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The Feeding Ecology of the Dingo I. Stomach Contents from Trapping in South-Eastern Australia, and the Non-Target Wildlife also Caught in Dingo Traps

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Abstract

The stomach contents were examined from 530 dingoes, *Canis familiaris dingo*, mostly caught in steel traps in south-eastern Australia. Large and medium-sized marsupials predominated (89·3% occurrence), especially the wallabies *Wallabia bicolor* and *Macropus rufogriseus* (50·8%), and the possums *Pseudocheirus peregrinus* and *Trichosurus vulpecula* (11·6%). Twenty-six species of prey were detected in all. Prey remains in stomachs were mostly meagre and about one quarter of stomachs contained no food. The length of time dingoes were in the traps may have been the cause. The representativeness for diet analysis of stomach contents so obtained is questioned, although the breadth of the diet is probably representative. Few stomachs contained the remains of sheep *Ovis aries* (4·8%), or European cattle *Bos taurus* (2·4%). Remains of feral pig *Sus scrofa* (4·0%), horse *Equus caballus* (0·3%) and rabbit *Oryctolagus cuniculus* (7·8%), which are pests, were also found. Of the 26 dingoes with sheep or cattle remains in their stomachs, 11 had eaten it as carrion and five of those had obtained it from carcasses used as lures. Of the 17 dingoes with sheep remains in the stomachs, 16 were trapped within 3 km of sheep; 207 other dingoes were caught within that distance. Almost a quarter of the dingoes had been caught from 10 to 72 km away. Trapping so far away from sheep is discussed.

Over 20 species of protected wildlife were also caught in the dingo traps at the rate of two to three such species for every dingo. After correcting for differences in trap-nights, the larger 'Lane' traps caught three times more protected wildlife than the smaller 'Oneida' No. 14 jump-traps, and 15 times more large marsupials. Placement of traps as well as size was involved. There was no indication that fewer dingoes were caught by the smaller traps.

Introduction

The vertebrate fauna in the remaining forests of south-eastern Australia includes dingoes *Canis familiaris dingo*, domestic dogs *C. f. familiaris*, and their hybrids (Newsome and Corbett 1982). All are referred to as dingoes here. Sheep *Ovis aries* and European cattle *Bos taurus* are grazed on cleared mountain valleys, tablelands and coastal plains, but some cattle graze in the remaining forested land as well. Because dingoes prey upon domestic stock (see Macintosh 1956; New England Development Association 1966; Rankine and Donaldson 1968; Seddon 1968), control of their numbers is traditionally attempted by trapping and poisoning (Leake 1921). Steel-jawed traps are set for dingoes at various distances from farmland into the adjacent forests. This paper reports on the stomach contents of dingoes caught in that way, together with some information from a few other dingoes. Non-target species of wildlife also caught in the dingo traps are reported upon and discussed.

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Methods

The study area of about 160 000 sq km in Gippsland, north-eastern Victoria and south-eastern New South Wales stretched from the mountains to the coast (Fig. 1). The study lasted from 1969 to 1975 and was conducted with the collaboration of 25 dingo trappers employed by dingo control organizations in the region.

Two kinds of trap were used. Heavy, very strong, 'Lane' steel traps, manufactured by Stockbrands Pty Ltd, Western Australia, were used by the trappers, and the lighter 'Oneida' No. 14 steel jump-traps, manufactured by Victor Oneida Co., U.S.A., in our ecological studies (Newsome *et al.* 1973). Some trappers later adopted the use of these lighter traps. Trap-lines 25–75 km long were established with up to 50 traps per line. Our traps were mostly checked daily, but checking so frequently was not always possible for professional trappers who had several long trap-lines or who operated in very remote, rugged country with horses for transport, or where access was impeded by heavy snow in winter. Long trap-lines were set for 2–12 months (Corbett 1974), but shorter ones for only a week or so.

