Environmental Enrichment Information Resources for Laboratory Animals:
1965 - 1995

Birds, Cats, Dogs, Farm Animals, Ferrets, Rabbits, and Rodents

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Introduction

*Environmental Enrichment Information Resources for Laboratory Animals* has been produced jointly by the Animal Welfare Information Center (AWIC) of the U.S. Department of Agriculture's National Agricultural Library (NAL) and the Universities Federation for Animal Welfare (UFAW) in an effort to encourage the implementation of environmental enrichment programs in laboratory animal husbandry. This publication covers birds, cats, dogs, farm animals, ferrets, rabbits, and rodents. The exclusion of non-human primates is deliberate as they are covered in a separate AWIC publication, *Environmental Enrichment Information Resources for Nonhuman Primates: 1987-1992.*

Various terms are used to describe the welfare requirements of animals in captivity--"psychological well-being," "ethological" or "behavioral needs," and "environmental enrichment." Whatever the term used, they are essential requirements, not luxuries. Legislation and guidelines in the European Union (EU) and the United States recognize this. The Council Directive of the EU concerning all laboratory animals stipulates that facilities "...should permit the satisfaction of certain ethological needs..." In the United States, the Animal Welfare Act requires facilities to provide exercise for dogs and programs to promote the psychological well-being of non-human primates, while the U.S. Public Health Service *Guide to the Care and Use of Laboratory Animals* encourages "enriching the environment as appropriate to the species...." The literature cited in this bibliography reflects the extent of research that has taken place...
in the field of environmental enrichment or deprivation. While offering a useful resource, the bibliography also reveals areas that are lacking in basic information. Consequently, for species about which little information exists, we have provided literature sources on natural and captive behaviors as a foundation for the development of enrichment programs.

Each section of this bibliography is introduced by a paper which provides general background information on the biology of the animals and their currently accepted needs in captivity. It is advisable to refer to all of the contributions. This should act as a starting point for those about to embark on an enrichment project and the citations can then provide further relevant information.

The staffs of the Animal Welfare Information Center and the Universities Federation for Animal Welfare hope that you find this publication to be a useful addition to your laboratory animal resources and welcome any comments for future editions.

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**How To Use This Document**

This publication is divided into 8 sections: articles and bibliographies, journal listing, subscription information for selected journals, organizations, suppliers and products, common devices and programs, subject index, and document delivery information for U.S. and foreign patrons.

**Articles and Bibliographies**

The primary section of this publication consists of seven subsections broken out by species or class of animal. Each subsection is introduced by an article written by a recognized authority in the field of environmental enrichment or behavior. The reference section for each article may or may not overlap with citations in the bibliographic portion of each subsection. Immediately following each article is a comprehensive bibliography containing citations that are arranged alphabetically according to the last name of the primary author. Each entry also contains descriptors and the NAL Call Number if the particular source is available at the National Agricultural Library (NAL).

**Journal Listing**

This section is a listing of journals that appear in the bibliography. It is further categorized by species or class of animal with all entries appearing in alphabetical order. Each entry lists the journal title, place of publication, language, International Standard Serial Number (ISSN) listing, brief description of contents, the NAL Call Number (if available at NAL), and the electronic databases that index the journal.

**Subscription Information for Selected Publications**

During the production of this publication, we found ourselves routinely going to several publications because of their excellent coverage of environmental enrichment research or applied programs. Consequently, we felt it important to include information on how to subscribe to these publications.

**Organizations**

There are many organizations that produce extremely useful materials for their members and other interested parties. In this section, organized by world regions, you will find information on how to contact these organizations via a variety of electronic means and that old standby, the postal service. You will also find World Wide Web addresses for those organizations that have posted homepages on the Web. However, readers are cautioned that because the WEB is a very dynamic media, these addresses may change. You will also find information on the type of organization, the resources or services offered, requestor priority, and fees (if any).

**Suppliers and Products**

To make it even easier for you to develop enrichment programs, we have put together a lengthy, but by no means
exhaustive, listing of commercial vendors and the enrichment products they supply. This listing include items as diverse as plastic tubes or tunnels for rodents to electric netting for free range chickens. All contact information is current as of September 1, 1995. Please note that "800" telephone numbers for U.S. companies may not be reached by all countries.

**Common Enrichment Devices and Programs**

In an effort to show the wide variety of items or strategies commonly employed in enrichment programs, we searched through articles for toys, devices, feed items, socialization programs, etc. and listed them according to the species or class of animal for which they are used.

**Subject Index**

The index for the publication was generated primarily from the descriptors that accompany each entry. In some instances, index words may have been taken from the title. Because people are more likely to be interested in a particular animal, indexes were generated for each species or class covered. The number associated with each index term corresponds to the *page number* on which the index term can be found.

**Document Delivery Information**

The information contained here provides directions on how to obtain copies of articles mentioned in the bibliography. There are separate directions for U.S. patrons and those readers outside the United States. **All patrons are encouraged to use their local resources before contacting the National Agricultural Library.** While the National Agricultural Library provides a variety of services to patrons around the world, videocassettes are not available for loan outside the United States and Canada.

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**USDA**

*This page's URL is http://www.nal.usda.gov/awic/pubs/enrich/intro.htm*
Environmental Enrichment for Birds

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- Introduction
- Recommendations
- References
- Bird Bibliography


The following links access AWIC and other chapters in this publication:

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[ Starlings ] [ Pigeons ] [ Airplanes ] [ Pelicans ] [ Vultures ] [ Main Subject Index ]

Introduction

Birds of many different species from a wide variety of original habitats are housed in research laboratories. Galliformes such as the quail (Coturnix coturnix) and the chicken (Gallus gallus) are used in biomedical research in studies of reproductive, digestive and "biological clock" physiology, and in genetic research. Pigeons (Columba livia) are stalwarts of the psychological laboratory, used primarily for learning and cognitive studies, whilst diverse species such as budgerigars (Melopsittacus undulatus), starlings (Sturnus vulgaris) and passerine species (e.g., the great tit, Parus major) may also be kept for behavioral research purposes. This diversity makes it difficult to generalize about the specific physical or behavioral needs of laboratory birds, and a preliminary first step should always be to consider the natural behavior of each species in the wild.

Wild quail and jungle fowl (the ancestor of the domestic fowl) live in small social groups, devote much of their day to scratching and foraging for food on the ground, and perform complex sequences of behavior such as dustbathing and pre-laying nesting. In the laboratory they may be housed in aviaries or floor pens, or in cages with varying opportunity to perform these behavioral patterns. The spatial restriction imposed by typical laboratory chicken (50 x 60 x 56cm high) or quail (27 x 36 x 20cm hi gh) cages may restrict even relatively simple movements such as wing-flapping. The pigeon is a more gregarious bird, often found in very large flocks, and capable of flying fast over distances of more than 1000km. In the laboratory pigeons are kept eith er in aviaries, pigeon lofts, or in cages (typically 44 x 44 x 54cm high).

In most laboratories veterinary supervision is good and careful attention is devoted to hygiene, and to the maintenance of strict temperature and lighting regimes. Despite this care, the welfare of many laboratory birds may be prejudiced in barren or restrictive environments. This may be a particular oversight when the birds are subjects of behavioral or psychological research, as there is some evidence that cognitive abilities may be detrimentally affected by barren housing. It is probably not possible to recreate a completely natural environment for all laboratory birds, but much can be achieved by relatively simple environmental enrichment, especially in conjunction with information about behavioral needs and priorities.
More is known about the welfare requirements of the domestic fowl than any other bird, largely because of research generated by the controversy over agricultural battery cages. Caution is required when generalizing across species, but a number of important points have emerged from this research, relating to both physical and mental well-being, that can be applied to the laboratory situation.

Laying hens are alarmingly prone to bone breakage if they fly into solid structures such as cage walls, or poorly positioned perches. The risk of breakage is exacerbated if bones are weak due to insufficient exercise in spatially restricted housing. Most cages for laboratory birds appear to allow sufficient space for wing stretching, if not for flapping or actual flight, but many birds may avoid stretching their limbs too close to solid walls or partitions. The greatest risk of physical injury will occur if birds become frightened and attempt to escape from their cages, either during catching procedures or simply when disturbed by human presence. It is therefore important to allow sufficient space for running and wing flapping to maintain bone strength, and because these are important behaviors in their own right (Nicol 1987). This freedom must be coupled with the provision of a small, safe catching area. Birds can often be enticed into such areas if they are well lit whilst the rest of the room is temporarily darkened. Protection from injury can also be facilitated by suspending protective nets just below the cage or aviary roof or by lining the cage or catching area (e.g., with fiberglass) and ensuring there are no rough projections.

If fear levels in laboratory-housed birds are low then panic flights leading to physical injury are less likely, and general welfare is improved. New birds should be gradually exposed to the specific sounds or stimuli that they will encounter in the laboratory so that they can habituate. Research on many species, including chickens and quail, has also shown that baseline fear levels can be reduced by providing an enriched environment. Rearing young birds with access to a variety of stimuli such as colored objects and background music appears to have long-term beneficial effects. But, for adult birds, environmental enrichment must do more than simply provide a more complex general environment. It must also provide opportunities for birds to perform high priority behavior patterns. Increasing evidence suggests that functional behavior performance is crucial to good welfare. Even when birds are provided with ad libitum food and pre-formed nests, they still need to perform foraging and nest-building behavior. Laying hens are even willing to "pay a cost" to obtain their food by foraging in litter, rather than eat readily available food from a dish.

**Recommendations**

Some simple suggestions for the environmental enrichment of laboratory birds include:

1. Allow birds to forage for their food (which should be as varied as possible), either by scattering the food in wood-shavings on the aviary floor, by hiding it amongst shredded paper in a large trough, or by providing it in a form where birds have to work e.g., stuck together in a grain-block. Operant feeders, where a button must be pecked to release food, may occupy solitary birds, but cannot be recommended for group-housed birds as they may not allow birds to feed simultaneously and hence could result in increased competition and risk of feather pecking.

2. Allow egg-laying birds the opportunity to perform nesting behavior by the provision of suitable nest-boxes and building material. If hen or quail have to be kept in cages consider the possibility of modifying the cage to incorporate a roll-away nest box. This can work successfully for laying hens housed in cages (Sherwin 1994).

3. Allow sufficient space for running or flying activity, and consider ways of increasing the value of the space available. Perches or roosting shelves can be incorporated cheaply into all housing systems. In small cages perches can be inserted at night to allow roosting but removed during the day to allow unrestricted space.

4. House birds in suitable stable social groups. If birds must be housed individually arrange the cages so that they have visual contact with others. This may reduce the incidence of stereotypic behavior (Keiper 1970). Since birds seem able to perceive 2-dimensional images the use of mirrors may also reduce the negative effects of social isolation.
References


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Bird Bibliography

NAL call number: SF494.5 M63 1994
Descriptors: chickens, laying hens, caging, depopulation, caging material, feather abrasion, cage floors, perches, economic consequences.

NAL call number: 47.8 B77
Descriptors: perch, housing, laying hens, egg production.

NAL call number: 47.8 Am33P
Descriptors: density, hens, water restriction, space, drinking, production.

NAL call number: 47.8 AM33P
Descriptors: pullets, density, comfort, behavior, cage, floor pens.

NAL call number: SF91.A5 1979
Descriptors: facilities, cage, housing, laboratories.

NAL call number: 49 AN55
Descriptors: space, pre-laying behavior, dustbathing, housing, behavior, hens.

NAL call number: 47.8 B77
Descriptors: behavior, hens, cage, substrate, rollaway hollow, space.

NAL call number: 47.8 W89
Descriptors: production, floor type, housing, hens, nest sites.

