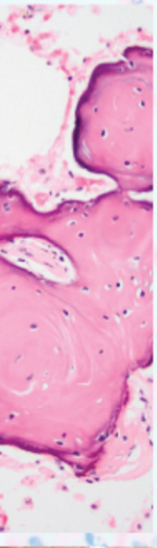
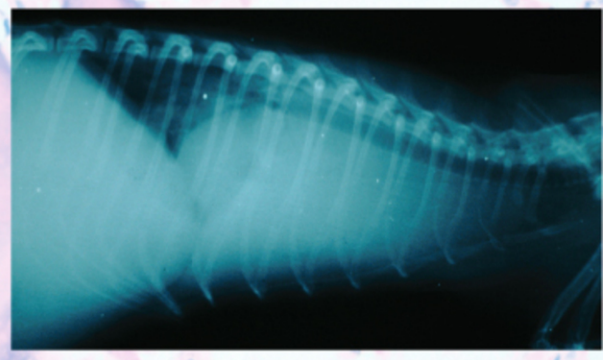
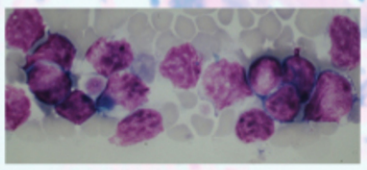
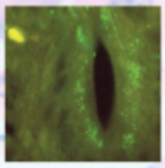
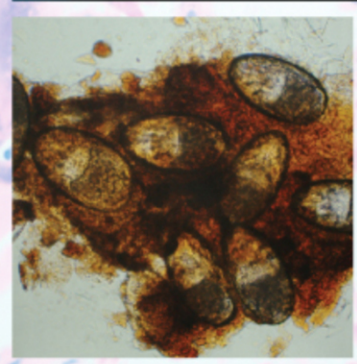
3rd Edition

Biology and Diseases of the Ferret

James G. Fox and Robert P. Marini






American College of Laboratory Animal Medicine

WILEY Blackwell

Biology and Diseases of the Ferret

Third Edition

Biology and Diseases of the Ferret

Third Edition

Edited by

James G. Fox

Robert P. Marini

American College of Laboratory Animal Medicine

WILEY Blackwell

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First edition, 1988 © Lippincott Williams & Wilkins

Editorial offices: 1606 Golden Aspen Drive, Suites 103 and 104, Ames, Iowa 50014-8300, USA
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Library of Congress Cataloging-in-Publication Data

Biology and diseases of the ferret / edited by James G. Fox, Robert P. Marini. – Third edition.
p. ; cm.
Includes bibliographical references and index.
ISBN 978-0-470-96045-5 (cloth)
I. Fox, James G., editor of compilation. II. Marini, Robert P., editor of compilation.
[DNLM: 1. Animal Diseases. 2. Ferrets. 3. Animals, Laboratory. SF 997.3]
SF407.F39
636.976′628–dc23
2013046017

A catalogue record for this book is available from the British Library.

Wiley also publishes its books in a variety of electronic formats. Some content that appears in print may not be available in electronic books.

Cover image: Top ferret image, iStock #26006446 © boxhdb
Cover design by Matt Kuhns

Set in 9.5/12 pt TimesLTStd-Roman by Toppan Best-set Premedia Limited

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This book is dedicated to my wife, Jody, and my children, Anne and Jim. Their love, continued support, and patience provided sustenance and good cheer throughout, making the effort worthwhile, and most of the time, enjoyable.

—JGF

To my dear ones, Debbie, Thalia, and Ianthe, for their love and support.

—RPM

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Preface

To whom shall I offer this fresh little book, just smoothed off with dry pumice-stone?
The Dedication: to Cornelius

—Catullus

The creation of the third edition of this text, conceived, compiled, and written 14 years after its predecessor, and 25 years after the first edition was printed, was motivated by the burgeoning clinical and scientific literature concerning the ferret. As a research animal, the ferret has contributed greatly to a number of disciplines, but most particularly to neuroscience, influenza, and other infectious diseases. As a pet, it has inspired a fervent ownership, and is attended by a growing number of expert and passionate clinicians. Pet owners, veterinarians, and researchers delight at this playful and animated creature. Moreover, the peculiar propensity of ferrets toward development of endocrine disorders and its unique susceptibility to human influenza virus, as well as to emerging diseases, such as the FIP-like ferret systemic coronavirus and disseminated idiopathic myofasciitis, have fascinated both veterinary clinicians and scientists.

