

Dog Keeping in Taiwan: Its Contribution to the Problem of Free-Roaming Dogs

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This study conducted a quantitative ethnographic analysis of the influence of demographic factors and early experience (childhood exposure to dogs) on Taiwanese dog-keeping practices and behavior. A telephone survey of a randomly selected sample of 2,001 Taiwan residents determined their dog ownership histories, current patterns of dog ownership and disposal, and other dog-related activities. The results suggest that low rates of neutering, easy availability of low- or no-cost puppies, a tendency to allow owned dogs free access to the outdoors, unrealistic expectations of dog ownership, canine behavioral problems, and religious and cultural taboos against euthanasia and shelter relinquishment have contributed to the recent increase in the numbers of free-roaming dogs in Taiwan. Logistic regression analyses determined that a relatively small number of demographic and experiential variables predicted dog ownership and disposal patterns. The most important of these was childhood experience of living with household dogs. In light of these findings, future efforts to reduce the stray dog problem should focus on enforcing registration fees, particularly for unsterilized animals; low-cost neutering schemes; and educational programs designed to promote neutering, improve knowledge of canine behavior and behavior

problems, and develop more realistic expectations and attitudes toward dog ownership. Marked Taiwanese resistance to canine euthanasia and shelter relinquishment suggests a need for alternative methods of managing the existing free-roaming dog population.

According to some estimates, the current world population of domestic dogs (*Canis lupus familiaris*) may be as high as 500 million, of which a substantial, although unknown, proportion is poorly supervised or free-roaming (Matter & Daniels, 2000). In most cases, free-roaming dogs suffer high mortality and low reproductive success, and their quality of life is generally poor due to chronic disease and malnutrition (Boitani, Francisci, Ciucci, & Andreoli, 1995). The socioecology of so-called stray dogs—used here as a synonym for free-roaming dogs (Boitani et al., 1995)—and their perceived impact on public health have been the subjects of reasonably extensive research (Beck, 1973; Bogel, 1990; Boitani et al., 1995; Daniels & Bekoff, 1989; Macdonald & Carr, 1995; Matter & Daniels, 2000; Rubin & Beck, 1982; Slater, 2001). However, although most authorities agree that human factors, such dog-related attitudes and beliefs, are responsible primarily for the worldwide problem of stray or free-roaming dogs, these factors have been poorly studied (Fielding & Mather, 2000; Matter & Daniels, 2000; Slater, 2001). This article is the first of two describing the results of a comparative ethnographic analysis of dog-related attitudes and behavior in Taiwan and their contribution to this island's stray dog problem. It focuses specifically on the influence of human demographic factors and early experience (e.g., childhood exposure to dogs) on Taiwanese dog-keeping practices and behavior. Serpell and Hsu are preparing a second article to address the role of Taiwanese attitudes both toward dogs in general and toward stray dogs in particular.

The Republic of China on Taiwan lies 160 km off the coast of mainland China. With a population of 22 million people living in an area of 36,000 km² (slightly smaller than the states of Maryland and Delaware combined), it is one of the most densely populated regions of the world. The human population of the island is of mixed ethnic and cultural origins, comprising Taiwanese (including Hakka; 84%), mainland Chinese (14%), and aboriginal groups (2%; Central Intelligence Agency [CIA], 2002). In addition to its human population, Taiwan, like many other Asian countries, supports a substantial population of stray or free-roaming dogs. During the late 1980s and early 1990s, the island experienced a sudden increase in its stray dog population, particularly in urban areas. In 1992, this population of free-roaming dogs was estimated at 1.3 million, or 36% of the island's total dog population (Shyr & Yeh, 1992). The poor welfare of these animals and the inadequacy of both public and private efforts to deal with them soon attracted worldwide media attention and vociferous lobbying by local and international animal protection groups (Leney & Marks, 1996).

In October 1998, in response to this and obvious public health concerns, the Taiwan government approved a new Animal Protection Law requiring (a) mandatory registration of dogs, (b) substantial dog registration fees, (c) fines for people who abandon companion animals, and (d) veterinary supervision of all animal control shelter euthanasia. Euthanasia methods in some local government shelters previously had included unsupervised electrocution, gassing, drowning, poisoning, and starvation (Leney & Marks, 1996). In addition, some municipalities instituted improved garbage disposal regimes to reduce the amount of waste food available to strays, and a number of new, state-of-the-art animal shelters were constructed at public expense. These efforts appear to have been partly successful, at least in the short term. According to recent surveys conducted in the city of Taipei, the stray dog population declined from 55,000 to 18,000 between July 1999 and July 2000, despite a small increase in the owned or pet dog population during the same period (Fei, 1999; Kuo, 2000).

Despite these promising short-term changes, lasting improvements in the treatment of dogs in Taiwan will be difficult to achieve without a better understanding of how demographic, sociological, and cultural forces contributed to the creation of the original problem. As previous authors have noted, successful management of companion animal populations involves three distinct components: legislation, animal control, and education (Arkow, 1991). Taiwan has made important strides forward in the first two of these areas, but appropriate public education programs still need to be developed and targeted where they will have the greatest positive impact on attitudes and behavior. An important goal of this study is to provide data to assist in the design and implementation of such programs.

MATERIALS AND METHODS

Questionnaire Development

Open-ended, face-to-face interviews with individual members of key focus groups in Taiwan—government administrators; animal protectionists; religious authorities; dog feeders (people who habitually feed stray dogs); veterinarians; and urban, suburban, and rural residents—were conducted initially and recorded on audiotape. The content of these interviews was transcribed and used as the basis for constructing a random-digit-dialed telephone survey to detect sociological, cultural, and demographic determinants of Taiwanese attitudes and behavior, both toward dogs in general and toward stray dogs in particular. The final survey comprised 95 questions. This article presents the results of this telephone survey as they relate to Taiwanese dog-keeping practices and analyzes how these practices are influenced by demographic and experiential factors such as

age, household size, income, gender, marital status, ethnic background, educational level (of the respondent and respondent's parents), religion (of the respondent and the respondent's parents), area of current residence, area of residence during childhood, housing situation, childhood experience with household dogs, and method of keeping childhood dogs.

Telephone Survey

The telephone survey was divided into six sections: (a) participant's demographic background; (b) participant's general attitudes toward dogs; (c) participant's attitudes toward stray or free-roaming dogs; (d) participant's experience or knowledge of dog abandonment by others; (e) participant's own dog ownership history; and (f) participant's attitudes toward, and care of, any currently owned dogs. All participants completed the first five sections, and completion of the final section depended on whether participants owned dogs currently or had owned them in the past. The questionnaire was developed initially in English and then translated into Chinese. Before the formal telephone interview, the Office of Survey Research (OSR) at the Academia Sinica in Taiwan reviewed, modified, and pretested the Chinese version. Only persons older than 18 years were interviewed. The OSR randomly selected telephone numbers from the Taiwan telephone directory. Of the 5,760 numbers dialed, 2,510 were answered; 509 (20%) households declined the interview, resulting in 2,001 (80%) completed telephone interviews between November 29 and December 16, 1999. The vast majority of the phone numbers (> 99%) were dialed between 5:30 and 9:30 p.m., and less than 1% were dialed between 1:00 and 5:00 p.m. The average time for completing one interview was 12.5 min ($SE = 0.6$ min). According to recent figures (CIA, 2002), Taiwan enjoys a higher rate of telephone ownership than does the United States (1.26 versus 0.94 telephones per person). Therefore, it is unlikely that the lack of a telephone excluded a significant proportion of the population from participation in the survey.

