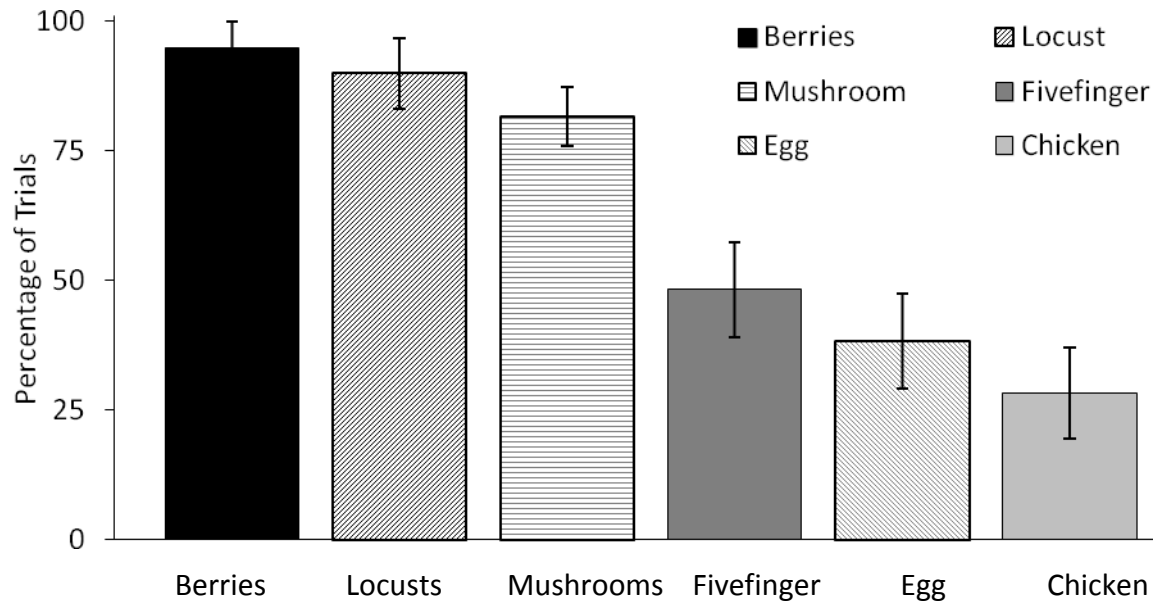

Figure 1. The percentage of trials when each food was consumed in Experiment 1. Error bars are the standard error of the mean.

Experiment 2: Method

Animals

12 possums (4 females and 8 males) weighing between 2732 g and 4204 g ($\bar{X}$ = 3369 g, σ = 391 g) were used in this experiment. Possums had been housed in captivity for 1-10 years ($\bar{X}$ = 3 years, σ = 2.8 years). The possums were selected at random from those used in the single stimulus assessment. Feeding and cleaning procedures were the same as Experiment 1. One possum did not eat any of the foods presented in the second experiment and their data were not included in the analysis.

Housing

Six possums were housed in the larger cages (540 mm wide x 1050 mm high x 470 mm deep) and six possums were housed in the smaller cages (540 mm wide x 850 mm high x 470 mm deep).

Apparatus

      Each home cage functioned as the experimental chamber. A custom built assessment device was attached to the door frame, replacing the door during each session. The device allowed the experimenter to view the possum during the experiment but prevented the possum from escaping. Figure 2 shows a diagram of the apparatus.
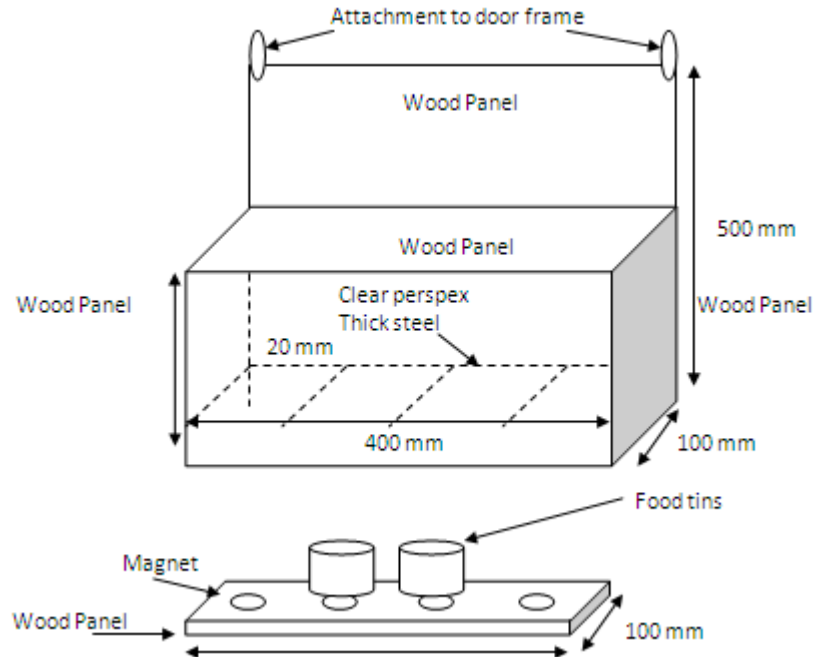