Our own interest in the species emerged on both clinical and research fronts. During investigations into factors influencing gastric carcinogenesis, one of our postdoctoral fellows submitted biopsies of a gastric ulcer from an experimental ferret to our diagnostic laboratory, an action which led to the discovery and eventual characterization of *Helicobacter mustelae*. This organism and its disease expression in the ferret remains a robust model for *Helicobacter pylori* of humans. At the same time, practitioners solicited help in understanding and treating conditions in ferrets, which were gaining in popularity as pets. In the course of providing such assistance, and as we adapted methodologies for the diagnosis and treatment of both privately owned ferrets and those in our institutional colonies, our sustained and enthusiastic appreciation for these engaging animals was born.

The third edition has been expanded to 32 chapters, with new chapters devoted to black-footed ferret recovery, regulatory considerations, cardiovascular disease, genetic engineering, auditory neuroscience, vision and visual plasticity, emesis, and nutritional chemoprevention of cancer. These new chapters reflect current usage and advances. At the same time, some of the traditional research uses of ferrets have diminished in importance and these have either been eliminated or merged into clinical chapters when appropriate. The contributions of those second edition authors whose chapters are no longer included are acknowledged in these respective chapters. All chapters have been revised to accommodate new findings. The second edition chapter entitled "Anesthesia, Surgery, and Biomethodology" has been replaced by three separate chapters whose subject matter bears either the same name, or, in the case of "Biomethodology," the new designation, "Physical Examination, Preventative Medicine, and Diagnosis." The third edition also features many color photographs and is accompanied by an electronic version. We gratefully acknowledge the support and gentle persistence of our partners at Wiley, particularly their liaison and managing editor, Susan Engelken. Additionally, this text is now published under the auspices of the American College of Laboratory Animal Medicine (ACLAM). We are indebted to our assistants, principally Lucy Wilhelm and Alyssa Terestre, and also to Elaine Robbins for their skill and endurance and for overlooking our occasional excesses. Theirs was a Herculean effort, and they bore it all with patience and equanimity. Finally, we thank our families for their love and support, and for forgiving our absences, delayed arrivals, and missed appointments. Without the solace of their company, the joy and light of every day would be much diminished.

We would like to recognize those colleagues, particularly the veterinary staff in the MIT Division of Comparative Medicine, as well as postdoctoral fellows and technicians, who helped advance the care and our understanding of the biology and naturally occurring diseases of these animals during the early years. We also acknowledge and thank the many authors who have contributed their expertise by generously providing

chapters in both past and present editions. Their scholarship forms the foundation of current medical practice, surgical intervention, and animal model development. At the same time, we look forward to and anticipate the efforts of those clinicians, researchers, and students who will use this current edition to aid in the discovery of the next generation of research and clinical findings that will advance our knowledge of this fascinating animal.

James G. Fox
Robert P. Marini

Biology and Diseases of the Ferret

Third Edition

Biology and Husbandry

I

Taxonomy, History, and Use

1

James G. Fox

TAXONOMY

Ferrets (*Mustela putorius furo*), like the stoat, weasel, badger, skunk, otter, and mink, are carnivores, and belong to the ancient family Mustelidae, which probably dates back to the Eocene period, some 40 million years ago (Fig. 1.1). The taxonomic groups in the family Mustelidae, as recognized by Corbet and Hill, include 67 species from North, Central, and South America, Eurasia, and Africa (Table 1.1) [1]. No other carnivore shows such diversity of adaptation, being found in a wide variety of ecosystems, ranging from arctic tundra to tropical rain forests. Mustelids have retained many primitive characteristics which include relatively small size, short, stocky legs, five toes per foot, elongated brain case, and short rostrum [2]. The genus *Mustela* is divided into five subgenera: *Mustela* (weasels), *Lutreola* (European mink), *Vison* (American mink), *Putorius* (ferrets), and *Grammogale* (South American weasels). The Mustelinae are the central subfamily of the Mustelidae. The best-known members of the Mustelinae are the weasels, mink, and ferrets (genus *Mustela*) and the martens (genus *Martes*) [2].