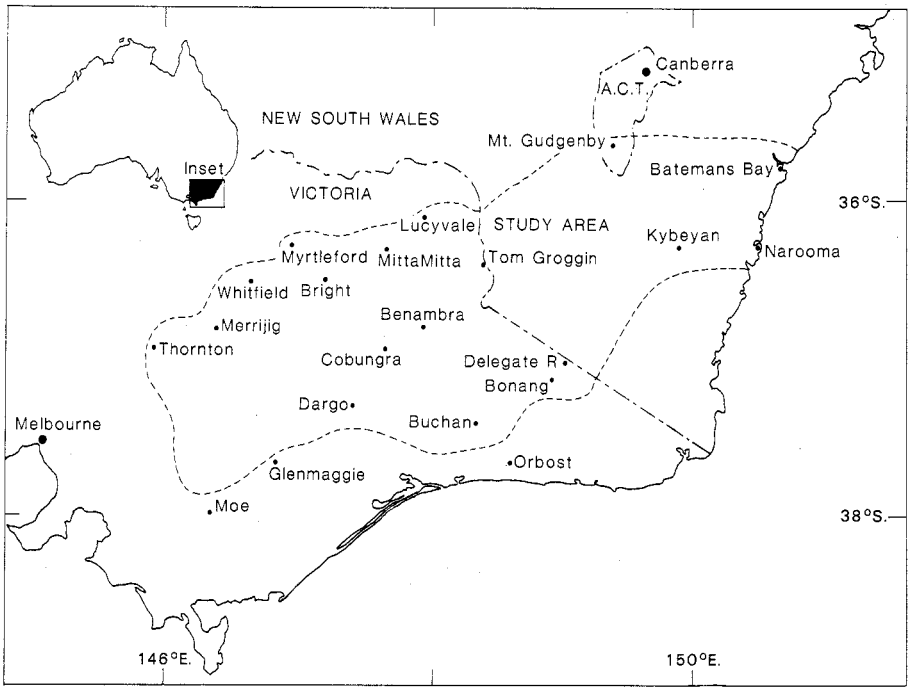

Fig. 1. Study area and major localities near which dingoes were caught.

Traps were set just below the ground in a variety of places, e.g. on fauna trails, on forestry roads, at creek crossings, at places were dingoes had urinated or defaecated, and on farms where livestock had been killed by dingoes. Trap-sites were mostly baited with lures or carcasses to attract dingoes. Most lures included dog or dingo faeces or urine or both, and sometimes the contents of the lower intestines of any trapped dingo. Some trappers used secret lures which were claimed to be unique. Sometimes, traps were set around carcasses of livestock on farms, and occasionally such carcasses were taken into the forest to use as lures. Common wombats *Vombatus ursinus*, red-necked wallabies *Macropus rufogriseus*, swamp wallabies *Wallabia bicolor*, eastern grey kangaroos *M. giganteus*, and other wildlife which had been accidentally killed on roads or caught in traps were also used. That practice is now forbidden in Victoria. In our program, we always used dingo or dog faeces and/or urine as a lure. Our traps were set up to a metre away from main trails or wheel tracks to try to avoid catching non-target species.

Stomach contents of killed dingoes were preserved in 10% buffered formalin and labelled individually. Skulls and other biological material were also labelled and kept for other studies. Trappers were asked to record the type of lure used and the non-target species trapped, and to estimate the distance, in kilometres, to the nearest sheep if a dingo was caught. In the laboratory, the wet weight of

ingesta was taken, and particular items in it identified mostly by R. Cooper and R. McIlroy (personal communication) from the microscopic patterning on hairs (Brunner and Coman 1974; Corbett 1974), but also from feathers, scales (reptiles), teeth and various skeletal bones, claws, or spines (as for short-beaked echidna *Tachyglossus aculeatus*). The presence of blowfly maggots (Calliphoridae) was accepted as indicating that carrion had been ingested.

