Acta Theriologica 35 (3–4): 299–309, 1990.
PL ISSN 0001–7051

Physical condition and ectoparasite infestation of feral pigs in New Zealand

Ryszard M. DZIĘCIOŁOWSKI and Colin M. H. CLARKE

Dzięciołowski R. M. and Clarke C. M. H. 1990. Physical condition and ectoparasite infestation of feral pigs in New Zealand. Acta ther. 35: 299–309.

Physical condition and ectoparasite infestation was determined for 2,674 feral pigs harvested by hunters in the northern half of the South Island, New Zealand, during 1986 and 1987. Condition was appraised from sub-dermal and visceral fat deposits. The occurrence of lice and ticks was assessed from a macroscopic examination of the carcass exterior. Feral pids in New Zealand appear in good condition, males more so than females. Such condition varied with age with 71 % of those aged 3 months to 4–5 years in good condition and pigs in older age groups less so. Patterns varied seasonally. Females showed good condition during winter and poor condition during summer, while males showed the opposite pattern. Ectoparasite infestations were mostly low. Females were less infested than males but had consistent infestations, irrespective of age. Male ectoparasite infestations increased with age. Seasonal differences in infestation rates were not evident for females, but were heaviest during winter and spring for males. Regional variations in both parameters were recorded for both sexes. Physical condition was negatively correlated with ectoparasitic infestation in males and in females.

Warsaw Agricultural University, Department of Zoology and Wildlife Management, ul. Rakowiecka 26/30, 00–528 Warsaw, Poland (RMD), Forest Research Institute, P. O. Box 31–011, Christchurch, New Zealand (CMHC)

Key words: feral pigs, ectoparasites, physical condition, New Zealand

Introduction

Feral pigs (*Sus scrofa*, Linnaeus, 1758) populations in the northern half of the South Island, New Zealand, comprise different breeds with different colours and physical size characteristics (Clarke and Dzięciołowski a, b in print). Populations are dominated by young animals as a result of high productivity and intensive harvesting by recreational hunters (Clarke 1989, Dzięciołowski and Clarke 1989). Pig densities have declined over recent years (Clarke 1989). Apart from present studies, there are few papers on feral pigs in New Zealand. The most significant document the pigs internal and external parasites (Ineson 1954), its significance as a disease vector (Martin 1972), movements (Martin 1975), environmental impact (Challies 1975), and diet (Thomson and Challies 1988). The present study is part of a wider investigation of the species biology and harvest capacity and ultimately its improved management in New Zealand.

This paper describes and relates physical condition and ectoparasite infestation of feral pigs by age, sex, season, and region, throughout the northern South Island (65,277 km^2). It is well established that both ecto- and endoparasites debilitate their

hosts (Chandler and Read 1961). In New Zealand, Ineson (1954) reported light infestations of parasites on feral pigs which he concluded had no significant effect on pig numbers. The effects of these infestations on physical condition were not examined. Similarly, while Tenquist and Charleston (1982) listed five ectoparasited on pigs in New Zealand, parasite/host relationships were ignored.

The study area was divided into 15 regions, based on pig colour (a prominent breed characteristic in this area) and geographic features (Fig. 1).

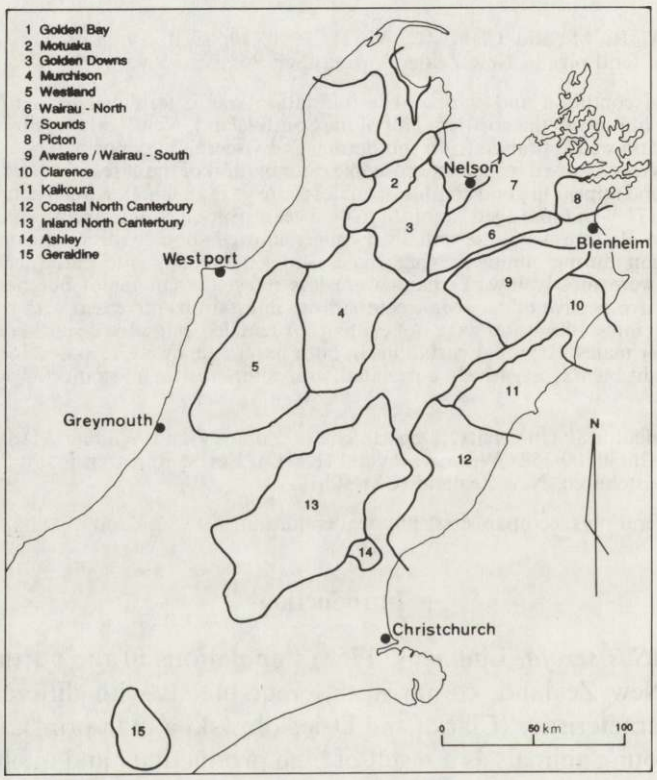

Fig. 1. The study area showing the population boundaries chosen during the study.