NAL call number: 47.8 W89
Descriptors: welfare, housing density, crowding, floor space, behavior, group size, cage size, bone strength.

NAL call number: 47.8 W89
Descriptors: dustbath box, nest box, group size, bone strength.

NAL call number: 47.8 B77
Descriptors: stocking density, litter, slat floor, foraging, behavior, hens.

NAL call number: 47.8 B77
Descriptors: cage, deep litter pen, nest box, preference, hen, flock.

NAL call number: 47.8 B77
Descriptors: wire floor nest box, rollaway nest box, egg production, nesting behavior, space, cage, nest box, hens.

NAL call number: 47.8 B77
Descriptors: perch-type preference, perch space, egg quality, crowding, behavior, perch, hens, cage.

NAL call number: QL750.A6
Descriptors: housing, floor type, feather pecking.

NAL call number: 47.8 AM33P
Descriptors: floor, substrate, pullets, debeaking, feeding.

NAL call number: 410 B77
Descriptors: filial preference, behavior, stimuli.

NAL call number: 472 N42
Descriptors: battery cage, percheries, confinement, exercise, disease.

NAL call number: 47.8 AM33P
Descriptors: laying hens, nest pad, preference, egg production.

Descriptors: quail, cage, litter, mortality, feed efficiency, mortality.


Descriptors: quail, cage, litter, production, reproduction.


Descriptors: fear, stress, battery cages, cage enrichment, cage, hens, body weight, behavior.


Descriptors: battery cages, breeds, production, cage, pullets, genetics, behavior.


Descriptors: handling, housing, genetics, hens.


Descriptors: density, hens, fear, egg production, behavior.


Descriptors: chickens, hens, alternative production systems, economic consequences.


Descriptors: tonic immobility, avoidance behavior, production, hen, 3-bird cage.


Descriptors: feeding, feather-pecking, pullet, cage, floor pen, density.


Descriptors: competitive, feeding, aggression, dominance, submission, social, cage.


NAL call number: QL55.I5
Descriptors: sturnus vulgaris, animal welfare, foraging, cocoa husks, calliphora vomitoria, laboratory rearing.

NAL call number: 442.8 Z35
Descriptors: statistical design, animal number, blocking, experimental units, split-plot design.

NAL call number: 47.8 B77
Descriptors: housing, substrate, flock management, production, broilers, welfare.

NAL call number: 410 Z35
Descriptors: learning, acoustic enrichment, play behavior, toys, budgerigars.

NAL call number: HV4711.E87
Descriptors: rearing environment, illumination, handler influence, social groups.

NAL call number: 47.8 AR2
Descriptors: floor pen, cage, body weight, antibody titers, blood lipids, carbohydrates, stress, physiological, hen, housing.

NAL call number: 47.8 AM33P
Descriptors: broiler chicks, fear, feeding, approach, Classical music.

NAL call number: QL750.A6
Descriptors: tier housing system, battery cage, cage, hens, productivity, fear.

NAL call number: HV4701 A557
Descriptors: animal welfare, conditioning, learning tests, housing, Skinner box.

NAL call number: 47.8 B77
Descriptors: deep litter system, cage, nest material, preferences, nest site, hen.

NAL call number: 410 B77
Descriptors: hens, behavior performance, motivation, nest building.
NAL call number: 47.8 AM33P
Descriptors: group size, body weight, industry, turkeys, cage.

NAL call number: 47.8 AM33P
Descriptors: resting behavior, comfort, space, surface area.

NAL call number: 47.8 AM33P
Descriptors: crowding, immunosuppression, heterophil-lymphocyte ratio, housing, chicks, cage.

NAL call number: S19 R42
Descriptors: cage, shape, colony size, performance.

NAL call number: 47.8 AM33P
Descriptors: growth, genetics, behavior, cage, production.

NAL call number: HD9437 E9 1989
Descriptors: fear alleviation, ontogeny, welfare, performance, behavior.

NAL call number: HV4704 A54 1989
Descriptors: fear, poultry, consequences, alleviate, behavior, adapt, novel, tonic immobility, handling, cage, cannibalism, socialization, artificial selection, welfare, performance, environmental enrichment.

NAL call number: QL750 B4
Descriptors: food neophobia, novel, chicks, environmental enrichment, fear, genetic factors, strain, sex, experiential factors, dietary diversity.

NAL call number: 47.8 W89
Descriptors: tonic immobility, handling, dominance, genetics, age, stress, fowl.

NAL call number: R5 J6
Descriptors: tonic immobility, handling, genetics, environmental enrichment, fowl, fear, performance, welfare, egg.
production, cage, adapt.

Jones, R.B. (1985). **Fearfulness of hens caged individually or in groups in different tiers of a battery and the effects of translocation between tiers.** *British Poultry Science* 26(3):399-408.
NAL call number: 47.8 B77
Descriptors: tonic immobility, tier system, avoidance, novel objects, hen, cage, translocation.

NAL call number: QP351 D4
Descriptors: environmental enrichment, fear, novel, behavior, open field, timidity, emergence latency.

NAL call number: 47.8 B77
Descriptors: novel objects, environmental enrichment, plasma growth hormone, prolactin, chicks, sex, strain, weight gain, gain-to-food ratio.

NAL call number: BF671 J6
Descriptors: tonic immobility, handling, environmental enrichment, activity, vocalizations, quail, genetics, fear.

NAL call number: 47.8 AM33P
Descriptors: handling, fear, quail, tonic immobility, genetics, behavior, breeding.

NAL call number: 410 B77
Descriptors: novel object, bird-human interaction, behavior, habituation, tonic immobility, chicks, fear, welfare, performance, handling.

Descriptors: body weight, broilers, cages, feed efficiency, breast blisters, production.

NAL call number: 47.8 B77
Descriptors: behavior, hens, density, housing, dominance, space.

NAL call number: QL750.A6
Descriptors: feed consumption, pecks, social behavior, stimulus, behavior.

NAL call number: 410 B77
Descriptors: stereotypies, cage size, hand-rearing, wild, social environments, food access, perch, behavior.

Descriptors: laboratory methods, disease control, canary.

Descriptors: care, housing, welfare, psychology, parrot, wellbeing.

NAL call number: 47.8 AM33P
Descriptors: stress, battery cage, floor pen, endocrinology, corticosterone, hen, management.

NAL call number: QL868.D6
Descriptors: hens, stress, housing, corticosterone, corticotropin.

Kovach, J.K. (September 1983). **Constitutional biases in early perceptual learning. I. Preferences between colors, patterns, and composite stimuli of colors and patterns in genetically manipulated and imprinted quail chicks (Coturnix coturnix japonica).** *Journal of Comparative Psychology* 97(3):226-239.
NAL call number: BF671 J6
Descriptors: perception, preference, color, pattern, stimuli, imprint.

NAL call number: aZ5071.N3 no. 95-05
Descriptors: husbandry, bibliography, housing, behavior, physiology.

NAL call number: aZ5071.N3 no.94-26
Descriptors: husbandry, bibliography, housing, behavior, physiology.

Lee, H-Y. and J.V. Craig (February1991). **Beak trimming effects on behavior patterns, fearfulness, feathering and mortality among three stocks of white leghorn pullets in cages or floor pens.** *Poultry Science* 70(2):211-221.
NAL call number: 47.8 AM33P
Descriptors: crowding, cannibalism, tonic immobility, pecking, weight gain, pullets, fear.

NAL call number: 47.8 AM33P
Descriptors: age, feed consumption, feed efficiency, feather scores, mortality, aggression, social behavior, turkey, floor space, beak trimming.

NAL call number: QL750.A6
Descriptors: cockatiels, preference testing, nest box, reproduction, behavior

Meijsser, F.M. and B.O. Hughes (December 1989). **Comparative analysis of pre-laying behaviour in battery cages**
NAL call number: 47.8 B77
Descriptors: perchery, deep litter, covered straw yard, battery cage, nesting, cage, hens, behavior.

NAL call number: QL55 A1L3
Descriptors: laboratory animals, chickens, behavior, exploratory behavior, devices, age, sex, social context, genetics, experience.

NAL call number: 47.8 N219
Descriptors: feed consumption, egg quality, stress, drinking, plumage condition, cage, layers, design.

NAL call number: S3 N672
Descriptors: battery cage, floor pen, weight gain, heritability, cage.

Descriptors: laying hens, broilers, substrate, mesh size, pecking targets, perches.

NAL call number: 41.8 IN22
Descriptors: cage space, egg production, feed efficiency, mortality, quail, cage.

NAL call number: 47.8 AM33P
Descriptors: mortality, productivity, hens, feather condition, cages, floor pen.

NAL call number: 47.8 AM33P
Descriptors: preening, feeding, pecking, genetics, cage, hens.

NAL call number: 47.8 AM33P
Descriptors: density, genetics, hens, industry.

NAL call number: QL750.A6
Descriptors: tonic immobility, handling, transport, activity, fear, behavior, broilers.
NAL call number: 410 B77
Descriptors: space, spatial allowance, behavior, single housing, activity rebound, welfare.

NAL call number: 47.8 B77
Descriptors: cage, hens, behavior, pecking, motivation, comfort, feeding.

NAL call number: QL750.A6
Descriptors: motivation, cage, floor area, time, hens, space.

NAL call number: 410 B77
Descriptors: motivation, exploratory activity, deprivation, behavior, activity, tunnel behavior.

NAL call number: HV4701 A557
Descriptors: budgerigars, behavior, social isolation, group housing, cage, aviary, novel chamber, neophobia, handling.

NAL call number: 47.8 B77
Descriptors: housing, bone strength, cage, deep litter, welfare.

NAL call number: QL750.A6

NAL call number: 47.8 N57
Descriptors: illumination, photoperiod, cage, density, quail.

NAL call number: 47.8 AM33P
Descriptors: dominance, stress, aggressive behavior, housing, density, social, agonistic, fowl.

NAL call number: 47.8 AM33P
Descriptors: tonic immobility, stress, floor pen, cage, hens, avoidance behavior.

NAL call number: SK357.A1W5
Descriptors: wildlife, field methods, wild birds, fiberglass screen.
NAL call number: 49 AN55
Descriptors: rearing environment, lighting, broilers, embryology.

NAL call number: 47.8 B77
Descriptors: cage, motivation, hens, feather pecking, environmental stimulation, behavior.

NAL call number: BF712 P7
Descriptors: social behavior, group housing, isolation.

NAL call number: 47.8 AM33P
Descriptors: housing, cages, density, shape, size, partitions, production.

NAL call number: 47.8 AM33P
Descriptors: aggression, genetics, production, social dominance, hen, pre-laying behavior.

NAL call number: 47.8 B77
Descriptors: housing, nest lining, cage partitions, nest disturbance, cage, behavior.

NAL call number: QL750.A6
Descriptors: handling, fear, housing, injury, humans, hens.

NAL call number: 47.8 AM33P
Descriptors: cage size, density, space, hens, egg production, mortality.

NAL call number: S960 W5
Descriptors: seed preferences, seed size, Psittaciformes, cockatoo.

NAL call number: QL750.A6
Descriptors: feed restriction, stress, group housing, battery cage, cage, broilers, behavior.

NAL call number: HV 4701 A557
Descriptors: foraging, feeding behavior, leather balls, rubber balls, tennis balls.

NAL call number: SF494.5 M63 1994
Descriptors: housing, caging, welfare.

NAL call number: 47.8 B77
Descriptors: motivation, choice, water provision, environmental control, behavior, hens, cage, peck.

NAL call number: 49 J82
Descriptors: feed trough, nest, feeding activity, hens, behavior, welfare, bar cage.

NAL call number: QL750 A6
Descriptors: hen, pre-laying behavior, cage, nest, housing, welfare, egg-laying behavior.