Table 1. Stomach contents of 372 dingoes from south-east Australia

Empty stomachs, 85; stomachs with detritus (sticks, stones, dirt), tabanids, blowflies and dingo hair, 73; total collected, 530

Identity	Percentage occurrence			
Large mammals				
Common wombat, *Vombatus ursinus*	12·9			
Swamp wallaby, *Wallabia bicolor*	15·9			
Red-necked wallaby, *Macropus rufogriseus*	12·1			
Indeterminate wallaby	22·8			
Total wallabies		50·8		
Eastern grey kangaroo, *Macropus giganteus*	5·9			
Total native large mammals			69·6	
Pig, *Sus scrofa*	4·0			
Horse, *Equus caballus*	0·3			
European cattle, *Bos taurus*	2·4			
Sheep, *Ovis aries*	4·8			
Total large mammals				81·1
Medium-sized mammals				
Short-beaked echidna, *Tachyglossus aculeatus*	7·0			
Indeterminate bandicoot, *Perameles* or *Isoodon*	0·6			
Common ringtail possum, *Pseudocheirus peregrinus*	6·2			
Common brushtail possum, *Trichosurus vulpecula*	2·7			
Indeterminate possum	2·7			
Total possums		11·6		
Potoroo, *Potorous* spp.	0·5			
Total native medium-sized mammals			19·7	
European rabbit, *Oryctolagus cuniculus*	7·8			
Fox, *Vulpes vulpes*	1·6			
Cat, *Felis catus*	0·3			
Total medium-sized mammals				29·4
Small mammals				
Marsupial mouse, *Antechinus* spp.	0·3			
Broad-toothed rat, *Mastacomys fuscus*	0·3			
Swamp rat, *Rattus lutreolus*	0·3			
Indeterminate, *Rattus* or *Mastacomys*	0·8			
Total small mammals				1·7
Birds				
Emu, *Dromaius novaehollandiae*	0·3			
Indeterminate bird	2·1			
Frog, lizard, snake, unidentified	1·9			
Fish, unidentified	0·3			
Insects, unidentified	4·4			
Bone, meat, fat, hide, indeterminate	2·7			

Results

Diet

Stomachs of 372 dingoes contained food items which are listed specifically in Table 1 along with respective percentage occurrences. Most dingoes had eaten large and

medium-sized native mammals (89·3%). with wallabies (two species) predominating (50·8%). The occurrence of sheep (4·8%) and cattle (2·4%) was low. The feral pig *Sus scrofa* (4·0%) and rabbit *Oryctolagus cuniculus* (7·8%), which are pests, were found in slightly more dingoes. The incidences of livestock are discussed further below. Among medium-sized mammals (29·4%), the rabbit was the commonest followed by the echidna (7·0%), but the possums as a group were most frequent (11·6%). All other dietary items were uncommon.

There were 85 dingoes with empty stomachs, and 73 with detritus or other items not regarded as food because they could have been ingested incidentally. March flies (Tabanidae) and blowflies were not regarded as food, as these insects pestered trapped dingoes, one of which had 121 March flies in its stomach. Dingo hair, found in 71 stomachs (14%), is ingested in grooming, and dingoes do gnaw at legs caught in the trap, sometimes biting off extremities.

Table 2. Domestic and feral livestock and other prey in dingoes' stomachs, and the distances at which dingoes were caught from the nearest sheep

Stomach contents	Distance (km) from sheep										Total
	0	1	2	3	5	10	15	25	50	72	
Pig	4	8	0	0	0	0	0	0	1	0	13
Horse	0	0	0	0	0	1	0	0	0	0	1
Cattle	4[A]	1[B]	0	0	0	2[C]	1	1	0	0	9
Sheep	8[D]	3[E]	4[F]	1[G]	0	1	0	0	0	0	17
Other prey	21	31	46	32	62	27	14	9	7	4	253
Nil or detritus	13	13	14	21	35	15	6	7	2	2	128
No. of dingoes	50	56	64	54	97	46	21	17	10	6	421
Percentage	11·9	13·3	15·2	12·8	23·1	10·9	5·0	4·0	2·4	1·4	

[A] Two contained calf, both killed by dingoes and used as lures. Another was carrion also.
[B] A carcass used as lure.
[C] One contained mostly rabbit.
[D] Four contained carrion and one had wombat hair also. Another contained mostly carrion wallaby.
[E] One contained carrion from a lure, and another a few feathers also.
[F] One contained carrion from a lure. Another was mostly ring-tailed possum and wallaby.
[G] Carrion.