Data and procedures

Some 2,674 feral pigs harvested by hunters throughout the study area during 1986 and 1987 were autopsied and information recorded on the individuals sex, kill site, physical condition, and ectoparasite infestation. Details of the pigs killed were mostly recorded by hunters though the authors recorded details for about 30% of the sample from game depots and pig hunting competitions. Condition was determined from the extent of fat deposits, either sub-dermal, around the heart, or about the kidneys and other viscera. Overall condition was scored on a four-point scale: poor, moderate, good, and very good. These different classes of

condition were assessed using dressed weight divided by body length as an index of condition. This ratio correlated significantly ($p<0.001$) for males and females with the four condition classes. Accordingly, this result was interpreted as providing support for the use of the subjective condition assessments. Ectoparasites were searched for over the whole carcass exterior, with particular attention paid to the belly, flanks, and ears. Infestations were scored as none, few, or many. Hunters did not usually identify the ectoparasites present, though during fieldwork we established that lice *Haematopinus suis* were common and ticks *Haemaphysalis longicornis* less so (Tenquist and Charleston 1982). The term "lice" is used here to describe all ectoparasites.

Pigs were aged using either tooth replacement and wear (juveniles) or dental cementum (older animals; Hyashi, Nishida and Mochizuki 1977). Ages derived from cementum annuli were compared with ages derived from tooth replacement and wear, and further checked with known-age animals. Age groups used in this paper are mid-points of 6-monthly classes (Dzięciołowski and Clarke 1989). Age groups >69 months contained too few records and were regrouped into one age class >75 months. All data were analysed using Chi-square available in the SAS Institute (1985) computer package.

Results

Physical condition

Of the feral pigs harvested in this study area, 25.1 % were in very good condition, 46.5 % good, 22 % moderate, and only 6.3 % were in poor condition. Condition varied significantly with sex ($\chi^2_3=69.091$, $p<0.001$), with higher percentages of males than females in good and moderate condition, and fewer males in poor and very good condition (Fig. 2). Consequently, all further condition data were analysed separately by sex.

The condition of both males and females varied significantly with age (males, $\chi^2_{36}=93.061$, $p<0.001$; females, $\chi^2_{36}=72.692$, $p<0.001$). The condition of the youngest age group (3 months) was similar for both sexes, and averaged 76 % in good and very good condition. Amongst the oldest pigs of both sexes (63—75 months, Table 1), the

Table 1. Percentage frequency distribution of feral pig condition classes by age.

Age group	Males			Females		
	Poor and moderate	Good and very good	N	Poor and moderate	Good and very good	N
3	23.6	76.4	149	24.2	75.8	131
9	24.1	75.9	181	17.2	82.8	183
15	19.8	80.2	197	29.8	70.2	182
21	23.7	76.3	163	28.5	71.5	105
27	30.7	69.3	181	38.7	61.3	112
33	31.3	68.7	102	20.9	79.1	46
39	28.2	71.8	95	34.2	65.8	39
45	41.7	58.3	36	35.4	64.6	32
51	32.2	67.8	32	45.0	65.0	20
57	40.0	60.0	26	35.0	55.0	21
63	18.2	81.8	11	41.7	58.3	12
69	56.5	43.5	23	12.4	87.6	16
>75	57.9	42.1	20	45.7	54.3	24
Mean	32.9	67.1		31.4	68.6	