Figure 2. A diagram of the paired stimulus apparatus in Experiment 2.

      The foods used in this experiment were the same as for Experiment 1 except that quail egg was replaced with hen egg and smaller amounts were presented in each trial. This allowed multiple presentations of each food pair within an experimental session, whilst limiting the total amount of food a possum could eat in an experimental session to no more that 11% of the possum's daily food intake (as in Experiment 1). The test foods presented during each experimental session were 2 g berries (defrosted and drained of juice), 1 locust, 2 g mushrooms (cut into 10 mm pieces), 0.5 g fivefinger leaves cut into 10 mm pieces, 2 g whisked egg and 2 g minced raw chicken breast. The foods were presented in round tins (50 mm high and 70 mm in diameter) attached by magnets to the base apparatus. Each food covered approximately the same surface area of the bottom of the tin (with the exception of egg).

Procedure

      To familiarise the possums with the test foods, a teaspoon (approx. 5 ml or 0.2 g) of all foods (or 1 locust) was presented in a separate tin individually in a random order to each possum before the experimental trials began for that day. When the possum had either sampled the food in each tin or if the possum's nose had been in and out of the tin without consumption the tin was removed.

      An experimental trial consisted of presentation of the food tins in the center of the tray when the possum was facing the apparatus. A choice was recorded if the possum consumed the food in the tin, that is, the possum either removed a 'mouthful' of the food (e.g., a berry, piece of mushroom or fivefinger or 1 locust) or lapped at the food (e.g., egg or minced raw chicken). After a 'choice' was made, the tins were removed. After 30 s, if no food was consumed, the food pair was removed and the next food pair was presented. If no choices were made on 10 consecutive food pair presentations the session was terminated.

      The possums experienced the experimental procedure in three sessions run on consecutive days (Series 1). Within each experimental session, each food item was paired with every other food item resulting in 15 different food

pair combinations. Food pairs were presented twice per session, with each of the foods presented on the left, and the right (30 food pair trials in total). The procedure was repeated on days 2 and 3 with the order of food pairs varied each day. The three day procedure was repeated two weeks after the first series (Series 2).

Data Analysis

For each food pair the number of times a food was chosen was summed across trials. The percentage of total trials when each food was consumed was then calculated for each possum, for each series (the total number of trials being the number of times that food was presented). The percentage of total trials when a food was chosen was used to assess possums' relative preference for each food type.

Results

A Wilcoxon signed ranks test revealed that the median percentages of choices between the first and second series were not significantly different for any food type [$z = $-0.64, $p = 0.523$]. Consequently, the percentage of trials when each test food was chosen from each food pair was combined across the two series for each possum. The average percentage of trials when each food was consumed from each pair is shown in Table 2. Locusts, berries and mushrooms were chosen most frequently when paired with fivefinger. Berries were chosen in approximately 50% of trials irrespective of the alternative food. Fivefinger was chosen in fewer than 20% of trials and the percentage of trials when no food was selected from a food pair ranged from 6 - 48% of trials and most often when fivefinger was presented.

There was variability between possums with no single food type being highly preferred by *all* possums. Table 3 presents a ranked order of preference for each food type for each possum. The most highly preferred foods were locusts ($n = 4$), berries ($n = 4$) and minced raw chicken ($n = 3$). For nine possums, the least preferred (or unselected food) was fivefinger. When data were averaged across possums, locusts were the most preferred food, followed by berries, egg, mushrooms, chicken and fivefinger (see Figure 3). The ranked preferences shown by individual possums were not consistent with the overall (group) food preferences.

Table 2
Average percentage of trials when each food was consumed within each food pair across possums. The percentage of trials when no food was chosen for that food pair is shown in brackets.