Distance from Sheep

The distances at which 421 dingoes were caught from the nearest sheep and their stomach contents are summarized in Table 2. Five dingoes with remains of livestock identified in the stomach had also eaten other prey, as indicated in footnotes, but they were recorded only in the appropriate livestock category in the Table (see Table 4 also).

Sixteen of the 17 dingoes with sheep remains in the stomach were caught within 3 km of sheep; 207 other dingoes were caught within that distance. The majority of food items in the stomachs of those dingoes were native prey (86·4%). Another 5·3% contained feral pig. There were almost as many dingoes with remains of pig in their stomachs as there were with sheep. Four of 100 dingoes trapped well away from sheep (>10 km) contained remains of cattle and another had the remains of horse in the stomach. Horses are wild in some places.

Only 20 dingoes (5·4% of those with any food in the stomach) contained blowfly maggots in their stomachs and seven of them contained sheep remains. Two of the dingoes had been trapped on sheep carcasses used as lures by the trappers.

Type and Weight of Stomach Contents

The kinds of tissue (hair, hide, bone, meat, fat) from large prey which were found in stomachs are given in Table 3. Of the 309 items specifically identified, the majority were hair

alone (58·2%) and over two-thirds were hide and/or hair only (67·3%). Only 9·7% contained any meat or fat, the more digestible items.

The wet weights of remains from large prey were mostly low (Table 4). Almost a quarter (23·4%) were of hair weighing 1 g or less, and two-thirds (66·7%) weighed 50 g or less. Only 12·1% of stomachs contained 500 g or more. Two of those 24 dingoes had fed on carrion sheep, one of which had been used as a lure (see footnote *c*, Table 4). Four dingoes with sheep remains in their stomachs had eaten native prey as well. Two which had cattle remains in the ingesta had eaten rabbit also. Another four dingoes had eaten carrion cattle, and three of them had been trapped on carcasses used as lures.

Table 3. Incidence of various tissues of large prey found in 293 dingo stomachs

Sixteen dingoes each contained two of the items listed, making a total of 309 items. Five dingoes which contained sheep remains also contained remains of bird, common ringtail possum, common wombat, wallaby and rabbit respectively

	Hair	Hair + hide	Hair + hide + meat + fat	Bone + any other	Total
Common wombat	32	5	5	6	48
Swamp wallaby	32	2	4	21	59
Red-necked wallaby	30	6	2	7	45
Wallaby (indeterminate)	58	7	7	20	92
Eastern grey kangaroo	10	3	2	7	22
Pig	5	2	4	4	15
Horse	1	0	0	0	1
Sheep	8	2	5	3	18
Cattle	4	1	1	3	9
Total	58·2%	9·1%	9·7%	23·0%	309

Table 4. Wet weights of large prey in stomach contents of 198 dingoes

	No. with weight (g) of:					
	<1	1–50	51–200	201–500	1000+	Total
Common wombat	5	17	6	1	1	30
Swamp wallaby	11	16	11	4	0	42
Red-necked wallaby	5	17	6	4	0	32
Wallaby (indeterminate)	17	19	9	6	0	51
Eastern grey kangaroo	1	7	3	2	0	13
Pig	3	1	2	1	0	7
Sheep	3	6[A]	4[B]	3[C]	1	17
Cattle	2	4[D]	2[E]	0	1	9
Total (%)	23·4	43·3	21·4	10·4	1·5	201

[A] One stomach contained carrion with common wombat hair (< 1 g), one had bird (12 g), and one had common ringtail possum (69 g) and wallaby (16 g) also.