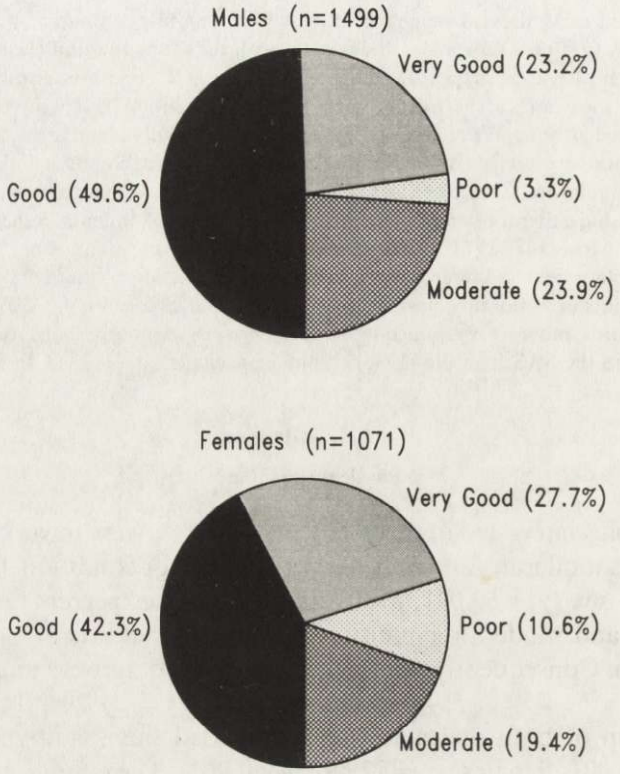

Fig. 2. Physical condition of feral pigs.

Table 2. Percentage frequency distribution of feral pig condition classes by season.

Season	Males			Females		
	Poor and moderate	Good and very good	N	Poor and moderate	Good and very good	N
Spring	26.2	73.2	366	33.4	66.6	282
Summer	18.2	81.8	189	29.7	70.3	116
Autumn	21.3	78.7	432	34.9	65.1	317
Winter	34.9	65.1	569	23.9	76.1	403
Throughout the year	25.2	74.8		30.5	69.5	

percentage in good and very good condition averaged 61.2%. On average, 71.5% of males aged 3–63 months were in good or very good condition, thereafter the percentage of both good and very good classes combined declined to 43%. A similar high proportion (*i.e.* 70.7%) of females were in good and very good condition, but only until 51 months, after which fewer were so classified (63.8%, Table 1). Condition in the 63–75 month75 month age groups were erratic for both sexes, perhaps because of small sample sizes.

The condition of males and females varied significantly with season (males, $\chi^2_9 = 72.635$, $p < 0.001$; females, $\chi^2_9 = 31.542$, $p < 0.001$). Males were in poorest condition in winter, in intermediate condition in autumn and spring, and in best condition during summer (Table 2). Females were in best condition in winter, in intermediate condition in summer, and poorest in spring and autumn (Table 2).

Pig condition varied significantly by region for both males ($\chi^2_{42} = 153.048$, $p < 0.001$), and females ($\chi^2_{42} = 120.316$, $p < 0.001$). Males from Westland (region 5) were in poorer condition than males from all other regions. There, those in good and very good condition constituted only 45.5% of the sample (Table 3), whereas in other regions percentages of males in good and very good condition ranged from 62.5 to 97.5%. Females from Westland were in better physical condition than males, and were similar to females in most other regions. The condition of pigs from Coastal North Canterbury and Geraldine (regions 12 and 15) was above average, with >82% of males and females in good and very good condition (Table 3). Apart from males from Westland, the majority of pigs in all regions were in good or very good condition.

Table 3. Percentage frequency distribution of feral pig condition classes by region.

Region	Males			Females		
	Poor and moderate	Good and very good	N	Poor and moderate	Good and very good	N
1	31.8	68.2	72	15.7	84.3	30
2	19.3	80.7	57	35.3	64.7	34
3	37.5	62.5	136	38.4	61.6	73
4	35.5	64.5	197	40.8	59.2	120
5	54.5	45.5	33	31.1	68.9	29
6	14.8	85.2	108	25.0	75.0	92
7	34.8	65.2	276	38.1	61.9	176
8	33.1	66.9	130	23.7	76.3	114
9	30.9	69.1	68	36.9	63.1	65
10	15.2	84.8	79	20.3	79.7	64
11	24.8	75.2	93	35.9	64.1	67
12	3.7	96.3	80	17.5	82.5	63
13	18.8	81.2	85	31.4	68.6	35
14	31.7	68.3	44	15.7	84.3	51
15	2.5	97.5	41	5.2	94.8	58
Mean	25.9	74.1		27.4	72.6	