NAL call number: QL750 A6
Descriptors: battery cage, litter-reared, nests, social interactions, cage, hens.

NAL call number: QL750 A6
Descriptors: hen, cage, nest, behavior, production, welfare.

NAL call number: QL55.I5
Descriptors: photoperiod, feed conversion, feathering, ring-necked pheasant.

NAL call number: aS21 D27S64
Descriptors: husbandry, bibliographies, biomedical research use.

NAL call number: 47.8 AM33P
Descriptors: debeaking, litter floor, wire floor, pullet, corticosterone.

NAL call number: QP251.A1TS
Descriptors: pairing intervals, mating opportunity, intercage transport, egg number, quail, handling.

NAL call number: 47.8 AM33P
Descriptors: battery cage, aviary, behavior, production, activity, environment.

NA call number: 47.8 AM33P
Descriptors: sudden illumination, gradual illumination, comfort, battery cage, activity, behavior, hens.

NA call number: 47.8 AM33P
Descriptors: housing density, feather-pecking, space, feeding, drinking, hens, behavior, cage.

Descriptors: cage, engineering-related trauma, neck, head, toe, claw.

NA call number: HV470 A557
Descriptors: animal welfare, dustbath, feather, lipid, litter, sand, peat.

NA call number: 49 J82
Descriptors: behavior, poultry, enrichment, displacement, feather pecking, dustbathing.

NA call number: 47.8 B77
Descriptors: floor space, age, density, battery cage, hen, plumage, group.

NA call number: 47.8 W89
Descriptors: hens, nest box, perch, behavior.

NA call number: 410 AR27
Descriptors: animal awareness, feelings, environmental control, behavior, farm, ethological.

NA call number: 47.8 N219
Descriptors: color, illumination, breeding, management, nesting, egg.

Descriptors: budgerigar, social proximity, social cues, breeding, familiarity.

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Enriching the Environment of the Laboratory Cat

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Cats are intelligent, highly specialized carnivores. Like many predators, their senses are highly developed (reviewed by Bradshaw 1992). The cat's ability to hear, see and smell outside our own range give it a very different perception of its environment to ours. For example, it has a second olfactory system, the vomerosensory system which is associated with social behavior. The system is used when cats come into contact with other cats or their urine. In addition, the cat's visual images are supplemented with information from its highly developed sense of balance and sensory hairs on the head and legs which give the cat its position relative to other objects.

The domestic cat, Felis silvestris catus, used in laboratories is the same species that is commonly kept as a pet and exists in substantial numbers in feral colonies. Until recently, cats were thought to be essentially solitary but studies have found in large socially structured groups (at densities of over 2000 per km² Izawa 1984; Izawa et al. 1982; Kerby and Macdonald 1988). The key to the success of the domestic cat is flexibility. Its ability to adapt enables it to survive in environments as diverse as the laboratory cage and isolated islands where individual territories can reach 6 km² (Liberg and Sandell 1988). The rest of this paper introduces the problems of confinement experienced by domestic cats, the principles of enrichment relevant to this species and the role of enrichment in preventing and relieving problems.

Specific problems associated with confinement include boredom, aggression to people and to cats, fearfulness, poor reproductive success, anorexia, tail-chasing, stereotypies, fabric eating and self-mutilation (Mellen 1988; Holmes 1993). It seems that cats confined in relatively restricted environments are more likely to develop behavior problems as Mertens and Schär (1988) claim pet cats restricted to indoors are more likely to be presented for behavior problems than cats with access to outdoors. As single laboratory caging represents the most extreme and barren environment in which cats are confined, it is likely that this is where the worst problems will develop. However, any form of cat housing can be made more stimulating, complex, and less predictable through both environmental and social enrichment.
Environmental enrichment

Above a critical minimum, improving quality of space for cats rather than quantity may be a better investment (Mansard 1989). In several species, increasing housing space alone did not change levels of activity (Hite et al. 1977; Bebak and Beck 1993). Quality of space can be improved by providing a range of resting places, by extending vertical space, by increasing complexity and by frequently changing internal structure and contents.

Elevated resting places are particularly favored by cats for watching their surroundings. They also preferred resting places that were warm, dry, and protected on one, or even better, two sides (Smith 1990; Roy 1992) and situated in the corners or edges of an enclosure where they can watch without the possibility of being approached from behind (Roy 1992). A range of resting places should be provided so that cats can choose their degree of contact with other cats. This may be particularly important if they are timid or the focus of aggression. The provision of shelves, ropes and climbing poles (illustrated in Loveridge 1984; Horrocks 1994) enrich the enclosure's vertical complexity and extend the available space. The latest advances in enriched group-housing are illustrated in Loveridge's paper (1994). Shelving allows the available space to be separated into functional areas. For example, the areas can be allocated to food, litter, scratch posts, toys, bedding and viewing points. These areas can be changed to promote activity. If shelves are hinged so they can fold down, the internal space periodically can be changed by erecting different combinations of the shelves available. Surface materials commonly used are metal and plastic but cats prefer materials which maintain a constant temperature such as straw, shredded paper, shavings, sacks, clothes or wood (Roy 1992).

Within the available space, furniture and objects can be provided to create a focus of interest, exploration and play. Toys which provide movement and which are frequently changed attract the most interest.

Food has been the focus of enrichment for several other Felis species (Mellen et al. 1981; Law et al. 1990). In laboratories, dry food is particularly suitable for hiding in the enclosure or for placing inside containers which the cat has to work at to extract individual pieces. A cheap version of a food puzzle can be made by gluing together two yoghurt containers containing dry food, with holes just large enough to extract one piece at a time. The puzzle can be made more challenging by hanging the tubs just above the cat's head height. Puzzle boxes for cats are now commercially available. Alternatives include hiding food inside cardboard boxes, in bedding, on shelves and inside rolling toys.

Social enrichment

The social environment can also improve the quality of time spent confined. Cats vary in their degree of sociability. In colonies where new cats frequently join the group, some cats remain essentially solitary (Roy 1992) whereas others form social attachments which undoubtedly enrich their lives by adding variety and complexity. By providing a variety of retreats and resting places, cats have the opportunity to interact closely with other cats or to remain alone if less sociable.

Social contact with cats

Singly caged cats lack the opportunity that communally confined cats have for rich, interactive relationships. Ideally, cats should remain in stable groups. If research requires single housing, cats can often be returned to social groups in between trials or for a period each day.

Social contact with people

People are also a rich source of stimulation. Many cats respond positively to human social contact. Cats kept in a
relatively restricted environment will seek additional stimulation from people (Turner and Stammbach-Geering 1990) indicating they may derive some benefit from the contact.

If direct contact is not possible, social enrichment can be indirect. Visual, vocal and olfactory communication are possible without direct contact by the use of glass partitions and grills between pens. Access to a communal room in which other cats have previously left chemical messages, rubbed from their glands, or sprayed in their urine, convey information to cats about each other (Natioli 1984). Providing scratch posts enables cats to keep their claws trimmed but also allows them to leave olfactory and visual messages (scratch marks) to other cats in the colony. The sound of voices on radio may habituate timid cats to people (Hurni and Rossbach 1987).

Many problems associated with confinement can be prevented by adequate early socialization and careful selection of cats for suitable temperament (McCune in press; Reisner 1994; McCune et al. 1995). One study showed that friendly, confident cats were less distressed by being caged, their normal behavior was less inhibited and they adapted sooner than timid cats (McCune 1992). For cats inadequately socialized as kittens and already stressed by caging, social contact can be an additional stresor. For these individuals, methods other than handling must be used to relieve stress and enrich the captive environment (McCune 1995). Individuals will vary in both their need for enrichment and the benefit it provides them. For example, cats with a timid temperament (McCune 1992), extremes of age (McCune 1994) and restricted experience (Konrad and Bagshaw 1970; Ledger 1993) are more likely to have problems adjusting to confinement and responding to novelty. Mellen (1988) claims that male cats are more likely than female cats to develop problems in restricted environments.

Few of these studies were primarily interested in environmental enrichment. Techniques of enrichment need to be scientifically validated to promote and communicate methods that work for cats and to avoid techniques which produce problems. Assessments should look for a decrease in abnormal behavior and a behavioral repertoire which more closely resembles that of free-ranging cats (UK Cat Behavior Working Group 1995). Research animals without behavior problems are likely to have better welfare and produce better quality data.

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Descriptors: resting boards, social housing, scratching post, tree trunks.

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Descriptors: colony cats, object play, social play, restricted versus ad libitum maternal feeding.

NAL call number: SF446.5.B4
Descriptors: senses, play, learning, communicative behavior, socialization, hunting.

NAL call number: SF447.B4513 1993
Descriptors: toys, scratching posts, exercise, play, hunting, color photos.

NAL call number: 41.8 Au72
Descriptors: animal behavior, cats, aggression, grief, social behavior.

NAL call number: SF446.5.B72 1992
Descriptors: sensory abilities, behavioral development, hunting, predation, social behavior, cat-human relationship, welfare.

NAL call number: QL750 A6
Descriptors: ACTH, cortisol, caged cats, caretaking routine, hiding behavior, reproductive hormones.
NAL call number: 410 B393
Descriptors: ontogeny, play, relationships.

NAL call number: QL55.A1L33
Descriptors: dogs, cats, swine, gumadisc, nylabone frisbee, plastic chain, decoys, gumabone tug, catnip, sheepskin mice, balls, bells, cotton tugs, scented apples.

Descriptors: attention, cats, psychology, orientation, predatory behavior, problem solving, object permanence, psychomotor performance, recall, prior experience.

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Descriptors: early experience, social environment, mother-offspring interactions, play, exploratory behaviour.

NAL call number: SF446.5.H37
Descriptors: sexual behavior, senses, development, sleep, grooming, predatory behavior, behavior modification.

NAL call number: SF985.F4
Descriptors: saliva, skin, hair, behavior, cat.

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Descriptors: research colony vs. pet cats, behavior differences, early experience, preference.

NAL call number: SF411.5.P47
Descriptors: social bonds, handling, critical period, friendly responses to humans.

Descriptors: behavior, animal behavior, cerebral cortex, intelligence, cats, haplorhini, memory, visual cortex, visual perception.

Descriptors: laboratory animal house, animal welfare, cage, technical personnel, laboratory animals, cat.

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NAL call number: QL737.C23L49
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NAL call number: QL55.15
Descriptors: cats, animal housing, environment enrichment, design, animal husbandry, socialization, animal welfare.

NAL call number: SF601 V523
Descriptors: grooming, polydipsia, circling, whirling, barking, aggression, early experience, conflict behavior.
NAL call number: 410 B77
Descriptors: laboratory conditions, indoor pen, climbing frame, kittens, locomotor behavior, vocalizations.

NAL call number: 410 B77
Descriptors: kittens, weaning, social play, object play, locomotor play.

NAL call number: 410 Z35
Descriptors: *Felis catus*, colony cats, kittens, percentage of total time spent playing, toys, metabolic rate.

NAL call number: QL77.5 Z6
Descriptors: human rearing, maternal rearing, aggression.

NAL call number: SF411.A57
Descriptors: colony cats, contact latency, play, vocalizations, head rubbing.

NAL call number: QL750 A33
Descriptors: approach behavior, ontogeny, cognition.

Descriptors: cues, discrimination learning, orientation, space perception, cats.

Descriptors: handler, experimenter, human-animal interaction.

NAL call number: QL77.5 Z6
Descriptors: *Felis viverrina*, *Felis bengalensis*, exhibit animals, activity budget, live prey, environmental enrichment.

NAL call number: aZ5071.N3 no. 94-25
Descriptors: bibliography, behavior, stress, housing, nutrition.