[B] One contained wallaby footpad (23 g) also.

[C] One a lure and one carrion.

[D] One a lure and one carrion, and two with rabbit (51 and 160 g) also.

[E] Both calves, killed by dingoes and then used as lures.

The maximum time which a dingo could have spent in the trap before it was checked appears to have influenced the weight of ingesta (Fig. 2). The latter was low for dingoes estimated to have been in traps for more than 24 h. Those recorded as having been in traps for 24 h were probably in them for less time. Of 25 dingoes that were shot or were road casualties, however, three were empty, another nine had less than 100 g in their stomach and

13 had more than 100 g (Fig. 2). So whether a dingo had eaten before it was trapped may also be a factor in the interpretation of our results.

Numbers of Non-target Wildlife Caught in the Two Types of Trap

During the period of capture of 146 dingoes for which we had detailed information, 513 other animals were caught (Table 5). The large 'Lane' traps caught proportionately more large native animals than the small 'Oneida' traps (Table 5). In particular, for 5·6 times more trap-nights, 'Lane' traps caught proportionately more wombats, wallabies, and kangaroos than 'Oneida' traps (169 *v.* 2). The trend was the same for the medium-sized possums, and lyrebirds (85 *v.* 1). Part of those differences may be due to different abundances, but all species are ubiquitous in the region. Moreover, kangaroo and wombats were never found in 'Oneida' traps although some were sprung by them. Because of their smaller size the 'Oneida' traps are unlikely to catch large-footed animals including the wallabies and emu. The sizes of jaw spaces of the 'Lane' and 'Oneida' traps when the jaws are open are respectively 383 and 240 cm^2, i.e. the 'Lane' is 1·6 times larger than the 'Oneida'. The ratio between captures of all non-target species per 100 trap-nights by the 'Lane' and 'Oneida' is 1·7, and 3·3 when only native wildlife are compared.

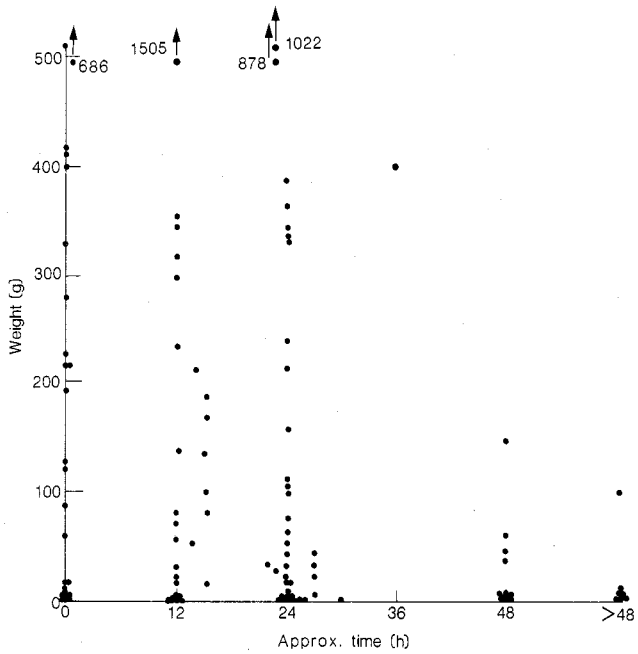

Fig. 2. The decline in wet weight of stomach contents compared with the maximum time during which the dingo was in the trap.

Frequency of Capture of Dingoes on Various Lures

Almost half (40·8%) of the dingoes were caught on carcasses, 19·3% on protected mammal species, 12·4% on sheep and cattle, and 9·1% on dingo, fox and cat (Table 6). Non-target wildlife caught in traps usually provided the relevant carcasses (see above). Only 11·1% of dingoes caught at carcasses had remains of the respective species in their stomachs and 45·2% of them had other items.