Ectoparasite infestation

Most pigs had few lice. Infestations varied significantly with sex $\chi^2_2 = 72.635$, $p < 0.001$), with females less infested than males (Fig. 3). Infestation intensity also increased significantly with age amongst males ($\chi^2_{24} = 87.335$, $p < 0.001$), with 26.7% and 28.6% having many lice in the 69 and >75 month age groups (Table 4). Overall

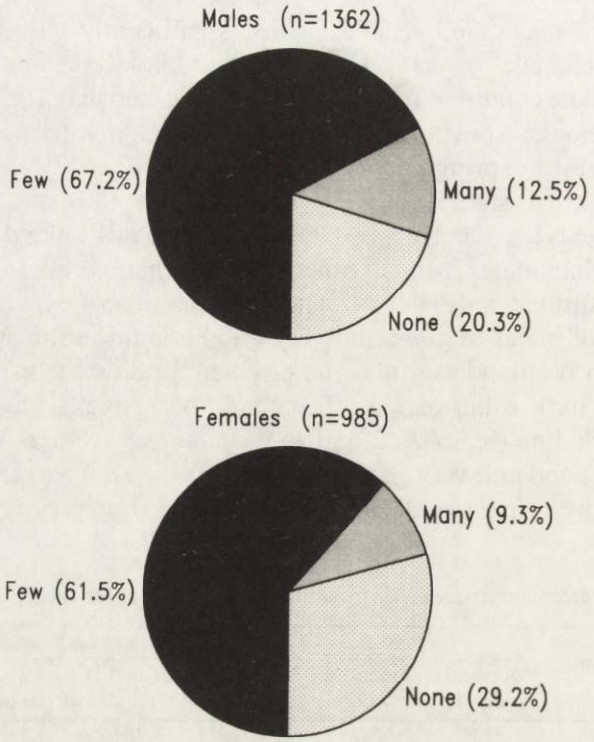

Fig. 3. Ectoparasite infestation of feral pigs.

Table 4. Percentage frequency distribution of feral pig ectoparasitic infestation classes by age.

Age group	Males				Females			
	None	Few	Many	N	None	Few	Many	N
3	42.1	54.1	3.8	133	34.8	57.6	7.6	118
9	22.7	72.4	4.9	163	34.2	59.5	6.3	158
15	23.3	67.6	9.1	176	28.8	62.2	9.0	156
21	21.1	65.5	13.4	142	26.7	61.1	12.2	90
27	16.8	71.4	11.8	161	23.1	70.2	6.7	104
33	14.0	72.0	14.0	86	31.0	59.5	9.5	42
39	10.4	68.8	20.8	77	34.2	60.5	5.3	38
45	9.7	71.0	19.3	31	48.2	40.7	11.1	27
51	7.7	84.6	7.7	26	31.6	57.9	10.5	19
57	4.8	71.4	23.8	21	16.7	72.2	11.1	18
63	33.3	66.7	0.0	9	18.2	63.6	18.2	11
69	9.5	61.9	28.6	21	33.4	58.3	8.3	12
>75	13.3	60.0	26.7	15	9.1	68.2	22.7	22
Mean	21.1	67.8	11.1		30.0	61.2	8.8	

percent frequencies of infestation recorded for males were: none, 21.1%; few, 67.8%; and many, 11.1% (Fig. 3). No age infestation relationship was recorded for females however. Compared percentages for females were: none, 30%; few, 61.2%; and many, 8.8%, thus reiterating the less intense infestation of females.

For males the intensity of ectoparasite infestation varied seasonally ($\chi^2_6 = 35.001$, $p < 0.001$), and was highest during winter and spring (Table 5). The intensity of infestation for females did not vary with season.

Table 5. Percentage frequency distribution of feral pig ectoparasitic infestation classes by season.