Descriptors: acoustic stimulation, housing, learning, cats, food, reward, sensory deprivation, vision.


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Dogs and Dog Housing

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Brief background

The dog is descended from the wolf, possibly the Southern wolf (Canis lupus pallipes). Wolves are social carnivores that can combine into packs, and this trait is still shown by some feral dogs (Feddersen-Petersen 1994). Thousands of years of domestication and artificial selection have produced breeds, with modified social repertoires (Bradshaw and Brown 1990), that are capable of transferring conspecific social behavior to humans. Like most larger mammals, dogs spend a considerable portion of their time inactive (Hubrecht et al. 1992, Adams and Johnson 1993). However, as a diet opportunist, the dog is adapted to seeking a wide variety of foods in unpredictable locations, it is therefore much more likely to be tolerant of novel items and circumstances than a more specialized feeder. Conversely, during its active periods it may be more easily bored by a predictable and limiting environment.

Physical needs

There are many publications that provide recommendations for the dog's general husbandry (e.g., MacArthur 1987, HMSO 1989, 1995). These are based on experience and provide valuable information but there has been very little research into specific physical requirements apart from diet. In most scientific work a tightly controlled environment is required to reduce unwanted variation, however, the dog is a very adaptable animal and a healthy adult can cope with a range of conditions, particularly if it has access to areas with different micro-climates.

Temperature, humidity, ventilation and lighting
An indoor temperature range of 15-24°C, and humidity of 55 percent ± 10 percent, with 8-12 air changes per hour is suitable. New-born puppies require an ambient temperature of 26-28°C for at least the first 10 days of life. Lighting should be adequate for staff to work, and there may be a case for a low level of nocturnal illumination in totally enclosed facilities.

**Diet**

Dogs appear to prefer meat to cereal diets (Houpt and Smith 1981). Some breeds have a propensity for obesity (Anderson 1973), however, they will usually adapt well to the many proprietary diets available. Advice, if needed, should be sought from the suppliers.

**Noise**

Dog housing is often very noisy because of barking, and sound pressures of well over 100 decibels have been recorded (Senn and Lewin 1975). Ottewill (1968) provided recommendations to reduce noise, mainly with the aim of improving conditions for the humans. The dog has a hearing frequency range of up to 55 kHz (Gamble 1982) with the most sensitive frequencies at 500Hz -16kHz. At these frequencies their hearing can be up to four times as acute as that of humans. Prolonged exposure to sound pressures of over 90 decibels is known to damage human hearing, and many sites advise or require hearing protection for the staff. It is not unreasonable to assume that such levels might also damage dog hearing, although there is very little evidence on this subject.

**Social needs**

It has been known for a long time that inadequate housing can lead to behavioral problems in dogs (Fuller 1967, Solarz 1970). Normal husbandry for the dog should allow plenty of opportunities for social interactions with humans (Wolfle 1992) and conspecifics (Fox 1986). Group housing of compatible dogs in pairs or larger groups is the preferred housing method, (HMSO 1989, Hubrecht et al. 1992, Hubrecht 1993b) but care is needed to control any fighting. Regular human contact during the puppie’s socialization period (3-14 weeks) is particularly important to produce dogs that are relaxed with humans (Scott and Fuller 1965).

**Environmental enrichment**

Many laboratory enclosures are simple structures, with little or no complexity provided by cage furniture or subdivisions, and in some countries it is still legal and common practice to house dogs in what would seem to be very small cages. It is unlikely that such small enclosures can provide for the dogs' psychological needs (Hetts 1991). A good housing system should allow the dog to exercise an element of choice, to manipulate or chew safe objects, and provide opportunities for human and canine socialization (Hubrecht 1993a). Dogs sometimes have to be housed singly for experimental or quarantine reasons, in which case greater thought should be given to providing extra human contact time and an interesting environment.

Dog pens should be subdivided into separate sleeping and exercise areas which provide complexity, choice and allows the dog to defecate/urinate away from its sleeping area (Fox 1986). Solid partitions between pens provide privacy and help to prevent injuries, but can isolate the dog from its surroundings. A good pen design should allow the occupants to satisfy their natural curiosity about what is happening outside the enclosure. One solution is to provide platforms at a
height that allows the dog to see over the partitions whilst lying down (Hubrecht 1993a). Such devices have the additional advantage of increasing the useable space available to dogs.

There have been a number of studies on the effects of exercise, and pen size (e.g., Campbell et al. 1988, Hughes et al. 1989, Bebak and Beck 1993, Hetts et al. 1992). There is no evidence that providing extra exercise per se improves welfare (Clark et al. 1991), although walks outside the enclosure are undoubtedly enjoyed.

Olfaction is an important canid sense. We know little about how to enrich an environment through odors but Hubrecht et al. (1992) found that dogs housed in groups spend more of their time sniffing and investigating the floor of their enclosure. Dogs will also make extensive use of chews, particularly if they taste of food and are presented properly (DeLuca and Kranda 1992, Hubrecht 1993a).

Breed differences and husbandry requirements should be kept in mind when considering enrichment options. It is also important to remember that dogs vary in temperament (Cattell and Korth 1973) and perhaps also in their housing requirements and ability to cope with a particular kennelling system.

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NAL call number: QL737.C22C36
Descriptors: dogs, animal housing, environment, laboratory animals.

NAL call number: SF601 V523
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NAL call number: SF601 N4
Descriptors: feral, dingo, bonding, social behavior.

NAL call number: 41.8 AM3
Descriptors: stress, eustress, feeding behavior, reproduction, ACTH, glucocorticoids, sympathetic nervous system, responses.

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Descriptors: dogs, exercise, stress, lymphocyte transformation, cortisol, animal welfare.

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Descriptors: welfare, well-being, environmental enrichment, social behavior, dogs, cats, rodents, rabbits, primates.

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Descriptors: dogs, pups, social behavior, deviant behavior, behavior modification, animal housing.

Descriptors: animal welfare, animals, dogs, housing, physical fitness, hydrocortisone.

Descriptors: confinement systems, housing, experimental design, EKG, muscle enzyme, behavior.

Descriptors: animal dominance, animal social behavior, animal environments, infanticide, dogs, social density, dominance hierarchy.

Descriptors: dogs, cats, swine, gumadisc, nylabone frisbee, plastic chain, decoys, gumabone tug, catnip, sheepskin mice, balls, bells, cotton tugs, scented apples.

Descriptors: service dogs, training methods, early experience.

Descriptors: behavior, bonding, human isolation, dogs.

Descriptors: dogs, resting area, housing.

Descriptors: ethology, socialization, exercise, housing, environment, psychological well-being.

NAL call number: SF406 F69
Descriptors: dogs, primates, rodents, cats, confinement effects, physical activity, stereotypies, cage size, brain development.

NAL call number: 410 B393
Descriptors: intra-species socialization, intra-species, identification, avoidance, recognition, bonding.

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Descriptors: review, dogs, rodents, poultry, behavior, social isolation, social stimulation, crowding.

NAL call number: QL750.A6
Descriptors: social behavior, social organization, domestication, Canis lupus, lycaon, effects on dogs.

NAL call number: QL55.A1L3
Descriptors: dogs, sex differences, hydrocortisone, blood serum, stress, adaptation, environmental factors, susceptibility.

NAL call number: 41.8 Z5
Descriptors: mouse, rat, guinea pig, rabbit, dog, cat, legislation, behavior, stress, exercise, laboratory animals, animal welfare, cages, housing.


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Descriptors: puppies, laboratory rearing, breeding colony, husbandry, animal welfare.

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Descriptors: Animal Welfare Act, regulations, history, physical and psychic well-being, measures, indicators, abnormal behavior, normal behavior, preference testing, caging, socialization.

NAL call number: 410.9 P94
Descriptors: early socialization, human contact, toys, chews, plastic pipe.

NAL call number: QL570.A6
Descriptors: activity pattern, toys, psychological well-being, socialization session.

Descriptors: welfare, behavior, socialization, stereotypies, enrichment, toys.

NAL call number: QL750.A6
Descriptors: dogs, kennels, cage size, animal behavior, shelters, laboratories, social behavior, animal housing, animal welfare.

NAL call number: 410.9 P94
Descriptors: dogs, animal housing, cage size, cage density, exercise, animal welfare, regulations.

NAL call number: QL737.C22C36
Descriptors: dogs, laboratory animals, animal housing, socialization, animal welfare.

Descriptors: Animal Welfare Act, exercise, environmental enrichment, space recommendations, feeding, water, enclosures.

NAL call number: 11 AC82
Descriptors: cage size, body weight, feed intake, tameness score, fur quality.

Descriptors: dogs, competitive behavior, physiology, feeding.

NAL call number: SF402 S3
Descriptors: circadian activity, behavioral patterns, rhythms, eating, elimination, aggression, environmental conditions.

NAL call number: 410 Z36
Descriptors: environment, red blood cell counts, packed cell volume, hemoglobin, plasma enzymes, substrates, minerals.

NAL call number: SF414.2.L32
Descriptors: pets, housing, design and construction, pet supplies, building, amateurs' manuals, handicraft.

NAL call number: QL750.A6
Descriptors: human sex differences, animal sex, familiarity.

NAL call number: SF601.V523
Descriptors: excessive grooming, stone chewing, wool sucking, polydipsia, barking, tail or foot biting, aggression, environmental enrichment.

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Descriptors: socialization period, responses to environment, sensory isolation, play.
NAL call number: 41.8 V641
Descriptors: dog, tongue injury, playthings, case report.

NAL call number: 41.8 T431
Descriptors: bonding, posture, behavior, social dominance.

NAL call number: Z5055 U49D53
Descriptors: dogs, animal environments, environmental stress, animal ethology.

NAL call number: 410.9 P94
Descriptors: physical activity, specific activity measurements, body weight, blood chemical and urine values.

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Descriptors: exercise, dog, cage confinement, musculoskeletal system, dogs kept in cages, muscle, enzymes.

NAL call number: QL751 M218 1990
Descriptors: pets, behavior, management, reviews.

NAL call number: 41.8 V6456
Descriptors: exercise, aggression, human-animal bond.

NAL call number: QP351.D4
Descriptors: Shetland sheepdogs, telomians, beagles, food, toys, human contact, canine contact, distress vocalizations, isolation.

NAL call number: QH301 C63
Descriptors: aggression, crowding, dominance, eating, spatial behavior.

NAL call number: QP351.D4
Descriptors: social attachment, beagles, Telomians, separation distress.

NAL call number: 41.8 P882
Descriptors: housing, husbandry, animal welfare, dog, pets.
NAL call number: 447.8 P564
Descriptors: legislation, physical conditioning, dogs, housing, primates.

NAL call number: SF601 N4
Descriptors: definitions, measurement, parameters, coping, adaptation, stress psychology.

Descriptors: dogs, education, socialization with humans, age differences.

NAL call number: 41.2 H198 [1976 No. 72]
Descriptors: dissertation, animal housing, animal welfare, cage, dog.

NAL call number: 410 Z36
Descriptors: dogs, animal housing, movements, dark, light, kinetic energy.

NAL call number: 41.8 So8
Descriptors: disease susceptibility, separation stress, mortality, weight gain.

NAL call number: aZ5071.N3 no.94-24
Descriptors: bibliography, behavior, welfare, stress, nutrition, exercise.

NAL call number: aS21.D27S64 no.92-02
Descriptors: bibliography, regulatory issues, physiology, behavior, husbandry, standard values.

NAL call number: Videocassette no. 2040
Descriptors: stress, handling, relaxation, training, behavior, body awareness.

NAL call number: 41.8 K67
Descriptors: cages, animal welfare, zootechny, dog, animal housing, laboratory animals.

Descriptors: petting, human presence, bradycardia, genetics.