Mandarin, the official spoken language of Taiwan, was used by 1,499 respondents (75%). Taiwanese also is common on Taiwan, and 299 (15%) respondents used it to complete the interviews. One hundred and ninety nine respondents (10%) used a mix of Mandarin and Taiwanese. Three respondents (0.15%) used a mix of Mandarin and Hakkanese.

Statistical Analysis

Multiple logistic regression analyses were used to evaluate the influence of demographic and experiential factors on Taiwanese dog-keeping practices when other important variables also were taken into consideration. A nonautomatic, backward stepwise selection procedure was used for model selection (Neter,

Kutner, Nachtsheim, & Wasserman, 1996). Beginning with a model containing all possible explanatory variables, individual variables were eliminated one by one, starting with the least significant ones (likelihood ratio test, $p > .10$), until no further variables could be dropped. A p value of .10 was selected so that any variable that might have an important effect on the response variable would be retained within the model. Previously eliminated variables then were retested (likelihood ratio test, $p \leq .05$), and any of those that significantly improved the fit of the model were re-added. This procedure was repeated until no more previously eliminated variables could be added back into the model. The model selection process was accomplished using StatView software (SAS, 1999).

RESULTS

Summary Statistics

Demographic characteristics of the sample. Although the total sample size for the telephone survey was 2,001, not every participant was asked to answer every question because of individual differences in dog-ownership status and history (discussed earlier). The findings reported here therefore are based on the number who answered the relevant survey questions rather than the total sample.

The relevant demographic characteristics of the sample are provided in Table 1. These results are similar to those obtained in previous surveys (CIA, 2002; Fei, 1999; Shyr & Yeh, 1992), which suggests that this was a representative sample of the Taiwan population. A number of demographic trends can be observed in the data. In particular, respondents to the survey tended to be educated to a much higher level than their parents, and they reported declining affiliation with traditional Asian religions (e.g., Buddhism, Taoism, Confucianism, Id-Kwan Tao, folk religion) and an increase in atheism, compared with their mothers and fathers. Although most respondents currently live in cities, the majority reported growing up in rural areas. These trends generally are symptomatic of the fast pace of urban industrialization in Taiwan in recent years (CIA, 2002).

Patterns of dog ownership and disposal. Slightly more than half (53.6%) of all respondents reported growing up in families with household dogs. Most of these dogs ($n = 1,073$) were unrestrained and allowed to move freely in and out of the house (46.7%); 29.5% of them were kept indoors and confined or restrained in some way; some were kept indoors but otherwise unrestrained (16.3%); and the rest (7.5%) were kept outdoors. These patterns of dog keeping were influenced by areas of residence during childhood. City families tended to keep their dogs indoors, rural families kept them outdoors or with access to the outdoors, and

TABLE 1
Demographic Characteristics of the Sample

<i>Variables</i>	<i>Respondents</i>	<i>Fathers</i>	<i>Mothers</i>
Age in years	<i>N</i> = 2,001	—	—
<i>M</i>	41		
<i>SE</i>	±0.3		
Income (%)	<i>N</i> = 1,688		
< 10,000 NT\$ ^a	4.9	—	—
10,000 to 50,000 NT\$	36.2	—	—
50,000 to 100,000 NT\$	36.6	—	—
100,000 to 200,000 NT\$	17.7	—	—
> 200,000 NT\$	4.6	—	—
Sex (%)	<i>N</i> = 2,000		
Women	50.8	—	—
Men	49.2	—	—
Marital status (%)	<i>N</i> = 2,001		
Married with children	73.5	—	—
Married without children	2.7	—	—
Single	22.3	—	—
Widowed	1.0	—	—
Divorced/separated	0.3	—	—
Ethnic identity (%)	<i>N</i> = 1,992		
Taiwanese	78.5	—	—
Chinese	11.6	—	—
Hakka	8.6	—	—
Aboriginal	1.2	—	—
Educational level (%)	<i>N</i> = 1,995	1,875	1,904
Post graduate degree	2.2	0.6	0.2
College degree	29.8	8.2	3.1
Senior high/professional school	34.4	12.0	8.3
Junior high	13.9	13.2	9.9
Elementary school or less	19.7	66.1	78.6
Religious affiliation (%)	<i>N</i> = 1,995	1,983	1,988
Traditional Asian	67.7	75.4	77.6
Western	4.8	3.9	4.2
No religion	28.2	20.7	18.3
Area of current residence (%)	<i>N</i> = 2,001		
Urban	58.6	—	—
Suburban	19.6	—	—
Rural	21.7	—	—
Area of childhood of residence (%)	<i>N</i> = 1,995		
Urban	36.9	—	—
Suburban	13.0	—	—
Rural	50.8	—	—
Current housing (%)	<i>N</i> = 1,996		
High-rise apartment	12.0	—	—
Low-rise apartment or house	87.0	—	—
Farm	0.6	—	—

^a1US\$ = approximately 34NT\$.

suburban families displayed intermediate dog-keeping habits, $\chi^2(6, N = 1,072) = 72.33, p < .0001$.

As adults, more than half ($n = 1,171$; 58.5%) of all respondents had owned at least one dog. These respondents are referred to hereafter as current or former dog owners. Of these people, 37.25% had owned 1 or 2 dogs; 33.3% had owned 3 to 5 dogs; 13.2% had owned 6 to 10 dogs; and 16.1% had owned more than 10 dogs. Among current or former dog owners, 30.4% reported having adopted a stray dog at some point in their lives; 33.6% reported losing dogs who had escaped, run away, or gotten lost; and only 1.5% reported having had a veterinarian euthanize at least one of their dogs.

Only 5.3% of the current or former dog owners admitted to having released or abandoned at least one of their dogs on the street or in a park. The two most common reasons for releasing or abandoning a dog were that it was too much trouble to look after (36.1%) and behavior problems (29.5%). Too much trouble included such reasons as too much time, effort, or trouble to keep the dog; losing interest in keeping the dog; and just not wanting it anymore. Other reasons for abandoning dogs were too many household dogs (13.1%); a change in life circumstance, such as moving, leaving the country, and so on (11.5%); and the dogs being ill or injured (9.8%).