Season	Males				Females			
	None	Few	Many	N	None	Few	Many	N
Spring	18.2	71.1	10.7	318	29.0	61.8	9.2	238
Summer	25.9	65.1	9.0	166	31.7	59.4	8.9	101
Autumn	24.9	67.1	8.0	389	27.5	62.7	9.8	295
Winter	16.2	65.4	18.4	489	29.9	61.0	9.1	351
Throughout the year	21.3	67.2	11.5		29.5	61.2	9.3	

Regional differences of infestation occurred for both males ($\chi^2_{28} = 278.582$, $p < 0.001$) and females ($\chi^2_{28} = 262.582$, $p < 0.001$). Lice were virtually absent (2% frequency) from pigs of both sexes from Geraldine (region 15; Table 6). Moderate levels of infestation of males and females were recorded from Picton (region 8; <70%), and for males from Kaikoura (68.2%) and Inland North Canterbury (69.1%;

Table 6. Percentage frequency distribution of feral pig ectoparasitic infestation classes by region.

Region	Males				Females			
	None	Few	Many	N	None	Few	Many	N
1	15.0	70.0	15.0	60	25.8	61.3	12.9	31
2	8.0	72.0	20.0	50	12.9	83.9	3.2	31
3	10.4	82.1	7.5	134	15.9	76.8	7.3	69
4	9.4	78.9	11.7	180	14.9	79.0	6.1	114
5	29.0	64.5	6.5	31	44.4	51.9	3.7	27
6	24.2	70.7	5.1	99	20.0	74.1	5.9	85
7	19.2	67.2	13.6	250	37.0	53.9	9.1	154
8	33.1	56.5	10.4	115	50.0	41.8	8.2	98
9	15.2	72.7	12.1	66	17.9	73.2	8.9	56
10	2.8	84.3	12.9	70	1.7	85.0	13.3	60
11	31.8	52.3	15.9	88	15.6	67.2	17.2	64
12	5.6	56.3	38.1	71	11.7	65.0	23.3	60
13	30.9	58.8	10.3	68	21.9	56.2	21.9	32
14	25.0	70.0	5.0	40	43.5	52.2	4.3	46
15	97.5	2.5	0.0	40	98.3	1.7	0.0	58
Mean	23.8	63.9	12.3		28.8	61.5	9.7	

regions 11 and 13). The highest percentage of animals infested occurred in regions 10 and 12 (Clarence and Coastal North Canterbury), where >94% of males and >88% of females had lice.

Relationship between condition and ectoparasite infestation

Pig condition varied significantly with the intensity of ectoparasite infestation ($\chi^2_6 = 313.618$, $p < 0.001$). Males in poor condition had the highest percentage with many lice and the lowest percentage free from infestation (Table 7). Conversely, males in very good condition had a low frequency of severe infestations and the highest percentage free from lice. Males in moderate and good condition indicated intermediate levels of infestation confirming the pattern established. Females had a similar pattern.

Table 7. Percentage frequency distribution of condition classes in relation to ectoparasitic infestation in feral pigs.

Condition class	Males				Females			
	None	Few	Many	N	None	Few	Many	N
Poor	5.1	43.6	51.3	39	11.4	55.3	33.3	105
Moderate	8.4	72.0	19.6	311	16.3	71.2	12.5	184
Good	19.8	72.9	7.3	675	24.5	70.7	4.8	413
Very good	34.7	54.5	10.8	323	52.6	42.7	4.7	274
Mean	17.0	60.7	22.3		26.2	60.0	13.8	

Discussion

The good condition of feral pigs in the study area reflects the recorded decline of pig densities since the early 1970s following increased harvesting by recreational hunters (Clarke 1989). Regionally, densities have declined with high density populations reduced by 60%, compared to the early 1970s. Pigs are now substantially below carrying capacity in many areas and it is logical to expect an improvement in their condition; indeed analysis of carcass weights sold to game buyers show that mean weights significantly improved between 1974 and 1984 (R. Dzięciołowski, unpubl.), presumably due to the increased availability of food.

Differences in density do not appear to explain the regional differences in condition as pigs from heavy density regions (defined from annual harvests of more than 20 pigs/km^2; Clarke and Dzięciołowski, in print a) and light density regions (defined from annual harvests of less than 10 pigs/km^2) had similar condition. Pigs from Geraldine (medium density) are in very good condition, presumably due to their recent (1982) history. In addition, the population consists of improved domestic breeds that are both larger and easier to fatten than the various earlier breeds predominant in other regions. Because of their recent domestic origins, pigs released in Geraldine may have been originally free of lice at liberation. Differences in physical condition in other

regions are unexplained, though presumably they relate to differences in food supply.