NAL call number: 447.8 J825
Descriptors: dog, training, heart rate, blood circulation, exercise, heart, atropine.

NAL call number: 41.8 D482
Descriptors: housing, behavior, companion animals.

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Descriptors: animal welfare, behavior, cats, dogs, housing.

NAL call number: QL55.A1L33
Descriptors: puppies, socialization, human-animal bond, toys.

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Descriptors: psychological well-being, exercise, socialization, management, performance vs. engineering standards.

NAL call number: QP351 D4
Descriptors: social organization, exploratory behavior, ontogeny, dominance, dogs.

NAL call number: QL750.A6
Descriptors: hand-rearing, litter-rearing, stimulus, exploratory behavior, locomotor activity, novel objects, reactivity, social environment, rearing, exploratory behavior, dogs.

NAL call number: SF601 N4
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There has been relatively little published on environmental enrichment for the mammalian farm animals used in "laboratory" studies. This may be partly because most such studies are carried out either in normal farm conditions, or in conditions regarded as similar to these (for example, growing pigs housed singly, similar to normal housing for sows) or on animals removed only temporarily from such conditions. There may, however, be welfare problems in normal farm conditions and the considerable work which has now been done on improvement of these is relevant here. In addition, the special treatment necessary for experimental work may cause further problems and also cast doubt on the results of the research, not least when imposed temporarily. In this brief commentary, three aspects of such treatment will be considered which act separately and in combination: human contact, social conditions and physical conditions.

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**Human contact**

Animals react to human contact behaviorally and physiologically in ways which may interfere with the topic under study. This is particularly likely if restraint is involved; for example, to obtain blood samples. A common approach to minimize such effects is to use remote sampling methods such as filming behavior, strapping on or implanting heart rate meters (Porges 1985), and automatically withdrawing blood samples from a catheter (Mayes et al. 1988). Other non-invasive techniques are also being developed, such as measurement of hormones in saliva, urine and faeces. Less
attention has been given to the possibility of accustoming animals to human contact including handling, which may considerably reduce such effects (Pearce et al. 1989), despite the fact that more is known about this for farm animals than for other species (Gonyou 1991). A particularly promising finding is that pigs and sheep can be trained to enter a restraining device for procedures including blood withdrawal voluntarily and repeatedly (Grandin 1986, 1989). Another important aspect of human contact is predictability (Carlstead 1986). Thus if feeding times are to be manipulated experimentally, animals can be trained in advance not to expect food at the same time each day (Reid and Mills 1962). As a general rule it is better to accustom animals to disturbance than to attempt to avoid disturbing them; if there is little disturbance for long periods then any disruption which does occur may be very stressful. This is probably the main basis of the idea which is sometimes expressed that animals should be subjected to "adequate levels of stress".

Social conditions

Many experiments involve isolation of animals. This can have very strong effects: heart rate of sheep when first isolated is greatly elevated (Baldock and Sibly 1986) and sheep on restricted diets behave more abnormally in isolation than in groups (Done-Currie et al. 1984). There is some indication that the chance of conception by dairy cows is lower if they have been kept in isolation prior to artificial insemination (cf. Moberg 1991). Effects are usually reduced if animals can see each other and it should be possible to arrange this even in restrictive housing such as metabolism crates. More consideration should also be given to methods for housing animals in groups while making individual measurements; for example, using film (Pajor et al. 1991) or electronic devices (Lambert et al. 1983) for recording individual food intake. When animals are housed in groups, though, care must be taken to minimize harmful social behavior such as aggression, as in any husbandry system. Precautions should include careful consideration of physical conditions.

Physical conditions

The space provided in experimental conditions is usually less constrained than that in commercial conditions with one major exception: the metabolism crate. This is commonly used to keep the animal in a fixed position for collection of urine and faeces, but more use could be made of bags fixed to the animal for this purpose; in pigs, it should also be possible to make use of their habitual urination and defecation sites as has been done for cats (Carlstead et al. 1993). Reactions of animals to close confinement may be extreme especially if it is combined with food restriction (Appleby et al. 1987). In experiments which do not use such crates, problems such as harmful social behavior and frustration of various behavior patterns are more likely to be associated with barrenness of the environment than with lack of space. Common causes for barrenness are cleanliness and avoidance of unwanted edible material (such as straw). Yet cleanliness is not always strictly necessary, and an acceptable degree of cleanliness may be achieved even with substrates such as woodchips (Chamove et al. 1982). The environment can be made more complex quite easily, for example by fitting barriers (Waran and Broom 1993) and providing manipulable objects. Many techniques which have been developed for other species such as primates could also be used for farm animals; these include, for example, increasing the animals' control over their physical environment (Baldwin 1979). Among other advantages, provision of "toys" makes handling of pigs easier (Grandin et al. 1987). It should be pointed out, however, that the effects of environmental enrichment need to be assessed rather than just assumed; there may be deleterious effects such as increased aggression (McGregor and Ayling 1990). Food can also be provided in ways which are more stimulating than a trough, such as operant devices. As with several of the other factors already mentioned, this will be particularly valuable if food is restricted. Without such measures, food restriction can have severe effects on behavior (Willard et al. 1977, Appleby and Lawrence 1987) with implications for physiological effects on the measurements being made (Marsden and Wood-Gush 1986). Such effects include extreme variability: one nutritional study of sheep which kept them without food for a period to obtain baseline measurements found that some reacted violently, with high metabolic
rate, while others were somnolent with low metabolism (Blaxter and Wainman 1961).

Environmental enrichment for farm animals in experiments is important both for the validity of the experiments and for the animals themselves.

References


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**Farm Animal Bibliography**

**General**

NAL call number: aZ5071.N3 no. 94-32
Descriptors: bibliography, livestock, poultry, handling, husbandry, transport, care.

NAL call number: SF81 C73
Descriptors: directory, information, journals, funding sources, academia, audio-visuals, conferences, books, reviews.

NAL call number: QL55 A1L33
Descriptors: canine, swine, feline, welfare, exercise, toys, play, balls, runs, comparisons.

NAL call number: QL55 A5
Descriptors: behavioral needs, comfort, shelter, flooring, legislation.

NAL call number: 410.9 P94
Descriptors: boredom, crowding, space, noise, photoperiod.

NAL call number: SF601.B6
Descriptors: cattle, sheep, handling, restraint, behavior.

NAL call number: QL750.A6
Descriptors: cattle, pigs, sheep, floor, lighting, chutes, pens, transport.

NAL call number: SF601.V535
Descriptors: livestock, handling, stress, movement, behavior, facilities.

NAL call number: 41.8 M69
Descriptors: cattle, physiology, stress, behavior.

NAL call number: QL55 A1L33
Descriptors: zoo, farm, laboratory, outdoor housing, noise.

NAL call number: HV4701.A557
Descriptors: stock people, human-animal bond, fear, handling.

NAL call number: SF601 V535
Descriptors: fear, handling, noise, husbandry, housing.

NAL call number: 410 B77
Descriptors: behavioral elasticity, motivation, appetitive and consummatory behavior.

NAL call number: QL750.A6
Descriptors: cattle, goats, horses, sheep, pigs, feed preferences, conditioning.

NAL call number: QL55 A1L33
Descriptors: exploratory behavior, appetitive behavior, genetics, experience.

NAL call number: HV4704.W38
Descriptors: handling, transport, management, care, behavior, regulations.
NAL call number: videocassette no. 1542
Descriptors: farm animals, pointless behavior, physiology, genetics, parasites, nutritional deficiencies.

NAL call number: videocassette no. 1327
Descriptors: zoo animals, housing, guidelines, captivity

NAL call number: 410 B77
Descriptors: novel objects, exploration, learning.

NAL call number: BJ52.5 J68
Descriptors: pigs, exploration, learning, social behavior, housing.

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Cattle

NAL call number: 44.8 J822
Descriptors: cows, welfare, review, housing, environment, behavior, environmental factors.

NAL call number: aZ5071.N3 no. 95-16
Descriptors: bibliography, handling, husbandry, facilities, care, welfare, well-being, behavior, stress, humane.

NAL call number: aZ5071.N3 no. 95-15
Descriptors: bibliography, handling, husbandry, facilities, care, welfare.

NAL call number: aZ5071.N3 no. 92-67
Descriptors: bibliography, handling, husbandry, facilities, care, welfare, behavior, stress, humane.

NAL call number: 44.8 J822
Descriptors: calves, handling, anesthesia, polling, cortisol, stress.

NAL call number: 100 AL1H
Descriptors: calves, steers, cattle, stress management, stress response, adrenal cortex hormones, immune response, transport of animals.

NAL call number: 41.8 T431
Descriptors: society critique, group vs. isolated housing, preputial sucking.

NAL call number: 23 AU792
Descriptors: cattle, stress response, space requirements, pens, size, behavior, welfare, heart rate, surveys, injuries, weight loss.

NAL call number: 290.9 AM32T
Descriptors: cattle, dairy, stalls, housing, behavior.

NAL call number: 275.29 M58B
Descriptors: cows, cattle, fencing, behavior, vision, movement.

NAL call number: SF601.B6
Descriptors: cattle, handling, behavior, perception, stress, guidelines.

NAL call number: 41.8 AM3
Descriptors: housing, husbandry, pathogen transmission.

NAL call number: QL750.A6
Descriptors: cattle, cows, milking interval, calving interval, handling, stress, cortisol, behavior.

Descriptors: stress, pain, social behavior, physiology, stereotypies.

NAL call number: 100 K41PR
Descriptors: cattle, steers, housing, pens, bedding, space requirements.

NAL call number: 49 AN55
Descriptors: calves, animal behavior, intensive livestock farming, extensive livestock farming, housing, welfare.


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Horses

Descriptors: welfare, racehorses, safety, preference, substrates.

NAL call number: HV4701.149
Descriptors: behavior, flight distance principle, human-animal bond, mutual confidence.

NAL call number: QL55 I44
Descriptors: flight distance, avoidance, feral horses, domestic horses, psychobiology, researcher personality.

NAL call number: QL750.A6
Descriptors: behavior, social interaction, herd structure, sex differences.

NAL call number: QL750.A6
Descriptors: behavior, colt, fillies, mating behavior, mares.

NAL call number: QL750.A6
Descriptors: welfare, behavior, grazing, natural environment.

NAL call number: SF955.E6
Descriptors: behavior, welfare, care, health, handling, well-being.

NAL call number: QL751 B4
Descriptors: foals, behavior, running, exercise, socialization.

NAL call number: 410 B77
Descriptors: social behavior, husbandry, grooming, stress.

NAL call number: HV4701.A34
Descriptors: foals, adaptability, domestication, behavior, welfare, training.

NAL call number: QL750.A6
Descriptors: behavior, learning, training, novel stimuli, conditioning, maze-learning.

NAL call number: QL750.A6
Descriptors: Equus caballus przewalskii, wild animals, housing, space requirements, socialization, behavior.

NAL call number: SF411.A57
Descriptors: aggression, behavior, handling, care, treatment, welfare.
NAL call number: QL750 A6
Descriptors: social behavior, feeding behavior, stress, newborn, foals, solitary confinement, pasture, familiarity, contact, space, grazing, novel environment.

NAL call number: SF951.E62
Descriptors: social environment, physical environment, operant conditioning, lighting, preferences, behavior.

NAL call number: 49.J82
Descriptors: social environment, physical environment, operant conditioning, lighting, preferences, behavior.

NAL call number: 49 J82
Descriptors: housing, behavior, substrate, straw, wood shavings.

NAL call number: SF951.J65
Descriptors: behavioral problems, vices, feeding behavior, mating behavior, group interaction, tractability, animal welfare, time allocation.