The greatest percentage of dingoes caught on any one lure, 22·5%, was for urine from dogs or dingoes. An additional 5·5% were caught at places in which trappers' dogs took special

interest, probably sites where dingoes had excreted. At least 46·4% of the dingoes were caught on material which probably contained canid pheromones. Also, some 'special lures', almost certainly included dog or dingo urine (including that from oestrous bitches), faeces, or mixtures of them.

Table 5. Target and non-target wildlife caught

Dingo capture: $\chi^2_1 = 45{\cdot}01$ ($P < 0{\cdot}001$). Other captures: $\chi^2_1 = 13{\cdot}81$ ($P < 0{\cdot}001$)

Species	'Lane' traps	'Oneida' traps
Mammals		
Short-beaked echidna, *Tachyglossus aculeatus*	1	0
Bandicoot, *P. nasuta* or *I. obesulus*	3	0
Common brushtail possum, *Trichosurus vulpecula*	49	1
Common wombat, *Vombatus ursinus*	69	0
Swamp wallaby, *Wallabia bicolor*	92	2
Eastern grey kangaroo, *Macropus giganteus*	8	0
European rabbit, *Oryctolagus cuniculus*	21	1
Pig, *Sus scrofa*	6	1
European cattle, *Bos taurus*	1	0
Dingo, *Canis familiaris dingo*	95	51
Farm dog, *Canis familiaris familiaris*	1	0
Fox, *Vulpes vulpes*	118	25
Cat, *Felis catus*	36	4
Birds		
Emu, *Dromaius novaehollandiae*	9	0
Whistling kite, *Haliastur sphenurus*	0	1
Wedge-tailed eagle, *Aquila audax*	1	1
Hawk, Fam. Accipitridae	0	3
Wonga pigeon, *Leucosarcia melanoleuca*	7	0
Tawny frogmouth, *Podargus strigoides*	1	0
Superb lyrebird, *Menura novaehollandiae*	16	0
Spotted quail-thrush, *Cinclosoma punctatum*	1	0
White-winged chough, *Corcorax melanorhamphus*	4	0
Australian magpie, *Gymnorhina tibicen*	1	0
Raven, *Corvus* sp.	7	6
Reptiles		
Goanna, *Varanus varius*	2	2
Blue-tongue lizard, *Tiliqua* sp.	1	0
No. of trap-nights	16 464	2692
Total non-target species (number per 100 trap-nights)	455 (2·76)	47 (1·59)
Total dingoes (number per 100 trap-nights)	95 (0·58)	51 (1·72)

Discussion

The results indicate that the dingoes in this sample had been eating mostly large and medium-sized mammals. This is similar to findings from other studies (Coman 1972; Newsome *et al.* 1973; Corbett 1974; Robertshaw 1976; Whitehouse 1977; authors' unpublished data).

That so many possums, common wombats and swamp wallabies (non-target species), were caught, killed and discarded might indicate that dingo populations may be sustained or assisted by such activities. We have no doubt that they do feed upon them even though four times as many dingoes caught at carcasses had eaten other food than had eaten the species used as carcasses. Along two of the CSIRO trap-runs, all non-target species caught were removed. Subsequently two dingoes were caught and found to contain remains of wallaby

and wombat respectively. Corbett (1974) provided evidence from four other dingoes caught along a trap-line before any other wildlife, and they had eaten possum, wallaby and wombat. Although these samples are small, scavenging is not indicated. The wildlife species mentioned above are common throughout the study area (Newsome and Catling 1979), so that the diet and fauna trapped are likely to reflect prey abundances more than anything. On the other hand, many of the dingoes which had sheep remains in the stomachs had been scavenging.