Although only 5.3% of current or former dog owners admitted to having released or abandoned dogs onto the street, 31.9% of those interviewed claimed to know personally of someone who had released or abandoned dogs onto the street. Most were described as neighbors (45.4%) or friends (35.6%) of the respondents. The rest were relatives (8.4%), casual acquaintances (5.7%), parents (3.2%), spouses (0.6%), or siblings (0.4%). When asked why these individuals abandoned dogs, 537 respondents provided answers. The most frequent responses were too much trouble (28.3%), too many dogs (25.9%), and behavioral problems (22.5%). Minor reasons included a dog being sick or injured (10.6%), a change in life circumstances (7.8%), allergy or other health problem (1.5%), to avoid the proposed new registration fee (0.9%), and others (2.4%). This last category included superstitious beliefs, such as the idea that it is bad luck to have two or more dogs in the same household or that keeping dogs with white paws or extra toes is unlucky. (Some informants attributed the inauspiciousness of dogs with white paws or extra toes to the fact that some believe such dogs to be the reincarnation of disreputable persons.) Three hundred and seventy-one respondents also provided reasons why abandoners did not have unwanted dogs euthanized. The most common reasons were that these individuals wanted to give the dogs another chance at life or they thought euthanasia was cruel (50.7%) and that the thought never occurred to these people or these people had never heard of euthanasia (34.5%). Minor reasons included too much trouble to have the dog euthanized or not wanting to spend the money (6.7%), being afraid of bad luck (2.7%), and others (5.4%).

When current or former owners were asked what had happened to their last or most recent previous dog, the most common responses were that they had died of natural causes (38.5%), escaped or got lost (15.5%), was given away (14.9%), all the dogs are still with me (12.8%), had died of an accident (12.5%), and was released or abandoned (2.6%).

Current dog owners. Four hundred and fifty-nine respondents (22.9%) owned at least one household dog at the time of the interview. The average number of dogs in each household was 1.64 ($SE = \pm 0.08$), with most (69.5%) households owning only one dog. Of the 749 owned dogs, 57% were male. This slight preference for male dogs was statistically significant, $\chi^2(1, N = 749) = 14.16, p < .001$. More than half (51.3%) of these respondents kept their dogs inside the house under some form of restraint or confinement, 27.7% of them kept their dogs indoors and unrestrained, 13.5% allowed their dogs to move freely in and out of the house, and 7.4% kept their dogs outdoors. Respondents tended to keep their current dogs the same way that their families kept their dogs when they were children (Fisher's Exact test, $p < .0001$), and respondents who kept their current dogs indoors tended to have owned fewer dogs than those who kept their dogs outdoors or who allowed them free access to the outdoors (Mann-Whitney U test, $p = .05$). Consequently, respondents who grew up in families who kept dogs indoors were likely to acquire fewer dogs as adults because of this relationship (Mann-Whitney U test, $p = .0008$).

Of the 452 respondents who provided the sources from which they acquired their dogs, 52.2% indicated they received the dogs from friends, relatives, or strangers; 22.6% reported rescuing dogs off the street; 13.5% bought their dogs from pet stores, breeders, or markets; 2.9% obtained their dogs by keeping puppies bred from previous household dogs; 0.7% adopted dogs from shelters; and 8.2% obtained their dogs from multiple sources. For the respondents who obtained their dogs from more than one source, 77.8% indicated friends, relatives, or strangers; 41.7% reported rescuing dogs from the street; 47.2% bought dogs from pet shops, breeders, or markets; 36.1% obtained them from previous household dogs; and 2.8% adopted dogs from shelters.

The primary reasons offered for acquiring dogs were multiple reasons (37.3%), for fun (21.4%), guarding or security (18.5%), companionship (11.0%), because they felt sorry for it (8.8%), and as a gift (2.7%). For the current owners who acquired dogs for multiple reasons, 52.0%, 77.8%, 81.4%, 16.8%, and 7.8% of them indicated fun, guarding or security, companionship, felt sorry for it, and gift to be one of their reasons, respectively. A highly significant relationship was found between respondents' reasons for acquiring dogs and their methods of keeping them, $\chi^2(12, N = 453) = 38.85, p < .0001$. Post hoc cell contributions suggested that those who acquired dogs primarily for companionship were likely to keep them inside, unconfined, whereas those acquiring them mainly for guarding or security tended to keep them inside and confined.

Those who acquired dogs because they felt sorry for them kept them mainly outdoors.

More than half (52.5%) of the current dog owners ($n = 453$) indicated that they spent less than an hour daily playing with, exercising, or taking care of their dogs; 27.4% of them spent 1 to 2 hr daily on their dogs; 8.2% spent 3 to 4 hr daily on their dogs; and 11.9% spent 5 hr or more daily on their dogs. Less than half (41.9%) of the current dog owners ($n = 451$) took their dogs to veterinarians for regular check-ups; 39.5% of the dog owners took their dogs to veterinarians only when the dogs were sick or injured or only for the initial vaccinations; and 18.6% of dog owners had never taken their dogs to a veterinarian. Only 20.3% of the current dog owners ($n = 454$) had their dogs spayed or neutered; 76.2% of the dog owners did not have any of their dogs spayed or neutered; and 3.5% of the dog owners had some of their dogs spayed or neutered. Most (71.7%) reported having their dogs vaccinated. Vaccination against canine rabies is a legal requirement in Taiwan.

Multiple Logistic Regression Analyses

Demographic and experiential factors associated with dog ownership. Multiple logistic regression analysis indicated that only six of the demographic and experiential factors examined had significant effects on the likelihood of a respondent's having owned at least one dog when all factors were taken into consideration (Table 2). The most important factor predicting whether respondents had ever owned dogs of their own was their exposure to dogs during childhood. The odds of having owned at least one dog for people who had grown up with dogs during childhood were 8.42 times greater than for those who did not have childhood dogs. In addition, the odds for male respondents of owning at least one dog were 1.55 times the odds for female respondents. Respondents with bigger families were more likely to have owned at least one dog (odds increased by 6% as family size increased by one); respondents whose fathers had higher levels of education were more likely to have owned a dog (odds increased by 14% as the education level increased by one level); and people describing themselves as Christians were 1.83 times more likely to have owned a dog than people who espoused either no religion or traditional Asian religions. The odds of having owned a dog for people who grew up in rural areas were only 0.78 times as great as the odds for people who grew up in suburban or city areas.