ORIGIN

The domestic ferret is often confused with the North American black-footed ferret, *Mustela nigripes*, which shows a striking physical similarity to *Mustela eversmannii* (the steppe polecat), so a short description of each will be provided to clarify the differences.

Domestic Ferret

According to one author, ferrets (*M. putorius furo*) have been domesticated for over 2000 years [3], but confusion exists because of the scarcity of written records, the use of different nomenclature in different regions, and translation difficulties from one language to another. Aristotle, in his early descriptions (ca. 350 BC), stated that there existed an animal, which may have been a ferret, that could become very mild and tame [3].

Early accounts in Greek and Roman literature from Strabo (ca. 63 BC– AD 24) and Pliny (AD 23–79) noted that ferrets were used for hunting rabbits. These earlier references to ferrets are probably the basis of the belief that ferrets originated in North Africa (Fig. 1.2) [3]. This belief has been questioned and a premise put forth that ferrets were first domesticated in countries of Southern Europe, bordering the Mediterranean [4]. Evidently, ferrets were bred specifically for rabbiting (rabbit hunting) and were muzzled before being sent into rabbit burrows. This practice was later introduced into Asia, and the British Isles, where the sport is still practiced today. The first illustration of ferrets used for rabbiting occurs in a fourteenth-century manuscript (Fig. 1.3) [3].

In the Linnaean classification system, the ferret was named *Mustela furo*, and its identity has remained firmly established since then. The word "ferret" is derived from the Latin *furonem* and the Italian *furone*, meaning thief [3,5]. The word "putorius" is derived from the Latin *putor*,

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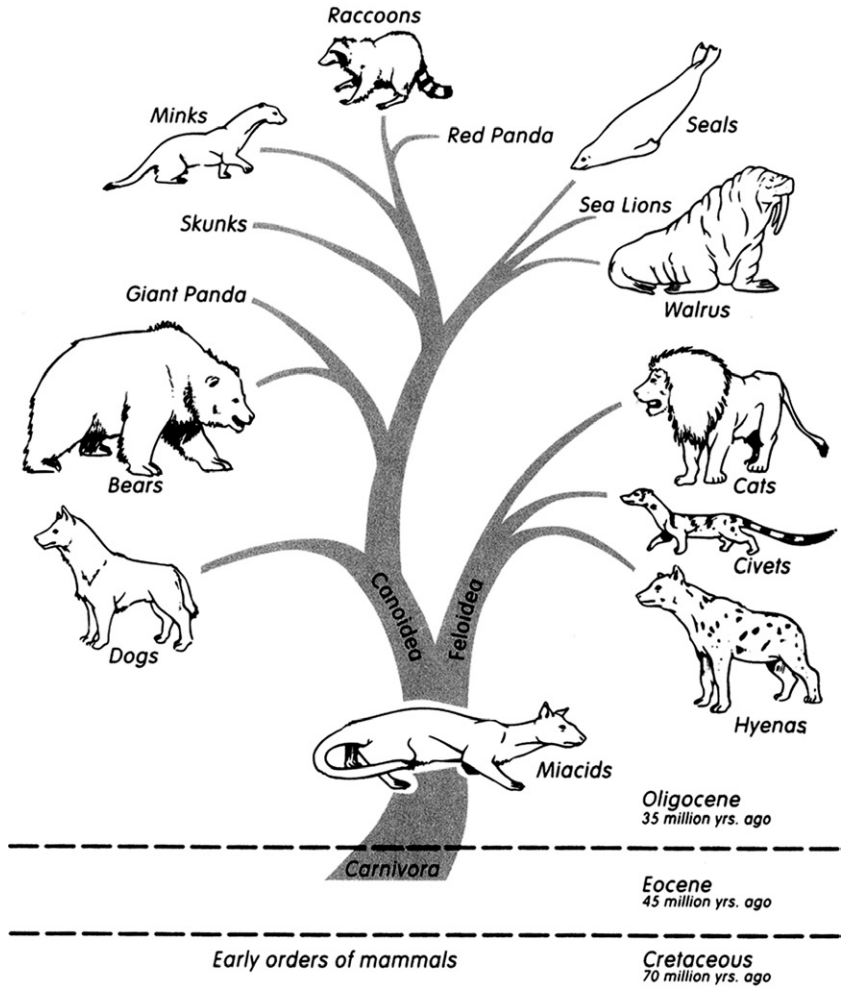

Fig. 1.1. The order Carnivora: anatomic relatives of the ferret. (Modified from Evans HE, Christensen GC (1979) Classification and natural history of the dog. In: Miller's anatomy of the dog, 2nd ed. Philadelphia, W.B. Saunders.)

a stench, which applies to the musky odor of the ferret. Today, "ferret" is also used as a verb and connotes the ferret's behavior and traits: to remove from a hiding place, to search out with keenness, or to draw out by shrewd questioning.