NAL call number: SF281.K5415 (German), SF281.K54 (English)
Descriptors: welfare, social behavior, learning, stereotypies.

NAL call number: QL750.A6
Descriptors: *Equus caballus przewalskii*, social behavior, housing, husbandry, facilities, zoological gardens, space requirements.

NAL call number: SF756.7.I5
Descriptors: social behavior, feeding behavior, housing, space, size.

NAL call number: S232 B24L36
Descriptors: saddle horses, housing, animal needs, livestock, work animals, preferences.

NAL call number: SF321 N5
Descriptors: animal behavior, group dynamics, social behavior, pastured, grazing.

NAL call number: SF321 N5
Descriptors: animal behavior, group dynamics, social behavior, exercise, field size, pastured, grazing.

NAL call number: QL750.A6
Descriptors: behavior, isolation, socialization, pastures, open housing, stalls, stress.

NAL call number: SF951.J65
Descriptors: isolation, stalls, cortisol, stress, disease, adrenal glands, haemoglobin, thyroid hormones, mitogens, lymphocyte transformation, environment, housing, haematology, immune response, age differences.

NAL call number: 49 J82
Descriptors: abstract, foal, behavior, care, management, livestock, stress.

NAL call number: SF951.J65
Descriptors: weaning, stress, hydrocortisone, concentration, immunity, behavior, blood plasma, separation.

NAL call number: SF405.5.A23
Descriptors: horses, environment, enrichment, foraging, abnormal behavior.

NAL call number: SF951.E62
Descriptors: disease, animal behavior, animal welfare, housing, feeding exercise, training, abnormal behavior, stimuli, positive reinforcement, learning.

NAL call number: 49 J82
Descriptors: learning ability, training.

NAL call number: SF287.M44
Descriptors: behavioral principles, psychology, handling, care.

NAL call number: Z5055 U49D53
Descriptors: theses, adaptation, training, behavior, stress, neuroleptics.

NAL call number: HV4704.A54
Descriptors: environment, stress, welfare, sports, isolation, space, socialization.

NAL call number: SF955.E6
Descriptors: social behavior, wild horses, wild burros, social structure.

NAL call number: QL750.A6
Descriptors: *Equus caballus*, maternal behavior, social behavior.

NAL call number: aZ5071.N3 no.94-22
Descriptors: bibliography, flooring, stress, housing design, ventilation, temperature control, transport, social environment.

Descriptors: training, handling, stress, human-animal bond, learning, total body recognition, vices..

NAL call number: GV1831 H8T44
Descriptors: handling, total body awareness, human-animal bond, learning.

NAL call number: SF955.E6
Descriptors: intensive husbandry, foal, social behavior.

NAL call number: SF309.H6
Descriptors: repetition, training, handling, varied routine.

NAL call number: 41.8 D482
Descriptors: animal needs, welfare, management, semi-natural environment, shelter, social behavior, comfort behavior.

NAL call number: 41.8 T445
Descriptors: stables, animal health, metabolic changes, humidity, environment, temperature, ammonia concentrations.

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**Sheep and Goats**

NAL call number: QL750.A6
Descriptors: isolation, handling, transport, stress, heart rate.
NAL call number: aZ5071.N3 no.94-36
Descriptors: bibliography, flooring, crate design, ventilation, temperature control.

NAL call number: QL750 A6
Descriptors: social environment, food selection, genetics.

NAL call number: 41.8 Z5
Descriptors: social isolation, stress, adaptation, physiology.

NAL call number: 49 AN55
Descriptors: housing, environmental temperature, feed intake, production.

NAL call number: QP1 P4
Descriptors: Nubian goat, Alpine goat, social isolation, fear, vocalization, behavior.

NAL call number: QL750.A6
Descriptors: social behavior, experience, sexual behavior, rams.

NAL call number: QL750.A6
Descriptors: ewes, border leicester, blood plasma, erythrocytes, sodium, potassium, calcium, hypocalcemia, stress, behavior.

NAL call number: 49 J82
Descriptors: preference testing, aversiveness, spatial behavior, social behavior.

NAL call number: QL750.A6
Descriptors: goats, parturition, cubicles, kids, pens.

NAL call number: 49 J82
Descriptors: production, growth, behavior, housing.

NAL call number: HV4701 A557
Descriptors: standing, moving, lying, flooring preference.

NAL call number: QL750.A6
Descriptors: handling, fear, heart rate, stress.

NAL call number: HV4701.A557
Descriptors: stockpeople, human-animal bond, fear, handling.

Descriptors: stress, pain, social behavior, physiology, stereotypies.

NAL call number: QL750.A6
Descriptors: space, housing, growth, stress, physiology, lambs.

NAL call number: SF600.C82
Descriptors: space, social behavior, loose housing, clustering.

NAL call number: QL55 I44
Descriptors: flight distance, avoidance, rearing experience, corticosteroids, production, psychobiology.

NAL call number: QL750.A6
Descriptors: fear, heart rate, vocalizations, human-animal bond.

NAL call number: QP351 D4
Descriptors: social affinities, pen-mates, locomotor activity, plasma corticosteroid, vocalizations, adrenocortical responses, natural grouping, object attachment, depression, psychology, socialization, stress.

NAL call number: 410 B77
Descriptors: genetics, rearing environment, social behavior, temperament.

NAL call number: QL750.A6
Descriptors: handling, lambs, human-animal bond.

NAL call number: QL1.D48
Descriptors: housing, stress physiology, rearing, lambs.

NAL call number: 41.8 Z5
Descriptors: social isolation, stress, adaptation, physiology.

NAL call number: 49 J82
Descriptors: production, lambing, age, ewe replacement.

NAL call number: QL750.A6
Descriptors: cortisol, isolation, stress, mirrors.

NAL call number: QL750.A6
Descriptors: feeding preferences, age, genetics, experience.

NAL call number: 41.8 M742
Descriptors: handling, isolation, noise, stress.

NAL call number: 41.8 R312
Descriptors: lambs, castration, docking, hydrocortisone, lidocaine, naloxone, behavior, blood plasma, pain, anesthesia.

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**Swine**

NAL call number: QL750.A6
Descriptors: background noise, vocalizations, litter size, milk production.

NAL call number: aZ5071.N3 no.94-14
Descriptors: bibliography, housing, flooring, pens, ventilation, temperature control, behavior, enrichment.

Anon. (May 1991). **Sow stall and tethers.** *Veterinary Record* 128(18):431-432.
NAL call number: SF601 I4
Descriptors: restraint, pregnancy, husbandry, welfare.

NAL call number: QL750.A6
Descriptors: housing, stocking density, play, stress, abnormal behavior.

NAL call number: 49 An55
Descriptors: earth substrate, bare floor, flat-deck cages.

NAL call number: QL750.A6
Descriptors: housing, suckling behavior, crates, abnormal behavior, pens, chewing, aggression, straw, and space.

NAL call number: TH4911 F37
Descriptors: litter, pens, housing, behavior, comparison, self-dispensing, manual dispensing, natural behaviors, foraging, exploration, activity.

NAL call number: SF91 L58
Descriptors: swine, litter, behavior, Straw-Flow, performance, feed conversion, behavioral effects, substrate.

NAL call number: SF391 P55
Descriptors: reviews, sows, parturition, piglets, housing, farrowing, environment.

NAL call number: HV4701 A557
Descriptors: reviews, straw, housing, behavior, litter, nesting.

NAL call number: TH4911 F37
Descriptors: lying activity, feeding activity, behavior, housing.

NAL call number: 49 An55
Descriptors: swine, behavior, substrate, bedding, growth rate, feed conversion efficiency, welfare, husbandry.

Descriptors: housing, litter, straw, self-dispensing, manipulation, bedding, sloped pens, behavior.
NAL call number: QL750.A6  
Descriptors: preference, lying, nesting behavior, farrowing, straw.

NAL call number: QL750.A6  
Descriptors: nest building, sand floor, straw enrichment, motivation.

NAL call number: QL750.A6  
Descriptors: preference testing, light, motivation, environmental control.

NAL call number: 410 B77  
Descriptors: light, heat preference, reinforcement, environmental control.

NAL call number: SF602 A5  
Descriptors: human-animal interaction, corticosteroid level, stress, handling.

Descriptors: group housing, pen shape, stress, tether-stall, density, aggression.

NAL call number: QL750.A6  
Descriptors: swine, cortisol, pen design, skin lesion, aggression, stress response, pregnancy statistics.

NAL call number: QL750.A6  
Descriptors: swine, cortisol, pen design, skin lesion, aggression, stress response, pregnancy statistics.

NAL call number: QL750.A6  
Descriptors: social interaction, tethering vs. groups, growth, stall-design, pregnancy, stress, aggression.

NAL call number: QL750.A6  
Descriptors: swine, social interaction, stress, corticosteroid, group-house, tether-stalls, cage-stalls, pen design.

NAL call number: QL750.A6

Descriptors: swine, chronic stress, aggression, stall-design, welfare, free-corticosteroid.


NAL call number: SF391.3 A87

Descriptors: swine, environment, stress, welfare, behavior, physiology, review.


NAL call number: SF91 L58

Descriptors: swine, behavior, housing, litter, nesting, slatted floors, flooring, groups, comparison, individual stalls, group housing.


NAL call number: 19 B635

Descriptors: welfare, feed conversion, environment, housing, restricted feeding, flooring, injuries.


NAL call number: QL55.I5

Descriptors: toys, social interaction, human-animal bond.


NAL call number: SF19.C45

Descriptors: abstract, behavior, husbandry, environment, housing, substrate, straw.


NAL call number: SF91 L58

Descriptors: swine, behavior, housing, litter, stress, exploratory behavior, comparison, individual stalls, group housing, behavioral effects, growth rates.


NAL call number: HV4701 A557

Descriptors: animal welfare, behaviour, environmental enrichment, intensive housing, tail biting, growth rates, substrate, barren pens.


NAL call number: QL750.A6
Descriptors: housing, welfare, behavior, bedding, socialization.

Descriptors: gilts, sows, behavior, pig housing, intensive husbandry, tether stalls, ACTH, cortisol, dexamethasone.

NAL call number: SF601 I4
Descriptors: stalls, tether, housing, welfare.

NAL call number: SF19.C45
Descriptors: abstract, swine, welfare, housing, litter, injuries, weight gain.

NAL call number: SF601 I4
Descriptors: stalls, tether, housing, welfare.

NAL call number: 46.8 Su3
Descriptors: welfare, behavior, reproduction, pregnancy, intensive husbandry, farrowing pens, litter, bedding.

NAL call number: 475 EX7
Descriptors: coping, tether, stereotypies, endorphins, chronic stress.

NAL call number: QP1.P4
Descriptors: food presentation, stereotypies, cortisol.

Descriptors: automatic feeding, natural behavior, individual housing, group housing, feed conversion.

NAL call number: 46.8 Su3
Descriptors: swine, husbandry methods, animal health, intensive husbandry, meat yield, meat quality, European community.

NAL call number: 41.8 C163
Descriptors: floor preferences, expanded metal, temperature, traction.

NAL call number: 290.9 Am32T
Descriptors: pigs, juvenile, braided cotton cord, rubber strips, chewing, tail-biting.
NAL call number: S232 B24L36
Descriptors: free range, housing, group size, straw.

NAL call number: QL55 A1L33
Descriptors: handling, social interactions, toys, psychological needs.

NAL call number: 46.8 Su3
Descriptors: straw, housing, husbandry, behavior, production.

Descriptors: slatted floors, feed dispensers, automation, group housing.

Descriptors: Gottingen miniature swine, breeding, boars, sows, body weight, litter size.

NAL call number: 41.8 SCH9
Descriptors: housing, social groups, isolation, standards.