		Berries	Locusts	Mushrooms	Egg	Fivefinger	Chicken
Food chosen	Berries	-	55	49	55	62	58
	Locusts	39 (6)	-	64	62	79	61
	Mushrooms	41 (10)	24 (12)	-	29	55	53
	Egg	31 (14)	28 (10)	57 (14)	-	56	20
	Fivefinger	10 (28)	6 (15)	5 (40)	9 (35)	-	19
	Chicken	17 (25)	29 (10)	32 (15)	45 (35)	35 (48)	-

For the single stimulus data, a repeated measures ANOVA revealed a significant difference between the mean percentage of trials when each food was chosen [$F(5, 50) = 8.04$, $p < 0.001$, $\eta_p^2 = 0.45$]. Pairwise comparisons confirmed that berries and locusts were consumed in a significantly higher percentage of trials than the other foods (all $p's < 0.038$).

Table 3
Possums' relative preference for each food type. Data are presented for individual possums and for the group overall.

Possum	Most Preferred 1st	2nd	3rd	4th	5th	Least Preferred 6th	Non Selected
P1	Chicken (68)	Mushrooms (65)	Egg (63)	Berries (55)	Locusts (48)		Fivefinger (0)
P2	Berries (77)	Locusts (68)	Mushrooms (54)	Fivefinger (23)	Egg (22)		Chicken (0)
P3	Locusts (95)	Egg (72)	Mushrooms (58)	Berries (7)			Fivefinger Chicken (0)
P4	Locusts (88)	Mushrooms (87)	Berries (40)	Fivefinger (12)			Egg Chicken (0)
P5	Berries (85)	Locusts (77)	Mushrooms (58)	Egg (58)	Fivefinger (2)		Chicken (0)
P6	Berries (52)	Locusts (48)	Mushrooms (41)	Egg (5)	Fivefinger (2)		Chicken (0)
P7	Chicken (92)	Egg (72)	Berries (58)	Locusts (57)	Mushrooms (8)	Fivefinger (2)	
P8	Chicken (67)	Egg (63)	Berries (62)	Locusts (57)	Mushrooms (17)	Fivefinger (2)	
P9	Berries (85)	Chicken (77)	Egg (72)	Locusts (47)			Mushrooms Fivefinger (0)
P10	Locusts (72)	Fivefinger (62)	Berries Mushrooms (55)		Egg (52)	Chicken (5)	
P11	Locusts (50)	Berries (7)					Chicken Egg Mushrooms Fivefinger (0)
Overall	Locusts (64)	Berries (53)	Egg (43)	Mushrooms (40)	Chicken (28)	Fivefinger (9)	

Note: Relative preference was caluated by dividing the number of trials when a food was chosen by the total number of trials when that food was presented.

For the paired stimulus data, a repeated measures ANOVA revealed a significant difference between the mean percentage of trials when each food was chosen [$F(5, 50) = 6.17$, $p = 0.003$, $\eta_p^2 = 0.38$]. Pairwise comparisons confirmed that berries were consumed in a significantly higher percentage of trials than fivefinger ($p = 0.001$), and chicken ($p = 0.023$). Locusts were consumed significantly more than all other foods except berries (all $p's < 0.037$) and mushrooms were consumed in significantly more trials than locusts ($p = 0.005$). Fivefinger was consumed in fewer trials than all foods except chicken (all $p's < 0.015$).