Factors contributing to the number of dogs ever owned. Because the variable of number of dogs that respondents had ever owned contained more than two ordered classes, ordered logistic regression (cumulative logit model) was performed using the proportional odds model (Allison, 1999; Stokes, Davis, & Koch, 1995) simultaneously to investigate the influence of all sociodemographic factors on this variable. Whether a respondent had any childhood dogs and how these dogs

TABLE 2
Results of Logistic Regression Analyses

<i>Variable (Versus Baseline Group)</i>	β	<i>SE</i>	<i>Wald p Value</i>	<i>Odds Ratio</i>	<i>95% CI</i>
Likelihood of "ever owning a dog"					
Likelihood ratio test, $\chi^2(6, N = 1,848) = 481.35, p < .0001$					
Had household dogs as a child—Yes (versus no)	2.13	0.11	< .0001	8.42	6.78 to 10.46
Gender—Male (versus female)	0.44	0.11	< .0001	1.55	1.25 to 1.93
No. people in the household	0.06	0.02	< .01	1.06	1.02 to 1.11
Father's education level	0.14	0.06	.02	1.14	1.02 to 1.28
Childhood residence—Rural (versus city/suburb)	-0.25	0.12	.03	0.78	0.62 to 0.98
Religion—Western (versus traditional/none)	0.60	0.29	.03	1.83	1.04 to 3.19
No. of dogs ever owned					
Model 1: Likelihood ratio test, $\chi^2(7, N = 1,151) = 141.21, p < .0001$					
Had household dogs as a child—Yes (versus no)					
Dogs were mostly kept inside the house, not confined	1.17	0.20	< .0001	3.23	2.21 to 4.74
Dogs were mostly kept inside the house, confined	1.19	0.17	< .0001	3.27	2.35 to 4.56
Dogs were free to get in and out of the house	1.57	0.15	< .0001	4.79	3.56 to 6.46
Dogs were mostly kept outside of the house	1.50	0.26	< .0001	4.48	2.68 to 7.50
Marital status—Married (versus not married)	0.54	0.14	< .0001	1.71	1.31 to 2.24
Residence—Rural (versus city/suburb)	0.36	0.14	< .01	1.43	1.09 to 1.87
Respondent's level of education	0.10	0.06	.07	1.11	0.99 to 1.24
Model 2 : Likelihood ratio test, $\chi^2(5, N = 1,151) = 141.13, p < .0001$					
Had household dogs as a child—Yes (versus no)					
Dogs were mostly kept inside of the house	1.18	0.15	< .0001	3.26	2.41 to 4.41
Dogs were free to get in/out or kept outside	1.56	0.15	< .0001	4.75	3.55 to 6.35
Marital status—Married (versus not married)	0.54	0.13	< .0001	1.72	1.32 to 2.24
Residence—Rural (versus city/suburb)	0.35	0.14	< .01	1.42	1.09 to 1.86
Respondent's level of education	0.10	0.06	.07	1.11	0.99 to 1.23

Likelihood of adopting stray dogs

Likelihood ratio test, $\chi^2(2, N = 1,162) = 7.12, p = .028$

Had household dogs as a child—Yes (versus no)	0.28	0.15	.06	1.32	0.99 to 1.77
No. people in the household	0.04	0.02	.06	1.04	1.00 to 1.10

Likelihood of releasing/abandoning a dog

Likelihood ratio test, $\chi^2(4, N = 1,167) = 14.34, p = .006$

Housing—Low-rise apartment/house (versus high-rise apartment)	1.46	0.73	.04	4.31	1.04 to 17.88
Farm	2.54	1.30	.05	12.72	1.00 to 162.48
Had household dogs as a child—Yes (versus no)	0.69	0.35	.05	1.99	0.99 to 3.98
Religion—Western (versus traditional/none)	0.83	0.43	.05	2.28	0.99 to 5.26

Likelihood of having household dogs escape, get lost

Model 1: Likelihood ratio test, $\chi^2(5, N = 1,162) = 83.03, p < .0001$

No. of dogs ever owned—3 to 5 (versus 1 to 2)	0.93	0.21	< .0001	2.52	1.83 to 3.48
6 to 10	1.16	0.20	< .0001	3.19	2.11 to 4.80
> 10	1.14	0.20	< .0001	3.11	2.12 to 4.58
Residence—Rural (versus city/suburb)	-0.53	0.17	.001	0.59	0.43 to 0.81
Had household dogs as a child—Yes (versus no)	0.38	0.16	.02	1.46	1.06 to 2.01

Model 2: Likelihood ratio test, $\chi^2(3, N = 1,162) = 80.94, p < .0001$

No. of dogs ever owned—More than 2 (versus 1 to 2)	1.03	0.15	< .0001	2.79	2.09 to 3.73
Residence—Rural (versus city/suburb)	-0.52	0.17	.001	0.59	0.43 to 0.82
Had household dogs as a child—Yes (versus no)	0.40	0.16	.01	1.49	1.09 to 2.05

were kept had a significant impact on the number of dogs a person had owned. Including the latter variable in the model would eliminate all the respondents who did not have childhood household dogs from the analysis. Therefore, the two variables were combined into a new variable containing five categories:

1. Did not have dogs as a child.
2. Had dogs as a child who were kept mainly inside and unconfined.
3. Had dogs as a child who were kept mainly inside and confined.
4. Had dogs as a child who were free to move in and out of the house.
5. Had dogs as a child who were kept outside.

When all factors were considered—other than whether the respondent had any family dogs as a child and how these childhood household dogs were kept—marital status and the area of residence also had significant influence on the number of household dogs a past or current dog owner had ever owned. In addition, a respondent's educational level had a marginal effect (Table 2, Model 1). The assumption of proportional odds was validated for this model, Score Test, $\chi^2(14, N = 1,151) = 18.54, p = .18$. Compared with respondents who did not have childhood dogs, the odds of owning more dogs were 3.23 times greater for the respondents who had dogs as a child who were kept inside of the house, unconfined; 3.27 times greater for the respondents who had dogs in childhood who were kept inside the house, confined; 4.79 times greater for respondents who had childhood dogs who were free to move in and out of the house; and 4.48 times greater for those whose childhood dogs were kept outside. The odds of having owned more dogs for respondents who were married were 1.71 times those of unmarried respondents. Respondents living in rural areas were 1.43 times more likely to have owned more dogs than respondents living in cities or suburbs. Although the effect was only marginal, each increase in the level of education of the respondents increased the odds of having owned more dogs by 11%.

As shown in Table 2, for the new variable that combined the effect of whether a respondent had childhood dogs and how these dogs were kept, the coefficient for keeping childhood dogs inside the house and unconfined is very similar to the coefficient for keeping childhood dogs inside the house and confined, whereas the coefficient for allowing childhood dogs to go freely in and out of the house is similar to the coefficient for keeping childhood household dogs outside. For the sake of simplicity, the number of categories in this new variable therefore was reduced to two: had dogs as a child who were kept mostly inside, and had dogs as a child who were allowed in and out of the house freely or kept outside. This reduction in the number of categories did not cause a significant reduction in the fit of the new model (Table 2, Model 2; likelihood ratio test), $\chi^2(1, N = 1,157) = 0.08, p = .96$, and the coefficients for these two categories were significantly different (likelihood ratio test), $\chi^2(1, N = 1,151) = 8.86, p = .003$. The assumption of proportional odds also was validated for this model (Score

Test), $\chi^2(14, N = 1,151) = 10.81, p = .37$. The coefficients for the other variables in the model remain relatively unchanged. Comparison of Models 1 and 2 reveals that respondents who had childhood dogs tended to have owned more dogs as adults than respondents who did not have childhood dogs. In addition, among respondents who had childhood dogs, the odds of owning more dogs was higher for the ones from families who allowed dogs to go outside (odds ratio [OR] = 4.75, compared with those who did not have childhood dogs) compared with those from families who kept their dogs inside (OR = 3.26).