NAL call number: QL750.A6
Descriptors: swine, pens design, barrow, gilt, weight gain, feed intake, diurnal.

NAL call number: QL750 A6
Descriptors: corticosteroids, chronic stress, reproductive effects, handling.

NAL call number: 290.9 AM32P
Descriptors: swine, hogs, housing, enriched environment, sensory restriction, excitability, transportation, temperament, husbandry, genetic effects, behavior.

NAL call number: 49 J82
Descriptors: care, handling, piglets, adaptation, housing.

NAL call number: 49 J82
Descriptors: stress, husbandry, fear, enrichment devices.

Descriptors: pigs, play, toys, games, behavior, welfare, performance.

NAL call number: SF19.C45
Descriptors: abstract, swine, welfare, housing, litter, nest building, breeding, piglets, movement.

NAL call number: SF19.C45
Descriptors: swine, chronic stress, fear, welfare.

NAL call number: QL750.A6
Descriptors: swine, early handling, behavioral response, patting, stroking, socialization.

NAL call number: QL750.A6
Descriptors: swine, handling, behavior, stress, growth, reproduction, corticoids, groups, individuals.

NAL call number: HV4701.A557
Descriptors: stock people, human-animal bond, fear, handling.

NAL call number: QL55.I44
Descriptors: fear, experimenter influence, corticosteroids, production.

NAL call number: QL750.A6
Descriptors: stress, handling, physiology, corticosteroids, behavior.

NAL call number: QL750.A6
Descriptors: swine, stress, welfare, reproductive status, breeding behavior.

NAL call number: QL750.A6
Descriptors: socialization, husbandry, handling, human-animal bond.

NAL call number: QL750.A6
Descriptors: swine, gilt, corticosteroid, mating, stress, crowding, behavior.

NAL call number: SF391.3 A87
Descriptors: swine, environment, hydrocortisone, growth, stress, welfare, behavior.

NAL call number: S675.L32
Descriptors: litter, building material, round bales, environment, housing, husbandry, piglets, costs, dietary supplement.

NAL call number: 49 AN55
Descriptors: behavioral needs, rooting, vertical chain, football, straw, tire, space requirements, weight gain.

NAL call number: 49 AN55
Descriptors: dominance, environmental control, sows.

NAL call number: 49 J82
Descriptors: abstract, manipulanda, device, housing, well-being.

NAL call number: S539.5 R473
Descriptors: alternative housing, family pens, commercial viability, abnormal behavior, lactational oestrus.

NAL call number: SF600.C82
Descriptors: social interaction, psychological needs.

NAL call number: QL750.A6
Descriptors: gilts, handling, novel objects, group feeding, social behavior.

Lien, J. and Klopfer, F.D. (1978). Some relations between stereotyped suckling in piglets and exploratory...
NAL call number: QL750.A6
Descriptors: artificially fed, sow-fed piglets, exploration, learning.

NAL call number: 41.8 T345
Descriptors: thesis, piglets, sows, behavior, socialization, housing.

NAL call number: 410 B77
Descriptors: pig, male, isolation, social contact, feed, behavior.

NAL call number: 41.8 T445
Descriptors: floor type, spatial behavior, lighting, lying area, defecation area.

Marx, D. and H. Schuster (February 1986). Ethological choice studies with early weaned piglets kept on flat decks. 4. Results of studies on the preference for type of floor, surface size and padding (straw) from the viewpoint of the animal and conclusions for the evaluation of flat deck rearing with reference to all results. [Ethologische Wahlversuche mit fruhabgesetzten wahren der Flatdeckhaltung. 4. Mitteilung: Ergebnisse der Untersuchungen zur Rangfolge der Bodenart, der Flachengrosse und des Reizangebotes (Stroh) aus der Sicht des Tieres und Schlussfolgerungen fur die Beurteilung der Flatdeckhaltung unter Berucksichtigung aller Ergebnisse.] *Deutsche Tierärztliche Wochenschrift* 93(2):75-80.
NAL call number: 41.8 D482
Descriptors: social behavior, preference testing, floor type, substrate, weaning, floor space.

NAL call number: 49 J82
Descriptors: literature review, social behavior, preference tests, behavioral frequency, animal care.

NAL call number: abstract, flooring, pens, stalls, groups, individual, stress, weight gain.

NAL call number: SF391.P55
Descriptors: behavior, housing, husbandry, age differences, welfare.

NAL call number: SF601 I4
Descriptors: stalls, tether, restraint, housing.

NAL call number: QL750.A6
Descriptors: pigs, socially reared, pen size, aggression, injuries, activity, performance, immune response.

NAL call number: QL750.A6
NAL call number: QL750.A6
Descriptors: aversive handling, effects, behavior, plasma cortisol, adrenal response, stress, growth performance.

NAL call number: SF391.3 A87
Descriptors: swine, sows, environment, hydrocortisone, housing, stress, welfare, behavior, sexual maturity.

NAL call number: QL750.A6
Descriptors: swine, stress, welfare, abnormal behavior, blood chemistry, hydrocortisone, boars, growth rate, pig housing, space requirements.

NAL call number: QL750.A6
Descriptors: animal behavior, pig housing, boars, handling, stress factors, growth.

NAL call number: SF91 L58
Descriptors: comparative study, swine, behavior, intensive housing, animal health, environmental factors.

NAL call number: 49 J82
Descriptors: conference paper, space requirements, hiding area, manipulanda, floor levels, weight gain, growth.

NAL call number: QL750.A6
Descriptors: animal behavior, housing, crates, stress factors.

NAL call number: 41.8 C163
Descriptors: farrowing crate, preference testing, floor space.
NAL call number: 41.8 C163
Descriptors: loaders, preference testing, ramps, behavior.

NAL call number: SF600.C82
Descriptors: social interactions, aggressive behavior.

NAL call number: QL750.A6
Descriptors: toys, aggressive behavior, postweaning interval.

Descriptors: pigs, stress, production, alternative housing.

NAL call number: 41.8 V641
Descriptors: human-animal bond, fear, handling, behavior.

Descriptors: chronic implants, blood sampling, pharmacokinetics studies, confinement unit, design, modifications.

NAL call number: 49 AN55
Descriptors: restricted feeding, housing, bedding, socialization, welfare, plane of nutrition, pregnancy, growth, longevity.

NAL call number: 18 L2353
Descriptors: alternative housing, species-specific feeding, economics, animal welfare.

NAL call number: aS21 D27S64 no. 94-01
Descriptors: disease, physiology, behavior, stress, biomedical use.

NAL call number: 44.8 J822
Descriptors: pigs, weanling, performance, abstract.

Descriptors: social behavior, exploration, alternative housing.

NAL call number: 49 J82
Descriptors: conference paper, abstract, socialization, isolation, aggression, behavior.

NAL call number: aZ5071.N3 no.91-14
Descriptors: bibliography, behavior, handling, transport, slaughter, housing.

NAL call number: aZ5071.N3 no.91-15
Descriptors: bibliography, flooring, crate design, ventilation, temperature control.

NAL call number: QL750.A6
Descriptors: social behavior, social structure, mixing groups, agonistic behavior.

NAL call number: QP901 P4
Descriptors: stereotypies, catecholaminergic systems, locomotion, amphetamines, stress.

NAL call number: 49 J82
Descriptors: mating behavior, growth rate, feed consumption, soundness, group housing, isolation.

NAL call number: 448.8 J8293
Descriptors: social isolation, group housing, testosterone, gonadotropin, seasonal cycles.

NAL call number: QL750.A6
Descriptors: sows, group housing, computerized feeding system, transponders.

NAL call number: SF601 14
Descriptors: stalls, tether, housing, welfare.

NAL call number: QL750.A6
Descriptors: straw, cloth, prepartum behavior.

NAL call number: 410 B77
Descriptors: play, exploration, curiosity, welfare.

NAL call number: QL750.A6
Descriptors: pigs, gilts, foraging device, Edinburgh Foodball, diets, welfare, feed dispensers, enrichment.

NAL call number: 410 B77
Descriptors: learning, operant conditioning, manipulanda.

NAL call number: 49 AN55
Descriptors: group housing, production, neurobiology.

NAL call number: 49 J82
Descriptors: livestock, space requirements, social stress, group size.

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Environmental enrichment and impoverishment are relative terms. We can measure them with reference to the normal keeping environment of laboratory animals or to the environment of their wild counterparts; in doing so we might form quite different conclusions. The environment of the average laboratory animal is clearly less complex than that of its wild counterpart, yet for many burrow-living species the average amount of visual and auditory stimulation may be higher in the laboratory (Milligan et al. 1993), and this is especially true during rearing. On the other hand the ready provision of food in all seasons, and the protection from both conspecific aggression and predation may make a good laboratory environment less stressful than a natural one if assessed on a life-time basis.

The ferret is a close relative of the polecat (Mustela putorius) and has been domesticated for 2000 years. It is widely kept as a working animal for use in trapping rabbits and is an increasingly popular laboratory animal: small enough to keep easily in the laboratory and relatively easy to breed and handle.

Social environment and impoverishment must always be measured with reference to the development stage of an animal and the environment in which this usually occurs. Feral ferrets are essentially solitary and nocturnal, but in captivity show much diurnal activity and individuals may be kept together, although males are often intolerant when in breeding condition. Keeping breeding males apart may reduce stress, but depriving ferret kits of conspecifics during the first month of life when much time is spent in play clearly impoverishes. By analogy with the rat (Potegal and Einon 1989, Morgan 1976, Einon and Sahakian 1983, Einon 1980) such impoverishment could alter later social interaction, sexual behavior, learning, drug tolerance, activity and body size. However as yet there has been little investigation of any of these questions in ferrets.

Most work on lifetime environmental enrichment and impoverishment has been carried out with rats and mice, work on ferrets has largely concerned the provision of objects and conspecifics for play during development. Exceptions include work by Korhonen and colleagues (Korhonen and Harri 1990, Korhonen et al. 1992) who examined the effects of differing housing regimes on body weight and pelt quality, concluding that males housed singly had poorer pelt quality than males raised in groups, but that large, all male groups weighed less. Floor space used in housing also influenced pelt quality. They suggest that cages containing one male and one female produces the best pelt size and quality. If body weight and pelt quality reflect the health of animals then this is the optimal housing outside the breeding season. They found that social status correlated with weight; but whether this is causal is unclear. The authors also found that
balls and bite cups reduced skin biting. The addition of "toys" to ferret cages is certainly desirable. Other work suggests that changing these toys on a day-to-day basis has advantages.

Where ferrets are kept in cages which restrict movements there are skeletal changes especially of the hind limbs (Slesarenko 1986), and in a related species social impoverishment has been found to induce more stereotyped behavior (Bildsøe et al. 1990). In hot climates there are reports that restriction, crowding and captivity may itself be stressful (Gazizov 1987). Heat stress, and such severe restriction of movement reflect poor husbandry, but while such work is of less relevance in countries with controls upon animal housing, giving ferrets and other mustelids access to space for exercise is clearly important. We should bear in mind that while the whole surface of a cage can provide a "gym" for young mice and rats, ferrets do not swing and climb in the same way.

Chivers and Einon (1982) found that some of the isolation induced effects on behavior which had been shown in rats also occurred in ferrets. Specifically, deprivation of rough and tumble social play caused hyperactivity which persisted into adulthood. Rats deprived in this way also showed poor reversal of previously learned tasks (Morgan 1976), increased susceptibility to amphetamine (Einon and Sahakian 1983) and poor spatial memory (Einon 1980). The fact that a group of socially reared ferrets whose environment was enriched with a series of changing tube systems (Weiss-Buerger 1981) were superior in maze learning and reversal, suggests that they may respond in a similar fashion. Chivers and Einon also showed that the isolation induced deficits in object exploration found in rats were absent in ferrets raised in isolation. The way in which ferrets manipulate objects is influenced by rearing environment. Russell (1990) found that isolated ferrets raised in enriched conditions (with a daily change of play objects) would choose the arm of a maze leading to the more prey-like of two play objects; were superior in capturing both crickets and moving prey-models, and that more elaborate prey-catching responses were elicited from enriched than impoverished animals when placed with dummy objects and remote controlled fur-covered toy cars. Captive as compared to laboratory rearing (Miller et al. 1990) also affects predatory skills, particularly the location of prey.