The ferret (*M. putorius furo*) has been and is now used for hunting, biomedical research, and in North America and other countries as a pet, and is most likely a domesticated version of the wild European ferret or polecat (*Mustela putorius* or *M. furo*) [3,6]. Alternatively, it may be related to the steppe polecat (*M. eversmannii*), which it closely resembles in skull morphology [7]. The domesticated ferret, although introduced to North America by the early English settlers some 300 years ago, has not established feral colonies on this continent.

Behavioral differences between the domesticated ferret and the wild European polecat have been documented. The ferret is not as temperamental nor as vigorous and agile as the European polecat [6]. In addition, domesticated ferrets do not develop a fear of humans nor of unfamiliar environments, and are more tractable. The F_1 hybrids of the domesticated ferret and polecat, however, were found to develop a fear of humans when left with their mothers during a critical period between 7.5 and 8.5 weeks of age

Table 1.1. The Family Mustelidae

Genus	Synonym(s)	Range	Member(s)	Number of species
Mustela	*Grammogale, Lutreola, Putorius*		Weasel, stoat, ferret, ermine, mink, polecat	15
Vormela		Southeast Europe, western China	Marbled polecat	1
Martes	*Charronia*	Eurasia, North America	Marten, fisher, sable	7
Eira	*Galera, Tayra*	Northeast Mexico to Argentina	Tayra	1
Galictis	*Grison, Grisonella*	Southern Mexico to Brazil	Grison	3
Lyncodon		Argentina, Chile	Patagonian weasel	1
Ictonyx	*Zorilla*	Senegal, Ethiopia	Striped polecat	1
Poecilictis		Sahara region	Striped weasel	1
Poecilogale		Southern Africa, Zaire, Uganda	White-naped weasel	1
Gulo		Scandinavia, Siberia, Alaska, Canada, western United States	Wolverine or glutton	1
Mellivora		Northern India, Arabia, Africa (south of the Sahara)	Ratel or honey badger	1
Meles		Europe, Japan, southern China	Eurasian badger	1
Arctonyx		Northern China, northeast India, Sumatra	Hog-badger	1
Mydaun	*Swillotaxus*	Sumatra, Java, Borneo, Philippines	Stink-badgers	2
Tasidea		Southwest Canada to central Mexico	American badger	1
Melogale	*Helictis*	Southeast Asia	Ferret-badgers	3
Mephitis		Canada, United States, Mexico, Nicaragua	Hooded and striped skunks	2
Spilogale		North and Central America	Spotted skunks	4
Conepatus		United States to Central and South America	Hog-nosed skunks	7
Lutra	*Lontra, Lutrogale*	Eurasia; North, Central, and South America; Africa	Otters	8
Pteronura		Venezuela to Argentina	Giant otter	1
Aonyx	*Amblonyx, Paraonyx*	Africa, southeast Asia	Clawless otters	3
Enhydra		Siberia, Alaska to California	Sea otter	1

[8]. Imprinting may be involved in this process. When attention response to a rustling noise was tested, the wild ferrets and the F_1 hybrids habituated more rapidly than the domesticated ferret. The F_1 hybrids' responses depended on their previous environmental history—animals raised outdoors responded differently from those raised indoors. Because the ferret's natural habitat contrasts greatly with the indoor environment, those ferrets raised indoors showed a greater response. These findings agree with Lorenz's hypothesis that the behavior of domesticated animals resembles that of juvenile individuals of their wild counterparts [9].