Factors associated with adopting stray dogs. Among all the demographic and experiential factors examined, only childhood exposure to dogs and size of household had marginally significant effects on the likelihood of a respondent adopting a stray dog (Table 2). The odds of adopting stray dogs for current or former dog owners who had been exposed to childhood dogs were 1.32 times as great as the odds for those who did not have any household dogs in childhood. As family size increased by one person, the odds increased by 4%.

Factors associated with dog abandonment. The number of people admitting to releasing or abandoning dogs ($n = 62$) was small, approximately one tenth of the number who reported knowing somebody else who had abandoned or released a dog ($n = 639$). This discrepancy suggests that respondents tended to underreport personal instances of dog abandonment or attributed some of these instances to other people, such as friends or neighbors. To investigate this possibility, reported rates of knowing other people who had abandoned dogs were compared between current and former dog owners and respondents who had never owned dogs (on the assumption that owners and nonowners would be equally likely to have known other people who abandoned dogs). The results indicate that current or former owners were far more likely to have known other dog abandoners than were nonowners (37.1% vs. 24.7%), $\chi^2(1, N = 2,000) = 34.32, p < .0001$.

The results of the regression analysis indicated that housing had the greatest impact, with the likelihood of people admitting to dog abandonment being 4.31 and 12.72 times greater among those living in low-rise housing or farms, respectively, compared with those in high-rise apartments (Table 2). People who grew up with childhood dogs were almost twice as likely to admit to abandoning a dog as those who did not, and Christians (Western religions) were 2.28 times as likely as atheists or followers of traditional, Asian religions to admit to abandoning a dog.

Factors associated with losing household dogs or allowing them to escape. Multiple logistic regression analysis found that the number of dogs respondents had ever owned, area of residence, and exposure to dogs in childhood were the only factors that had significant effects on the likelihood of people losing dogs or

letting them escape (Table 2, Model 1). Of these, the total number of dogs owned was the strongest predictor: People owning 3 to 5, 6 to 10, or more than 10 dogs all were more likely to have lost dogs than those with only 1 or 2 dogs (OR = 2.54, 3.19, 3.11, respectively). However, these three groups did not differ significantly from each other (likelihood ratio test), $\chi^2(2, N = 1,162) = 2.10, p = .35$, and so were combined such that the variable of number of dogs respondents had ever owned contained only two categories: 1 or 2 dogs and more than 2 dogs. The odds of losing household dogs for respondents owning more than 2 dogs were 2.79 times greater compared with those owning only 1 or 2 dogs (Table 2, Model 2). The likelihood of losing household dogs for people living in rural areas was only 0.59 times as great as for those living in cities and suburbs, and people who grew up with childhood dogs were 1.46 times as likely to lose a dog as those lacking this experience.

DISCUSSION

Patterns of Dog Ownership and Dog Acquisition

This study notes some important social and demographic trends that may influence patterns of dog ownership in Taiwan. In particular, and confirming Taiwan's recent phenomenal rate of urban industrialization, we detected a dramatic movement from rural to urban living among our respondents within their own lifetimes. In parallel with this rural exodus, there has been a substantial shift in methods of keeping dogs. More than half (54.2%) of our respondents' parents kept their dogs outdoors or allowed them free access to the outdoors. In contrast, the majority (79%) of current dog owners keep their dogs indoors, presumably in response to their increasingly urban lifestyles. Although this might appear to be a positive trend from an animal control perspective, it also may place unusual strains on the human–canine relationship. The prominence of too much trouble and behavior problems among the list of reasons why dogs are disowned or abandoned (discussed later) certainly points to this conclusion. Compared with their parents, the survey respondents also were considerably better educated and less likely to espouse traditional Asian religious beliefs. This suggests that the current generation of dog owners and prospective dog owners may be more open to accepting new ways of thinking about dogs and their role in society.

The percentage of households identified as owning a dog in this study (22.9%), was similar to other recent estimates of 27.3% (Shyr & Yeh, 1992) and 23.1% (Fei, 1999), respectively. This rate of dog ownership is markedly lower than the 38% reported for the United States (Pet Food Institute, 2000) but similar to that of Japan (24.2%) and the United Kingdom (20.9%), and higher than that of Sweden (15.5%; Egenvall, Hedhammar, Bonnett, & Olson, 1999; Inaba, 1998; Pet Food Manufacturer's Association, 2002).

The average number of dogs in Taiwan households (1.6 dogs per household) and the percentage of dog-owning households that owned only one dog (69.5%) were comparable to that of the United States (1.7 dogs per household, 63%), the United Kingdom (1.3 dogs per household, 79.2%), and Sweden (1.36 dogs per household, 77.9%; American Veterinary Medical Association, 1997; Egenvall et al., 1999; Pet Food Institute, 2000; Pet Food Manufacturer's Association, 2002). People in Taiwan, however, displayed a stronger preference for male dogs (57%) compared to dog owners in the United States and Sweden (both 50%). This finding confirmed a statement by one of our informants that female dogs are less popular in Taiwan because they tend to attract the unwelcome attentions of free-roaming males as well as producing unwanted puppies. The proportion of dogs spayed or neutered in this Taiwan sample (20%) is considerably lower than the 70% reported for the United States (Patronek & Glickman, 1994), although higher than that reported from Japan (12%) or Sweden (5%; Egenvall et al., 1999; Hart, Takayanagi, & Yamaguchi, 1998). Relatively low rates of spaying and neutering in Taiwan do not appear to be due to any cultural prejudice against surgical sterilization. Too much trouble and expense were the reasons most commonly cited by respondents for not having their dogs spayed or neutered. Probably reinforcing this attitude is the reported reluctance of veterinarians to offer these procedures. According to several of our key veterinary informants, many veterinarians believe that the resulting reduction in the dog population will be bad for business. In addition to promoting uncontrolled breeding, low rates of neutering also may contribute more directly to the stray dog problem in Taiwan. Studies of dogs relinquished to animal shelters in the United States have found that sexually intact animals are at considerably greater risk of being disowned (New et al., 2000; Patronek, Lawrence, Beck, McCabe, & Ecker, 1996).

Similar to U.S. residents, people in Taiwan acquire most of their dogs—presumably at little or no cost—from friends, relatives, or strangers (64% in the United States versus 52% in Taiwan). Taiwanese, however, are far more likely to obtain their dogs as strays (22.6%) than are Americans (10%) and much less likely to acquire them from pet stores, breeders, or markets (13.5% in Taiwan versus 36% in the United States); animal shelters (0.7% versus 18%); or by breeding from a previous dog (2.9% versus 18%; American Pet Products Manufacturers Association, 1996–1997).