A major difficulty in using this sample of trapped dingoes to indicate diet was the small amounts and the kinds of animal remains found in stomachs, due to differential digestion and the length of time that any dingo was in a trap. Over half of the dingoes had hair only in the stomach, and two-thirds, hair and hide. The stomach contents accordingly weighed 1 g

Table 6. The number of dingoes caught on various lures and the stomach contents of dingoes caught on those carcasses

Lures	No. caught	No. with that prey in stomach	No. with other food present
Carcasses			
Possum	5	1	3
Common wombat	26	2	15
Wallaby	20	5	9
Eastern grey kangaroo	7	0	2
European rabbit	1	0	1
Sheep	12	2	2
Cattle	26	1	14
Dingo	14	3	2
Fox	6	0	4
Cat	8	0	4
Other			
Dog urine	69		
Dog faeces	12		
Places where dingoes urinate or defaecate	24		
Places of interest to trappers' dogs	17		
Trappers' special recipes	44		
Aniseed oil	1		
Diesel oil	2		
Fauna trails	11		
Total	305		

or less in about one-quarter of the animals and 50 g or less in about two-thirds of them. The representativeness of such data in providing a rigorous analysis of diet is therefore questioned. The breadth of the diet as determined is probably representative for animals with hard parts; but frogs, offal and similar material are less likely to be represented adequately. Another factor influencing interpretation is that some trapped dingoes may not have eaten. Three of the 25 shot dingoes which had not been trapped had empty stomachs, a proportion (0·12) not significantly different from that found in the trapped dingoes (0·16) and the same as found by Corbett (1974) in trapped dingoes from part of the same general study area. Whitehouse (1977), however, found significantly fewer empty stomachs in his sample (0·09) from various inland parts of Western Australia than found in this study ($P<0·05$). Possibly the trappers there checked their traps more frequently.

About 1 in 30 of the full sample of dingoes had remains of sheep in stomachs, and 1 in 60 had remains of cattle. For dingoes with any food in the stomachs, the values were about 1 in 20 and 1 in 40 respectively. Over one-third of them had eaten sheep or cattle as carrion and

almost half of those eating carrion had obtained it from lures. However, it is commonly reported that sometimes sheep are killed by dingoes and not eaten immediately, if at all. Nevertheless, the dingoes with sheep and cattle remains in their stomachs appear to have been scavenging to a greater extent than those with remains of native mammals in their stomachs.

The great majority of dingoes with sheep and cattle remains in the stomach were caught within 3 km of sheep. Trapping further into the forest is considered by trappers and landholders to be 'insurance' against dingoes moving in from afar to attack sheep on farmland. A study of this kind can provide no evidence one way or the other. On the basis of the dingoes caught, however, at least one-half of the trappers' effort was on land more than 3 km from farmland, and up to 72 km away from it. Perhaps more trapping effort should go into the first 3 km or so, rather than deeper in the forest.

The smaller 'Oneida' traps caught proportionately fewer 'non-target' species of wildlife than the larger 'Lane' traps. Admittedly, in our trapping we tried to avoid catching wildlife, by setting just off the roads and fauna trails, and away from trees used by possums. On the other hand, the trappers at the time sometimes aimed to remove other wildlife (non-target species) so that dingoes could then be caught, a practice which is now banned. The difference in the catches of non-target species, however, was strongly correlated with the different sizes of the traps. That the 'Oneida' traps caught proportionately fewer non-target species than the 'Lane' traps may have contributed to the higher catch of dingoes in the former.

Overall 'Lane' traps caught an average of 1·9 individuals of protected wildlife for every dingo, compared with 0·3 for every dingo in 'Oneida' traps. Corbett (1974) recorded other mammalian species caught in 'Lane' traps than are reported here, the common ring-tail possum *Pseudocheirus peregrinus*, the sugar glider *Petaurus breviceps*, the greater glider *Petauroides volans*, koala *Phascolarctos cinereus*, long-nosed potoroo *Potorous tridactylus*, deer *Cervus* sp. and a marsupial carnivore, probably a tiger cat, *D. maculatus*. The capture of wildlife, though not to be condoned, is probably not detrimental to their populations as a whole. The results reported here indicate that the toll of non-target species caught in steel-jawed traps set for dingoes could be reduced by the use of the small 'Oneida' traps and, in all probability, by better selection of trap-sites.

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