The percentage of trials when each food was consumed was compared between the single and paired stimulus assessments using paired sample t-tests (Figure 3). Berries ($t(10) = 6.05$, $p = 0.001$, $d = 1.73$), locusts ($t(10) = 6.96$, $p = 0.001$, $d = 2.97$), fivefinger ($t(10) = 2.58$, $p = 0.028$, $d = 0.96$) and mushrooms ($t(10) = 4.73$, $p = 0.001$, $d = 1.12$) were consumed on a significantly higher percentage of trials in Experiment 1, the single stimulus assessment compared to Experiment 2, the paired stimulus assessment.
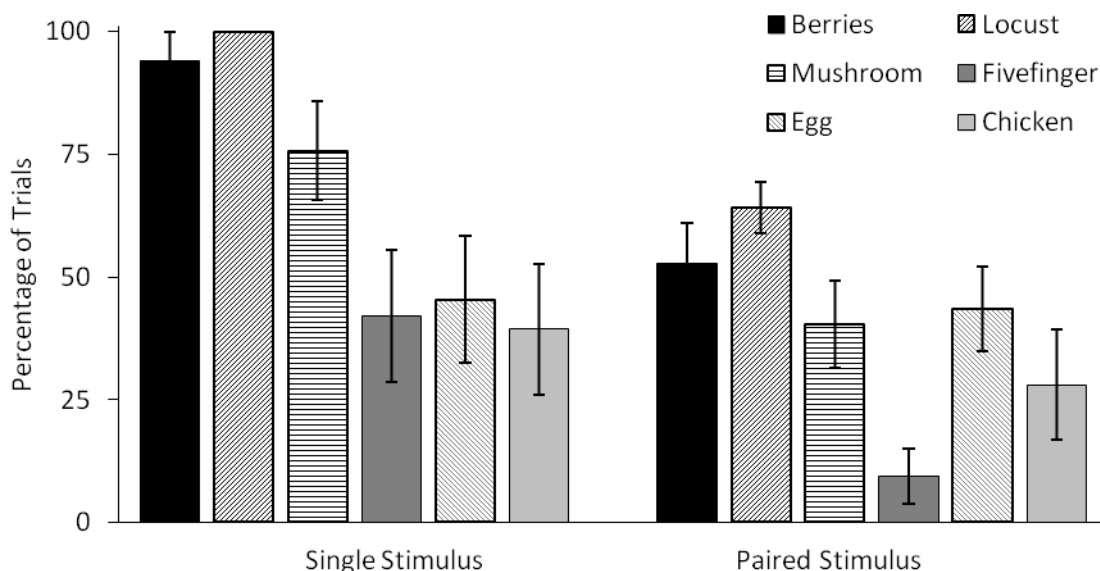
Figure 3. Mean percentage of trials when each food was selected by possums that had participated in both the single stimulus assessment (Experiment 1) and the paired stimulus assessment (Experiment 2). Error bars are the standard error of the mean.

General Discussion

The purpose of the present experiments was to identify what possums would consume using the single stimulus method (Experiment 1), and to ascertain relative preferences for those same foods when offered as a choice between two food types (Experiment 2). The results of Experiment 1 showed that all the test foods were consumed by at least one possum; berries were the most consumed food, followed by locusts, mushrooms, fivefinger, egg, and chicken. In Experiment 2, when alternative foods were available, no single food was preferred by all possums; locusts were the most preferred food, followed in order of preference by berries, egg, mushrooms, chicken and fivefinger.

These findings are similar to those of previous field and experimental studies. All possums ate berries in both Experiments 1 and 2, which was consistent with accounts of previous studies of possums in the wild (e.g., Harvie, 1973; Gilmore, 1965, 1967). Berries or fruit in general, are a preferred food in a possum's diet and are likely to be consumed when available.

It was surprising to us that some possums did not consume fivefinger in the single and paired assessments as foliage makes up between 50-95% of a possum's diet and fivefinger in particular is reported to be consumed by wild possums in New Zealand (e.g., Fitzgerald, 1978; Kean & Pracy, 1953). However, the high proportion of foliage in the diet of wild possums may be a result of availability relative to other food types rather than it being highly preferred (Nugent et al., 2000). Fivefinger was collected fresh each morning and was prepared for the experiment by cutting the leaves into small pieces. It is possible that in attempting to control for consistent presentation that we made the fivefinger more difficult for the possums to eat and less recognizable as a leaf. This might explain the minimal selection of fivefinger by most possums;

however, one possum consistently consumed it in Experiments 1 and 2 (P13) suggesting that it was palatable.

With regard to consumption of invertebrates, locusts were ranked as the most preferred food in both the single and paired assessments. These findings add further support to the suggestion of Cowan and Moeed (1987) and Cochrane et al. (2003) that invertebrates may be a source of food for possums. Mushrooms were also consumed by most of the possums and were ranked as the 3rd most preferred food in the single stimulus assessment and the 4th most preferred food in the paired stimulus assessment.

Foods consumed in the single stimulus assessment were consumed in the paired stimulus assessment in a similar order of preference. In both assessments locusts were the most preferred followed by berries. In the single stimulus assessment mushrooms were preferred over egg, but this order was reversed in the paired stimulus assessment, as was the case with fivefinger and chicken.

Fewer than half the possums (45%) consumed chicken in the single stimulus preference assessment, making it the 6th ranked food overall, but for three possums it was the most highly preferred food. The percentage of possums consuming meat in our study was considerably higher than the 18% of possums reported eating dead chicks in earlier studies (Brown et al., 1996), however, this may be due to how the food was presented; the smell and appearance of minced chicken is quite different to dead chicks used in that study.