These differences probably reflect the greater availability of surplus puppies (because of the low rate of sterilization) and free-roaming strays on Taiwan and the paucity and poor quality of the island's animal shelters (Leney & Marks, 1996). Previous studies have shown that pets obtained at little or no cost are at greater risk of being disowned or relinquished by their owners (Arkow & Dow, 1984; New et al., 2000; Patronek et al., 1996). The easy availability of low- or no-cost puppies on Taiwan therefore is likely to be a major contributor to the stray dog problem.

People's reasons for acquiring dogs in Taiwan influenced the way in which they were kept. For instance, people who acquired dogs primarily for companionship tended to keep them indoors but otherwise unconfined, whereas those who acquired them for guarding or security purposes tended to keep them indoors and confined. Keeping guard dogs or watchdogs habitually caged or tethered inside the house or property is a common practice both in Taiwan and mainland China (Osgood, 1975), and it is one that raises special animal welfare concerns. Taiwanese who acquired dogs because they felt sorry for them kept them mainly outdoors, presumably because these were adopted strays who either were penned, caged, or tethered outside or allowed to continue a free-roaming existence despite being owned. Typically, such animals carry no identifying collar or tag and therefore are vulnerable to being classed as strays and then collected by animal control agents. This may help to explain why so many of our respondents reported losing dogs (discussed later).

Although these findings are not strictly comparable because of differences in methods of data collection, it appears that Taiwan dog owners are less likely to acquire their dogs for companionship than are people in Western countries. Companionship or love is the major reason given by people in the United Kingdom for owning a dog (58%) as well as being cited as the primary benefit of dog ownership by 70% of people in the United States (American Pet Products Manufacturers Association, 1996–1997; Pet Food Manufacturers Association, 2002). Although 41% of current dog owners in Taiwan reported companionship as one of their main reasons for obtaining a dog, this was slightly fewer than those who cited guarding or security (47.3%) and fun (45.6%).

Presumably because it is legally required, a high proportion of Taiwanese dog owners reported vaccinating their dogs (71.7%). However, many also reported never taking their dog to a veterinarian (18.6%), or doing so only for initial vaccinations or when the animal was sick or injured (39.5%). Data on dog owners' use of veterinary services in North America and Europe tend to be annualized and therefore are not strictly comparable, but they generally indicate much higher frequencies of veterinary visits (American Veterinary Medical Association, 1997; Egenvall et al., 1999). Infrequent veterinary care has been identified as an important risk factor for canine relinquishment in U.S. animal shelters (Patronek et al., 1996) and also may contribute to dog abandonment in Taiwan. The majority (52.5%) of Taiwanese dog owners also reported spending very little time playing with, exercising, or caring for their dogs (< 1 hr/day). Again, comparable data for the United States and Europe are not available, but it is likely that North American and European dog owners would report higher levels of interaction and involvement with their dogs than this. Taken together, these findings may indicate a less intense human–canine bond in Taiwan than is typical in most Western countries and cultures. (Currently, Serpell & Hsu are exploring this topic in greater detail.)

Both the likelihood of having owned a dog in Taiwan and the total number of dogs owned were found to be affected strongly and positively by childhood expo-

sure to household dogs. These findings replicate the results of previous studies in the United Kingdom and the United States, which found that the experience of living and associating with particular animals during childhood predisposes people to seek relationships with the same species as adults (Paul & Serpell, 1993; Poresky, Hendrix, Mosier, & Samuelson, 1988; Serpell, 1981). Respondents also tended to keep their current dogs the same way that their families kept them when they were children. This, in turn, affected the total number of dogs they were likely to own as adults. Childhood exposure to dogs also predicted people's tendencies to adopt stray dogs as adults, perhaps because early experience of canine attachments promotes greater sympathy toward homeless dogs later in life.

The finding that dog ownership likelihood—and dog numbers—increased with household size and married (versus single) status is in line with previous studies that have shown higher rates of pet ownership among families with children (Brown & Silverman, 1999; Messent & Horsfield, 1985). The greater number of dogs owned by rural (versus urban or suburban) residents may be a reflection of fewer space limitations in rural areas, or it may reflect the greater utilitarian value of dogs as guard dogs or watchdogs among farming communities. The finding that respondents with better educated fathers owned more dogs probably reflects the relatively patriarchal nature of Taiwanese society in which men still tend to dictate family activities. It is not obvious from our survey data why male respondents, or those who espouse Western religions, were more likely to have owned dogs; nor is it clear why better educated respondents kept more dogs. However, if levels of educational attainment continue to rise in Taiwan, as they have in the recent past, this can be expected to continue to impact dog numbers.

Dog Loss, Abandonment, and Disposal

More than one third of dog-owning respondents reported having lost a dog at some point or having had one escape. Comparative data on rates of household dog loss and escape are not available for other countries, but it is likely that the Taiwan figure is high. It is unclear why the Taiwanese are so prone to losing their dogs, but the preponderance of intact male dogs in the population may be a factor. Sexually intact male dogs are more likely to exhibit escaping and roaming behavior than are neutered males or females (Hart & Hart, 1985). Significant numbers of dog owners in Taiwan (20.9%) either keep their dogs outdoors or allow them in and out at will, and this certainly increases the likelihood of animals wandering off and becoming lost. Not surprisingly, this likelihood increases with the number of dogs owned and seems to be a bigger problem in urban and suburban areas—perhaps because wandering dogs find it more difficult to find their way home in densely populated areas or because they are more likely to be injured or killed by traffic or captured by animal control agents. At least some of

these “lost” dogs also may have been abandoned deliberately by their owners but not reported as such. The finding that childhood exposure to dogs also predicted dog loss may reflect the fact that such people also are more likely to adopt strays and keep them outdoors.

Only 62 (5.3%) of the 1,171 respondents who had owned at least one dog admitted to having abandoned or released a dog. Because such a low rate of dog abandonment could not begin to account for the estimated stray dog population of the island—666,549 in 1999 (Fei, 1999)—it appears likely that many respondents gave a false answer to this survey question, perhaps by attributing their own dog abandonments to others or by reporting them as dogs who escaped or got lost. Significantly, 639 respondents reported knowing someone else who abandoned a dog, 10 times the number who admitted doing so themselves. Taiwan’s new Animal Protection Law (1998) makes it an offense, subject to a fine of between \$20,000 and \$100,000 NT (\$700 to \$3,300 U.S.), to abandon a dog. Therefore, respondents had ample incentive to dissimulate on this question.

Among those who admitted to abandoning dogs, the two most frequently reported reasons for abandonment were too much trouble (36.1%) and behavioral problems (29.5%). Furthermore, 50.8% of the people who personally knew of someone who had abandoned a dog believed the abandoner did so because of these two reasons. These findings, together with the statements of some of our key informants, tend to confirm the impression that many Taiwanese dog owners harbor unrealistic expectations of the time, effort, and space required to keep dogs and that they lack basic knowledge of dog behavior. The recent demographic shift from rural to urban living may lie at the root of this problem because rural attitudes toward dogs in Taiwan tend to be relatively detached and *laissez faire*. Behavioral problems and inappropriate care expectations have been identified previously as being among the major reasons that dog owners in the United States relinquish their animals to shelters (Patronek et al., 1996; Salman et al., 1998). This would suggest that providing prospective dog owners (and veterinarians) with greater access to appropriate dog care and behavioral information could help to reduce rates of dog abandonment in Taiwan. Low-rise housing, Western religious beliefs, and childhood dog exposure were the main demographic predictors of reported dog abandonment. However, given the low rate of reporting, it is impossible to say whether these factors predict actual abandonment or the likelihood of reporting it.