The good condition of females during winter indicates a time of abundant food. This is consistent with data on the seasonal body weights of adult females (Dzięciołowski *et al.* 1990) which rise steadily from summer to autumn and plateau during winter. The poor condition of males in winter was also consistent with a decline in adult male body weight during winter and spring (Dzięciołowski *et al.*). Rather than due to any deficiency in food supply, the pattern for males probably resulted from their breeding activities during winter.

Of the five ectoparasite species listed by Tenquist and Charleston (1982) for New Zealand feral pigs, *i.e. Demodex phylloides*, *Haemaphysalis longicornis*, and *Sarcoptes scabiei* (*Acari*); *Haematopinus suis* (*Phthiraptera*); and *Pulex irritans* (*Siphonaptera*), Ineson (1954) found only two species on 22 feral pigs from a study area which included the northern South Island. Lice *Haematopinus suis* were most common (68% frequency), and *Sarcoptes scabiei* occurred in only one animal. Conversely, we found four of the five ectoparasite species noted earlier (Tenquist and Charleston 1982) even though the nature of our data collection did not permit species identification in most instances. The only distinction made by hunters in some replies was between "lice" and "ticks". However, lice such as *Haematopinus suis* and ticks such as *Haemaphysalis longicornis* were commonly identified from carcasses inspected. In addition, we also found there cases of *Sarcoptes scabiei* and a single heavy infestation from *Demodex phylloides*. Studies of parasites of European and South-east Asian feral pigs suggest that *Haematopinus* and *Haemaphysalis* species may be common ectoparasites of pigs globally (Hoogstraal *et al.* 1968, Blancou *et al.* 1987).

While parasites occur in greater numbers among feral pigs compared to domestic pigs (Chandler and Read 1961), feral pigs may limit ectoparasite infestation by frequent wallowing, rubbing, and changing of bedding sites (Cuthbertson 1974, Ineson 1954). Our observations indicate ticks are restricted to the pig's head, inside the ears, crotch, and under the front legs, probably as a consequence of effective wallowing and rubbing of flanks and belly. Lice or their eggs, on the other hand, occurred over most of the pig's body, appeared a more difficult parasite to remove by wallowing and rubbing, and thus was the principal ectoparasite of feral pigs in the study area.

In pigs in the Southern Appalachia ticks were more prevalent in the spring and summer, while lice were more prevalent in the winter (Henry and Conley 1970). In these pigs lice parasitism was higher among juveniles and tick parasitism higher among adults. We found ectoparasitic infestation intensities to be consistent across age groups in females, but to increase with age in males. Similarly the reported percentage of feral pigs parasitised was rather uniform throughout the year.

We are unable to explain the age-related trends in ectoparasite intensities in males, except to speculate that it could be a result of social interactions among competing males. Hunters report that outside the breeding season the older males are generally segregated from the females, though the males engage in frequent fights with other males as judged by the extent of woundings and scar tissue.

We are also unable to completely explain the grater or lesser intensity of infestation of pigs in the various regions, except in Geraldine (see above). Even those regions with the heaviest infestation (*e.g.* Clarence, Coastal North Canterbury) had high proportions (80–96%, Table 3) of animals in good or very good condition. Although *Haemaphysalis longicornis* occurs widely in both domestic and feral animals in New Zealand (Tenquist and Charleston 1982), and is of major economic concern (Heath 1988), there was little regional relationship between infestation intensity and overlap of pigs and domestic stock. The eastern part of the study area including Awatere/Wairau-south, Clarence, Kaikoura, Coastal North Canterbury, and Inland North Canterbury, had a high overlap of pig range with cattle and sheep range, but failed to show a uniform pattern of heavier ectoparasite infestation. However, habitat conditions for pigs in the regions with the highest percentage of infested animals (Clarence and Coastal North Canterbury) apper similar in that they contain mostly grasslands. A possible explanation therefore, could be that grassland habitat provides favourable conditions for lice transmission.

Our results show a significant relationship between physical condition and ectoparasite infestation. The question of whether poor physical condition predisposes pigs to parasitic invasion or a high ectoparasitic results in poor condition, remains open. However, it was noted that seriously injured pigs (mostly shot or bitten by dogs) were invariably in poor condition and heavily infested, usually with lice.