Over half of the possums (55%) consumed egg in the single stimulus experiment, 82% consumed egg in the paired stimulus experiment and overall it was ranked as the 3rd most preferred food. The proportion of possums eating egg in the first experiment was lower than the 85% of possums reported by Brown et al. (1996), although this may be because Brown et al. (1996) classified damaged eggs as eaten.

Preference assessments are typically used to establish a reinforcer, usually a food, to reward the occurrence of a particular behavior for that subject (Pace et al., 1985). It is crucial for operant work that an effective reinforcer is found to maintain behavior, such as response rates (e.g., Mintz, Wallace, Najdowski, Atcheson, & Bosch, 2007). It should be noted, that food preferences varied widely across animals and it would be misleading to assume that the averaged preferences hold for all animals. For example, for three possums minced chicken was a highly preferred food but for the remaining possums chicken was either one of the least preferred or non-selected foods. Similarly, Laska (2001) also found that the grouped ranking of food preferences did not represent individual food preferences of pigtail macaques.

The strength of this study is that it provides a systematic assessment of possums' food preference whilst controlling food availability. This addresses one of the major limitations of field studies which may underestimate possums' preference for certain food due to their local and/or seasonal availability. In addition, the current study provides a ranked order of preference for foods possums have been reported to eat in the wild. To date preference indices, used to calculate consumption of foods in the wild by possums (Nugent, 1990), have only been calculated consistently for foliage and not for other foods (invertebrates, meat and eggs).

The current study could not control all the dimensions on which the different food presentations could vary. It was not possible to deliver the same weight of each food type because they differed markedly in their density and consistency; however, the same surface area of the tin was covered by each food. Given that the supplementary diet was the same across possums it seems unlikely that nutritional composition alone can account for the individual differences in taste preferences for the test foods, but it may have contributed to overall trends as possums

generally preferred sweeter foods such as berries, and foods with more protein such as locust, over others.

It is unlikely also that a single nutritional element determines preference. Table 1 shows the approximate energy, protein and fat content of each of the foods. Fivefinger and locusts contain the most energy with mushrooms the least; and locusts and chicken have the most protein. In addition, it has been suggested that selection of locusts and mushrooms may be due to the complex carbohydrates found in chitin which makes up the exoskeleton of locusts and cell walls of mushrooms (anonymous reviewer). The nutritional content of the foods may help explain the preference for locusts, however, it does not account for the overall lack of preference for chicken (high in protein) and fivefinger (high in energy). It is highly likely that multiple factors contribute to selection of foods such as other mineral content (Cowan, 1992), smell (Morgan, 1981), size (Cowan, 1992), texture and consistency.

The findings are unlikely to have been influenced by possums becoming satiated as all possums subsequently consumed their normal daily supplementary feed that was presented after experimental sessions, and the total amount of food presented during an experimental session never exceeded 11% of the possums total daily food intake by weight. Testing a wider variety of foods, specifically foliage, would have allowed for greater generalization of the findings, however, we were limited to foods that were available in sufficient quantities throughout the experiment.

In summary, the study findings show that; 1) possums will choose to eat foods other than foliage when available, 2) possums will eat meat and eggs, and 3) invertebrates and berries are a highly preferred food of possums. These findings have implications for pest management of possums in New Zealand. Improved knowledge of possum food preferences may inform the refinement of existing lures and bait delivery systems. Some of the wet foods such as berries, chicken and egg might present a technological challenge, although, recent technology developed to control mustelids by King, McDonald, Martin, Tempero, and Holmes (2007) made use of aerosol cans containing an egg and oil mix or homogenated sheep brain, with some success. The idiosyncratic nature of possum's food preferences suggests that a variety of baits may need to be used to maximise the success of possum control efforts. In contrast, in Australia carefully controlled studies independent of availability might inform the planting of preferred foliage species.

The present research has confirmed in a controlled study that possums will consume a variety of foods and that certain foods are more preferred than others. The single and paired stimulus assessments, however, do not allow calculation of the relative demand for foods. Techniques used in behavioral economics might provide insight into the relative preference for different foods because animals are required to work for food giving an estimate of the effort expended to obtain a preferred food. Further experimentation focusing on the relative demand for foods obtainable and reported as consumed by possums in the wild is currently underway in our laboratory.

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