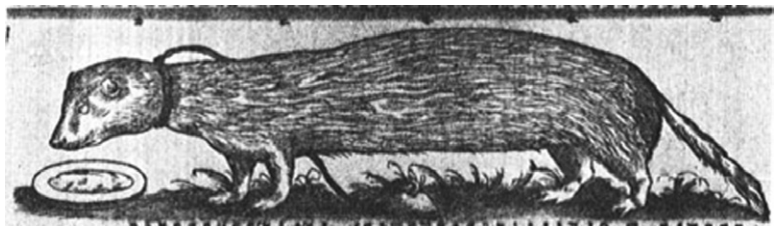

Fig. 1.2. The ferret. (Reprinted from Thomson APD (1951) A history of the ferret. J Hist Med 6: 471.)

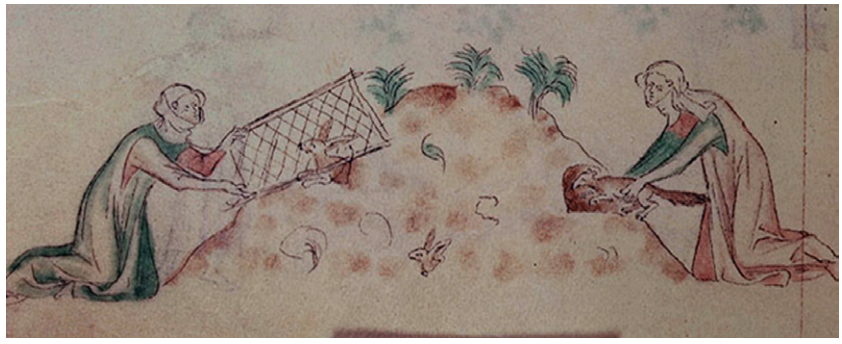

Fig. 1.3. Ferreting in the Middle Ages, about 1300 AD. (Reprinted from Thomson APD (1951) A history of the ferret. J Hist Med 6: 471.)

The wild ferret is completely interfertile with the European polecat, thus verifying their close genetic relationship. The wild European ferret, however, usually produces only one litter, while the domesticated ferret produces two or more litters yearly [10]. The female ferret and male stoat (*Mustela erminae*) will also produce fertile hybrids [11]. In addition, the F_1 generation of a wild polecat and domesticated ferret is fertile. The steppe polecat can also interbreed with black-footed ferrets [12]. The wild polecat, or ferret native to much of the British Isles and northern Europe, is also known as the fitch, fitchew, foul marten, fitchet, or foumart [5,6].

The Dutch were the first to visit New Zealand in 1642 but received an inhospitable welcome by the native Maoris who killed four of the explorers [13]. The islands weren't seen again by the Europeans for another 127 years when James Cook made three visits in 1769–1770, 1773–1774, and 1777. Whaling and sealing occupied the first settlers' primary interests for the next several decades, followed by a period when settlers exploited abundant timber resources. In 1860, gold was discovered and resulted in an influx of tens of thousands, and in 1867, the West Coast reached a peak population of 29,000. Land-hungry colonists expanded acres of farming, and because of a lack of native game to shoot for food, began to import a variety of game animals. Wild rabbits were introduced in 1864 on the South island. By the 1870s, rabbits were creating serious economic loss as well as soil erosion on large tracts of farming land. Flocks of sheep were reduced drastically because of lack of natural grazing pasture. Even though millions of rabbits were killed in an effort to control their devastation on grazing land, there was only the slightest effect on reducing the rabbit population. Natural predators to control the rabbits in New Zealand were lacking, and the farmers therefore turned to importing a predator, the domesticated ferret, already renowned in Europe for its skills as a rabbit hunter. Strong objections were voiced by ornithologists and some of the acclimatization colonists in New Zealand who argued that ferrets, if introduced to control rabbits, would instead decimate the native bird population, especially the flightless birds. The farmers' demands prevailed, and the first five ferrets were released in the Conway River valley in 1879. They were released by the thousands in 1882–1886 as were two other

mustelids, stoats, and weasels. However, the debate about the merits of the introduction of these predators continued. For example, researchers predicted the consequences of these actions in 1885 in a presentation to the Auckland Institute: ". . . if stoats, ferrets, weasels . . . are turned out to destroy rabbits, it will be difficult to protect the birds, as these creatures destroy them, especially ground birds such as kiwis, kakapos, wrens . . . in Austria we destroy these animals at every opportunity. They are very cunning, and will not take poison while they can get live prey. Rabbits are much easier destroyed by shooting, netting, or bagging with ferrets when the land becomes more closely settled" [14].