Despite the effects of parasitism, this was not sufficient to cancel the gains in condition that healthy pigs have enjoyed over recent years. Indeed the small percentage of pigs in poor condition ($\times$ males, 3.3%; females, 10.6%; Fig. 2) and the low percentage of pigs with many ectoparasites ($\times$ males, 12.5%; females, 9.3%; Fig. 3) may be largely accounted for by injured, diseased, orphaned, and the occasional unthrifty piglet that characterises large litters (C. M. H. Clarke, unpubl.). The mostly good condition and low infestation by ectoparasites suggests that feral pigs in the northern South Island currently enjoy a generally healthy state of well-being.

Acknowledgements: We wish to thank the Forest Research Institute in Christchurch, New Zealand for funding the project, and especially Dr. J. Coleman for his support. Special thanks are also due to hunters, game buyers, and government departmental staff for assistance in field work, and to B. Fredric for statistical analyses. Dr. H. McAllum from the Lincoln Animal Diseases Laboratory, Ministry of Agriculture and Fisheries, kindly identified the ectoparasites reported.

References

Blancou J., Barrat J., Devaud J. P., Vannier P. and Gourreau J. M. 1987. Pathologie du sanglier (*Sus scrofa* L.) connaissances actuelles en France. Gibier Faune Sauvage 4: 279–294.

Chandler L. and Read C. P. 1961. Introduction to parasitology. John Wiley and Sons Inc., New York.

Challies C. N. 1975. Feral pigs (*Sus scrofa*) on Aucklan Island: status, and effects on vegetation and nesting sea birds. New Zealand J. Zool. 2: 479–490.

Clarke C. M. H. 1989. Can hunters control feral pigs? Seminar 2000 – Wild Animal Management. New Zealand Deerstalkers Association, Christchurch, New Zealand: 64–66.

Clarke C. M. H. and Dzięciołowski R. (in print a). Feral pigs in northern South Island, New Zealand: I. Origins, distribution and density. J. Roy. Soc. N. Z.

Clarke C. M. H. and Dzięciołowski R. (in print b). Feral pigs in northern South Island, New Zealand: II. Breed composition of present populations. J. Roy. Soc. N. Z.

Cuthbertson K. 1974. Pig hunting in New Zealand. A. H. and A. W. Reed. Wellington: .

Dzięciołowski R. and Clarke C. M. H. 1989. Age structure and sex ratio in a population of harvested feral pigs in New Zealand. Acta theriol. 34: 525–536.

Dzięciołowski R., Clarke C. M. H. and Fredric B. J. 1990. Growth of feral pigs in New Zealand. Acta theriol. 35: 77–89.

Heath A. C. G. 1988. The impact and importance of ectoparasites to the New Zealand livestock industry. New Zealand J. Zool. 15: 327–328.

Henry V. G. and Conley R. H. 1970. Some parasites of European wild hogs in the southern Appalachians. J. Wildl. Manage. 34: 913–917.

Hoogstraal H., Kohls G. M. and Parrish D. W. 1968. Studies on Southeast Asian Haemaphysalis ticks (*Ixodoidea, Ixodidae*). H. (*Kaiseraina susphillipensis* sp. n., a parasite of Luzon and Mindanao boars. J. Parasitol. 54: 616–621.

Hayashi Y., Nishida T. and Mochizuki K. 1977. Sex and age determination of the Japanese wild boar (*Sus scrofa leucomystax*) by the lower teeth. Jpn. J. Vet. Sci. 39: 165–174.

Ineson M. J. 1954. A comparison of the parasites of wild and domestic pigs in New Zealand. Trans. Royal Soc. New Zealand 82: 579–609.

Martin J. T. 1972. Wild pigs: potential vectors of foot and mouth disease. New Zealand J. Agric. 125: 18–23.

Martin J. T. 1975. Movements of feral pigs in North Canterbury, New Zealand. J. Mammal. 56: 914–915.

SAS Institute Inc. 1985. SAS Users' guide: Statistics, Version 5 Edition. SAS Institute Inc., Gary, NC: 1–956.

Thomson C. and Challies C. N. 1988. Diet of pigs in the Podocarp-Tawa forests of the Urewera Ranges. New Zealand J. Ecol. 11: 73–78.

Tenquist J. D. and Charleston W. A. G. 1982. An annotated checklist of ectoparasites of terrestrial mammals in New Zealand. J. Roy. Soc. N. Z. 11: 257–285.

Received 4 December 1989, accepted 20 July 1990.