Among respondents who reported knowing people who had abandoned dogs, the most frequent reason given for choosing abandonment in preference to euthanasia was to give the dog another chance of life (50.7%). This finding and statements made by many of our key informants suggest that Taiwanese people prefer releasing or abandoning dogs on the street or in public parks to alternative ways of disposing of unwanted animals (e.g., euthanasia or shelter relinquishment). Although this preference for abandoning dogs sometimes is attributed to the influence of Buddhism, one of our informants, a Buddhist monk, indicated that it had more to do with the animist

folk belief in the persistence of animal spirits capable of exacting revenge on those who either killed them or were responsible for their deaths. Only 1.5% of dog owners in Taiwan admitted to seeking euthanasia for one or more of their dogs and usually because the animal was sick or injured. Similarly, only 0.5% indicated that their most recent previous dog was euthanized by a veterinarian.

Comparable data are not available for other countries. According to U.S. surveys, however, roughly 3% of all veterinary visits by dog owners result in euthanasia (American Veterinary Medical Association, 1997), and about 4% to 5% of the dog population is euthanized annually in shelters (Patronek & Glickman, 1994; Patronek & Rowan, 1995). More recently, a survey of shelter relinquishments in the United States suggested that nearly a quarter of these dogs are relinquished for immediate euthanasia (Kass, New, Scarlett, & Salman, 2001). These findings, confirmed by many of our key informants, point to a strongly negative cultural perception of canine euthanasia in Taiwan. Prejudice against euthanasia also extends to the veterinary profession. At the time of this survey, few veterinarians were adequately trained to perform humane euthanasia, and most were reluctant to offer the procedure as an option to their clients. Similar cultural prejudices against euthanasia as a means of disposing of unwanted dogs have been described in Japan (Kogure & Yamazaki, 1990; Miura, Bradshaw, & Tanida, 2000) and the Bahamas (Fielding & Mather, 2000) and may be widespread globally (Serpell, 1995).

This survey did not ask people how often they relinquished unwanted dogs to shelters, but one may assume that such incidents are rare. We heard of a few cases of people abandoning dogs outside the gates of some private shelters, but in general there is no tradition in Taiwan of disposing of unwanted animals by relinquishing them to animal shelters. In any case, as Leney and Marks (1996) demonstrated, the term *shelter* as applied to most animal control or holding facilities in Taiwan is a misnomer—conditions in 62 of the 67 facilities they visited were classified as poor or unacceptable—so it is easy to understand why the majority of Taiwanese would consider abandonment morally preferable.

CONCLUSIONS

A variety of factors have contributed to the creation of Taiwan's free-roaming dog problem. Judging from the fact that more than half of those surveyed grew up with dogs, most of whom were allowed outdoors, it is clear that dog keeping always has been popular on the island and that free-roaming dogs are not a new phenomenon. However, Taiwan's dramatic and recent transition from a predominantly rural to a predominantly urban industrial society has created a situation in which relatively detached rural attitudes toward dogs suddenly have been translocated to urban settings in which they are no longer appropriate. Many modern Taiwanese evidently are ignorant of the difficulties associated with

keeping dogs in spatially restricted urban housing. As a result, many of their dogs develop behavior problems because of excessive confinement or social isolation. Unwanted pets are the inevitable outcome of this process (New et al., 2000). In addition, the majority of Taiwanese dogs are sexually intact, leading to an overproduction of puppies and the general devaluation of dogs because of an excess of supply over demand. When all these factors are combined with specific religious and cultural traditions that discourage the killing of unwanted animals while promoting their abandonment, the recent stray dog population explosion is not entirely surprising.

Efforts to overcome this problem should focus, in the short term, on increasing the value of dogs by enforcing registration fees, especially for unsterilized animals. The creation of low-cost, subsidized neutering schemes operated through local humane societies or veterinary practices also might be beneficial in combination with public education campaigns stressing the health and behavioral benefits of neutering. Although robust evidence of the effectiveness of subsidized neutering schemes as a method of canine population control is not available, it is intuitively likely that reducing the size of the effective breeding population will help to reduce the numbers of unwanted puppies in Taiwan. The reluctance of the Taiwanese veterinary profession to encourage people to spay or neuter their animals also must be addressed through educational efforts because the procedure is unlikely to become widely adopted without the support of veterinarians (Avanzino, 1991). Well-designed educational materials aimed at prospective dog owners also might help to improve public knowledge of dog behavior as well as inculcating more realistic expectations of dog ownership.

It is somewhat doubtful whether Taiwanese cultural resistance to euthanasia and shelter relinquishment can be overcome, at least in the short term. It may, therefore, be more appropriate to capitalize on Taiwanese willingness to feed, care for, and adopt homeless dogs by exploring ways of managing existing free-roaming animals in situ in ways comparable to the various trap–neuter–vaccinate–release programs used increasingly to manage feral cat colonies in the United States (Slater, 2002). This, however, would require a fundamental change in priorities on the part of both government and animal protection agencies.