The New Zealand Department of Agriculture bred ferrets for release until 1897, and private breeders continued until 1912, producing approximately 300 a year.

Despite this influx of mustelids, it soon became painfully obvious that the newly introduced predators were not having the desired dramatic effect on rabbit numbers. Instead, within 6 years, there was a drastic decline in native birds in the areas where the mustelids were released. On a positive note, however, the wild rat and mouse population did appear to be reduced. The government finally changed its policy in 1903 and amended the Rabbit Act by removing from the statute protection of the "natural enemies of the rabbit." Instituting bounties on mustelids had little effect on their numbers and was abandoned in 1950. Even harvesting large numbers of ferrets and stoats for their fur in 1944–1948 made no apparent reduction in their numbers [15]. It wasn't until the 1950s when rabbits were controlled by chemical means that ferret numbers were significantly reduced [16]. The direct damage to native fauna attributed to the introduction of mustelids are on endangered bird species in New Zealand, particularly flightless birds. Of 18 separate bird populations now considered rare or endangered, 11 of these could have been affected by stoats and/or rats, in addition to other factors such as deforestation or other effects by human encroachment on native habitat. Interestingly, however, there is not a single known extinction or diminution of a bird species in New Zealand that can be solely or definitively attributed to any of the mustelids, despite all that has been written about their destructive predatory behavior. In a detailed survey conducted in 1973, the authors concluded, "It is actually difficult to attribute the decline of any native bird directly to mustelids" [17]. Likewise, throughout the recorded histories of bird species extinctions since 1600, on islands worldwide, only 1% of 163 extinctions were directly attributable to mustelids, compared with 26–54% attributed to cats and rats, respectively [18].

Interestingly, the Department of Natural Resources in Queensland, Australia, have declared pet ferrets illegal under the Rural Protection Act, 1985, stating that buying and selling pets can result in fines up to $60,000. In July 2003, the Rural Lands Protection Act was replaced with the Land protection (Pest and Stock Route Management) Act 2002 and Regulations 2003 and lists ferrets as a prohibited/declared Class 1 pest. A Class 1 Pest under the Act are animals which represent a threat to primary industries, natural resources, and the environment. Under the Act, it is an offense to introduce a ferret into Queensland, feed a ferret, release a ferret, or keep a ferret, unless issued with a permit to do so; permits to own ferrets are issued only to bona fide zoos and wildlife parks [19]. In a National Resources, Mines and Energy (NRME) correspondence, Mr. John English MP, Member for Redlands, wrote to Stephen Robertson MP, Minister for NRME, on behalf of the President of the Queensland Ferret Welfare Society, Barbara Cowell. The following reply was forwarded to Barbara from John English. "Thank you for your letter of 30 April 2004 making representation on behalf of Mrs Barbara Cowell of Macleay Island concerning the keeping of ferrets as pets in Queensland. Only zoos or wildlife parks are able to apply for a permit to keep ferrets in Queensland. There are no provisions in legislation for the keeping of ferrets as pets due to their pest potential. Ferrets are not native to Australia and have the potential to establish wild (feral) populations, as they have already done in New Zealand and the British Isles. In New Zealand, ferrets and stoats have become serious predators of native birdlife and their eggs, particularly ground-nesting birds. Ferrets are also known to be vectors for dangerous exotic diseases such as rabies. Although other states have failed to restrict the keeping of ferrets, they are taking a major risk by allowing these animals to be kept as pets. This concern is highlighted by a recent report of wild ferrets being seen in Tasmania. Also, ferrets established in Western Australia were controlled by trapping. Several states have banned the keeping of wild ferret breeds, known as polecats even though there is no reliable way of differentiating between wild and domestic breeds. Queensland, therefore, considers that it is sensible and important to prevent the keeping of this potential pest. I have noted the suggestion for regulation or licensing of keeping. Restricted keeping using permits was investigated for pet domestic rabbits and found to be prohibitively expensive. Section 274(3) of the Land Protection (Pest and Stock Route Management) Act 2002 provides the power for an authorised person to destroy or dispose of a seized pest if a permit for keeping is not produced within 48 hours. An authorised officer