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REFERENCES

- Allison, P. D. (1999). *Logistic regression using the SAS system: Theory and application*. Cary, NC: SAS.
- American Pet Products Manufacturers Association. (1996–1997). *National pet owners' survey*. Greenwich, CT: Author.
- American Veterinary Medical Association. (1997). *U.S. pet ownership and demographics sourcebook*. Schaumburg, IL: Author.
- Animal Protection Law. (1998). Retrieved August 2002, from http://www.coa.gov.tw/org/animalindustry/Animal_Protection_Law/index.html
- Arkow, P. (1991). Animal control laws and enforcement. *Journal of the American Veterinary Medical Association*, 198, 1164–1172.
- Arkow, P., & Dow, S. (1984). The ties that do not bind. In R. K. Anderson, B. L. Hart, & L. A. Hart (Eds.), *The pet connection* (pp. 348–354). Minneapolis, MN: CENSHARE.
- Avanzino, R. (1991). Pet overpopulation and humane education in schools and communities. *Journal of the American Veterinary Medical Association*, 198, 1237–1240.
- Beck, A. M. (1973). *The ecology of stray dogs: A study of free-ranging urban animals*. Baltimore: York.
- Bogel, K. (Ed.). (1990). *Guidelines for dog population management*. Geneva, Switzerland: World Health Organization/World Society for the Protection of Animals.
- Boitani, L., Francisci, F., Ciucci, P., & Andreoli, G. (1995). Population biology and ecology of feral dogs in central Italy. In J. A. Serpell (Ed.), *The domestic dog: Its evolution, behaviour & interactions with people* (pp. 217–244). Cambridge, England: Cambridge University Press.
- Brown, J. P., & Silverman, J. D. (1999). The current and future market for veterinarians and veterinary medical services in the United States. *Journal of the American Veterinary Medical Association*, 215, 161–183.
- Central Intelligence Agency. (2002). *World fact book*. Retrieved August 2002, from <http://www.odci.gov/cia/publications/factbook/index.html>
- Daniels, T. J., & Bekoff, M. (1989). Population and social biology of free-ranging dogs, *Canis familiaris*. *Journal of Mammalogy*, 70, 754–762.
- Egenvall, A., Hedhammar, Å., Bonnett, B. N., & Olson, P. (1999). Survey of the Swedish dog population: Age, gender, breed, location, and enrollment in animal insurance. *Acta Veterinaria Scandinavica*, 40, 231–240.
- Fei, C. Y. (1999). *Estimating the size of household dog and stray dog populations in Taiwan*. Taiwan: Bureau of Animal and Plant Health Inspection and Quarantine, Council of Agriculture, Executive Yuan.
- Fielding, W. J., & Mather, J. (2000). Stray dogs in an island community: A case study from New Providence, The Bahamas. *Journal of Applied Animal Welfare Science*, 3, 305–320.
- Hart, B. L., & Hart, L. A. (1985). *Canine and feline behavioral therapy*. Philadelphia: Lea & Febiger.
- Hart, L. A., Takayanagi, T., & Yamaguchi, C. (1998). Dogs and cats in animal shelters in Japan. *Anthrozoös*, 11, 157–163.
- Inaba, A. (1998). *Japan pet foods and supplies*. Washington, DC: U.S. & Foreign Commercial Service and U.S. Department of State.
- Kass, P. H., New, J. C., Scarlett, J. M., & Salman, M. D. (2001). Understanding animal companion surplus in the United States: Relinquishment of nonadoptables to animal shelters for euthanasia. *Journal of Applied Animal Welfare Science*, 4, 237–248.

- Kogure, N., & Yamazaki, K. (1990). Attitudes to animal euthanasia in Japan: A brief review of cultural influences. *Anthrozoös*, 3, 151–161.
- Kuo, D. (2000, October 18). Number of stray dogs in Taipei declines noticeably. *Taiwan Central News Agency*.
- Loney, J., & Marks, D. (1996). *Disposable dogs: Made in Taiwan*. London: World Society for the Protection of Animals.
- Macdonald, D. W., & Carr, G. M. (1995). Variation in dog society: Between resource dispersion and social flux. In J. A. Serpell (Ed.), *The domestic dog: Its evolution, behaviour & interactions with people* (pp. 119–216). Cambridge, England: Cambridge University Press.
- Matter, H. C., & Daniels, T. J. (2000). Dog ecology and population biology. In C. N. L. Macpherson, F. X. Meslin, & A. I. Wandeler (Eds.), *Dog zoonoses and public health* (pp. 17–60). Wellingborough, England: CABI.
- Messent, P. R., & Horsfield, S. (1985). Pet population and the pet–owner bond. In IEMT—Institute for Interdisciplinary Research on the Human–Pet Relationship (Eds.), *The human–pet relationship* (pp. 7–17). Vienna, Austria: IEMT—Institute for Interdisciplinary Research on the Human–Pet Relationship.
- Miura, A., Bradshaw, J. W. S., & Tanida, H. (2000). Attitudes towards dogs: A study of university students in Japan and the UK. *Anthrozoös*, 13, 80–88.
- Neter, J., Kutner, M. H., Nachtsheim, C. J., & Wasserman, W. (1996). *Applied linear regression models*. Chicago: Irwin.
- New, J. C., Salman, M. D., King, M., Scarlett, J. M., Kass, P. H., & Hutchinson, J. M. (2000). Characteristics of shelter-relinquished animals and their owners compared with animals and their owners in U.S. pet-owning households. *Journal of Applied Animal Welfare Science*, 3, 179–201.
- Osgood, C. (1975). *The Chinese: The study of a Hong Kong community*. Tucson: University of Arizona Press.
- Patronek, G. J., & Glickman, L. T. (1994). Development of a model for estimating the size and dynamics of the pet dog population. *Anthrozoös*, 7, 25–41.
- Patronek, G. J., Lawrence, T. G., Beck, A. M., McCabe, G. P., & Ecker, C. (1996). Risk factors for relinquishment of dogs to an animal shelter. *Journal of the American Veterinary Medical Association*, 209, 572–581.
- Patronek, G. J., & Rowan, A. N. (1995). Determining dog and cat numbers and population dynamics. *Anthrozoös*, 8, 199–205.
- Paul, E. S., & Serpell, J. A. (1993). Childhood pet keeping and humane attitudes in young adulthood. *Animal Welfare*, 2, 321–337.
- Pet Food Institute. (2000). *Pet incidence trend report*. Washington, DC: Author.
- Pet Food Manufacturer's Association. (2002). *Pet ownership demographics*. Retrieved August 2002, from <http://www.pfma.com/petownership.htm>
- Poresky, R. H., Hendrix, C., Mosier, J. E., & Samuelson, M. L. (1988). Young children's companion animal bonding and adults' pet attitudes: A retrospective study. *Psychological Reports*, 62, 419–425.
- Rubin, H. D., & Beck, A. M. (1982). Ecological behavior of free-ranging urban dogs. *Applied Animal Ethology*, 8, 161–168.
- Salman, M. D., New, J. G., Jr., Scarlett, J. M., Kass, P. H., Ruch-Gallie, R., & Hetts, S. (1998). Human and animal factors related to the relinquishment of dogs and cats in 12 selected animal shelters in the United States. *Journal of Applied Animal Welfare Science*, 1, 207–226.
- SAS. (1999) StatView Version 5.0.1 [Computer software]. Cary, NC: Author.
- Serpell, J. A. (1981) Childhood pets and their influence on adults' attitudes. *Psychological Reports*, 49, 651–654.
- Serpell, J. A. (1995). From paragon to pariah: Some reflections on human attitudes to dogs. In J. A. Serpell (Ed.), *The domestic dog: Its evolution, behaviour & interactions with people* (pp. 245–256). Cambridge, England: Cambridge University Press.

- Shyr, J. R., & Yeh, L. S. (1992). *Taiwan stray dog management and people's opinions on dogs* (Rep. No. EPA-81-J102-09-12). Taiwan: Environmental Protection Administration.
- Slater, M. R. (2001). The role of veterinary epidemiology in the study of free-roaming dogs and cats. *Preventative Veterinary Medicine*, 48, 273-286.
- Slater, M. R. (2002). *Community approaches to feral cats: Problems, alternatives, and recommendations*. Washington, DC: Humane Society Press.
- Stokes, M. E., Davis, C. S., & Koch, G. G. (1995). *Categorical data analysis using the SAS system*. Cary, NC: SAS.