In conclusion although little work has been carried out on impoverishment and enrichment in ferrets, investigations so far suggest impoverishment, whether physical restriction, social or in manipulation of objects has wide ranging effects; especially when imposed during rearing.


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Descriptors: ferret, husbandry, health, biology.


Descriptors: ferrets, polecats, foxes, coypus, chinchillas, animal welfare, husbandry, stunning.


NAL call number: QL750 B4

Descriptors: ferret, prey-catching, dummies, visual stimuli, tactile stimuli.


Descriptors: mink, housing, stress, stocking rate, husbandry.


Descriptors: ferret, behavior, housing, handling, physiology.


NAL call number: QL750 B52

Descriptors: ferret, male, female, play, sex differences, aggression.

NAL call number: SF402 S3
Descriptors: mink, male, female, stereotypic behavior.

NAL call number: SF402 S3
Descriptors: mink, abnormal behavior.

NAL call number: QL750 B4
Descriptors: mink, stress, starvation, feeding, behavior, restraint.

Descriptors: weasels, activity, behavior, exploration.

Descriptors: mustelids, play behavior, social groups, group activity.

NAL call number: 41.9 AM36
Descriptors: ferret, reproduction, housing, restraint, nutrition, anesthesia.

NAL call number: QP351 D4
Descriptors: ferret, male, female, isolation, hyperactive, play, toys, exploratory behavior.

NAL call number: 410 B77
Descriptors: ferret, male, female, behavior, seasons, communication.

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NAL call number: 410 Z35
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NAL call number: 410.9 P94
Descriptors: ferret, bibliography, behavior, reproduction.

NAL call number: SF95 A9
Descriptors: ferret, reproduction, weanling, housing, nutrition.

NAL call number: 41.8 V6426
Descriptors: mustelids, housing, environment, circulatory system.

NAL call number: 241.8 AS7
Descriptors: ferret, dog, play, behavior, social interactions.

NAL call number: SF402 S3
Descriptors: mink, male, female, neonates, weanling, husbandry, nest boxes, caging, stress, cortisol.

NAL call number: SF402 S3
Descriptors: mink, female, reproduction, behavior, activity.

NAL call number: QL76 I5
Descriptors: ferret, black-footed, reproduction, behavior.

Descriptors: ferret, behavior, activity, exploratory behavior, environment, light.

NAL call number: QK901 A1033
Descriptors: weasel, bank vole, diet, predation, prey, food preferences.

NAL call number: SF402 S3
Descriptors: mink, stress, toys, behavior.

NAL call number: 41.8 Am3
Descriptors: ferret, handling, breeding, grooming, behavior.

NAL call number: SF402 S3
Descriptors: polecat, male, female, behavior, seasons.

NAL call number: SF402 S3
Descriptors: polecats, social behavior, body weight, social groups.

NAL call number: SF402 S3
Descriptors: polecat, behavior, feeding.

NAL call number: 410 Z36
Descriptors: polecat, male, female, housing, social groups, body weight, pelt quality.

NAL call number: 41.8 V6416
Descriptors: polecat, behavior, zoo animals, wildlife.

NAL call number: 410 Am3
Descriptors: ferret, nursing, play behavior, body weight.

NAL call number: 410 Am3
Descriptors: ferret, play, behavior, development.

Descriptors: ferret, male, female, behavior, personality, body weight.

Descriptors: fitch, alpine weasel, feeding, activity, behavior, predation.

Descriptors: polecats, seasons, diet, feeding behavior.
NAL call number: QH301 V5
Descriptors: polecat, Stone marten, space, feeding zones, shelter, hiding place, diet, foraging behavior, behavior.

NAL call number: Film S-1806
Descriptors: ferret, male, female, play behavior, reproduction, body weight.

NAL call number: QL750 J68
Descriptors: ferret, male, female, pre-copulation behavior, courtship.

NAL call number: QP1 P4
Descriptors: ferret, cats, mouse, rabbit, rat, sound, behavior, low vs. high frequency.

NAL call number: SF402 S3
Descriptors: mink, housing, nest boxes, body weight, behavior, reproduction.

NAL call number: 410.9 P94
Descriptors: ferret, husbandry, diet, handling, breeding.

NAL call number: Videocassette no. 971
Descriptors: ferret, mink, dog, cat, social interaction, husbandry, environmental factors, guidelines, regulations, resource information.

NAL call number: 410 Am3
Descriptors: ferret, mink, male, female, exploration, behavior.

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NAL call number: QP351 B45
Descriptors: ferret, male, female, prepubertal play, toys, endocrine control, age factors.

NAL call number: 410 B77
Descriptors: ferret, activity, endocrine system, behavior, circadian rhythms.


NAL call number: SF402 S3
Descriptors: ferret, male, female, breeding, behavior.


NAL call number: 410.9 P94
Descriptors: ferret, diet, behavior, breeding.
Rabbits

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- The Laboratory Environment
- Conventional Housing for Rabbits
- Welfare and Behavioral Needs
- Improvements in Rabbit Housing
- References
- Rabbit Bibliography


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This short paper introduces the general housing and husbandry of laboratory rabbits. The behavior of wild rabbits is compared with that of their laboratory counterparts, and consideration is given to their behavioral needs from the welfare point of view as well as to the effects of husbandry on scientific research.

The natural environment

The wild rabbit is gregarious, living in family groups in natural colonies or warrens (Cowan 1987). Rabbits spend most of their time underground in burrows during the diurnal period and venture above ground at night when they are generally more active, feeding mainly at dawn and dusk (Mykytowycz 1958). Females dig burrows to prepare nests for the protection of their young which are born helpless and blind; they also serve as a haven in an emergency (Cowan and Bell 1986). In terms of their social activities, stable breeding groups are formed with linear hierarchies of both males and females (Mykytowycz 1958, Cowan 1987). Once stabilized, the order of dominance is generally sustained and fighting is rare (Mykytowycz and Rowley 1958, Lockley 1961); the social organization being controlled by scent marking and territorial patrols which involve chin-marking from cutaneous glands, urination, defecation, and behavioral displays. Male rabbits naturally distance themselves to avoid conflict (Mykytowycz 1958) while females will only fight to compete for burrows if they are in limited supply (Kunkele 1992). Social behaviors include allogrooming and group foraging activities. Rabbits adopt "look-out" positions for potential predators and foot-thumping serves as an alarm signal to alert the colony (McFarland 1987), from which the rabbits run at high speeds for cover, often leaping and jumping obstacles in the process.

Observations on domestic rabbits have shown that there are few differences in their behavior compared with their wild counterparts (Mykytowycz and Hesterman 1975, Bell 1984) so it remains likely that the potential for the full range of behavior of wild rabbits is still present genetically, despite some selection for physical, physiological and behavioral
The laboratory environment

Whilst the quality and quantity of laboratory bred rabbits have improved over the past 40 years or so, their psychological well-being has largely been neglected. Advances have included genetic selection for clearly defined pure-bred strains, such as New Zealand Whites, Dutch and Lops, with traits for docility, reproductive performance and growth as well as a vastly improved health status. Other improvements include a standardized complete diet, and a protected and standardized environment of caging, ventilation, lighting, temperature and humidity (Clough 1982). However, such standardized cage designs have evolved mainly for the ease of husbandry and economic considerations, and it is apparent that some of these designs have had undesirable effects on the animals, particularly a reduction in space (Gunn and Morton 1994). Physical and social isolation offers no mental stimulation (Huls et al. 1991). Furthermore, the constant feeding of a highly refined pelleted diet is likely to be monotonous (BVAAWF/FRAME/RSPCA/UFAW 1993). There is evidence that all of these have lead to both physiological (Lehmann 1984, Wieser 1984) and psychological problems. Caged rabbits also show behavioral abnormalities including stereotypies (Stauffacher 1992, BVAAWF/FRAME/RSPCA/UFAW 1993) which may be signs of discomfort, mental suffering and distress (Lawrence and Rushen 1993, Gunn 1994) even though the animals are able to grow and reproduce. There is an ethical mandate to improve the animal's well-being (Broome 1988, Wemelsfelder 1984). It is important to minimize suffering not only for welfare reasons, but also because such "suffering" may result in a range of physiological or psychological changes which could add unintentional variables to the experimental design and affect the accuracy and reliability of the scientific results (BVAAWF/FRAME/RSPCA/UFAW 1993, Gunn 1994). This in turn may lead to more animals being used in research than is necessary.

Conventional housing for rabbits

For many years rabbits have been housed in purpose-built metal cages. Single caging isolates rabbits from physical and visual contact and prevents any social interaction, particularly in solid-walled cages (Gunn 1994, Huls et al. 1991). They also restrict movement (with minimal floor area (Gunn and Morton 1994, BVAAWF/FRAME/RSPCA/UFAW 1993) and height) so that rabbits are unable to perform normal ambulation or rearing activities (Gunn and Morton 1994, BVAAWF/FRAME/RSPCA/UFAW 1993). The barren environment provides no stimulation which leads to abnormal behavior patterns such as bar-biting and clawing of the cage (Stauffacher 1992, Gunn and Morton 1994). These stereotypic activities substitute for natural behaviors which are denied by standard laboratory conditions (Stauffacher 1992) and may indicate frustration, anxiety or boredom, and develop in stages involving a progressive narrowing of the behavioral repertoire (Gunn 1994). A lack of exteroceptive stimulation, restricted movement and social inhibition are reported to be initial causal factors (Dantzer 1986). Other indicators of boredom have been observed such as hunched posture (Gunn and Morton 1994), inertia (Metz 1984), and a staring coat and dull eyes which may also indicate poor health (Wallace et al. 1990). As the caged environment is not sufficient to permit an adequate level of physical activity, caged rabbits can develop osteoporosis (Lehmann 1984) and back-bone distortions (Wieser 1984), and a high percentage of intestinal disorders (Jackson 1991) may be a result of "caging stress".

Welfare and behavioral needs
It is no longer considered acceptable to only provide for animals' physiological needs or to provide conditions which maximize productivity (Dawkins 1980). The care of captive animals should also include consideration of their behavioral needs. Some behaviors which are essential to the animal's well-being are not provided for in the laboratory, such as allogrooming, digging for the purpose of nest-building (Podberscek et al. 1991), and foraging (Stauffacher 1992). The inability to perform certain behaviors is thought to lead to intention movements, or inappropriate or abnormal behaviors (Dantzer 1986, Lawrence and Rushen 1993). Subjective states, such as boredom and frustration, can be evaluated through the use of careful experimental design. Other abnormal activities include under- or over-grooming and eating, leading to a staring coat, hair-balls (intestinal stasis - Jackson 1991), weight loss and obesity, respectively. These conditions are commonly observed in singly caged rabbits (BVAAWF/FRAME/RSPCA/UFAW 1993, Gunn 1994). Such behaviors are maladaptive and provide clear evidence of a need for some environmental improvement. These activities are often associated with apathy and a refusal to respond which are indicative of psychological disorders and show a lack of adaptation rather than a coping strategy (Lawrence and Rushen 1993).

**Improvements in rabbit housing**

The natural social organization of this species should influence how we house rabbits in laboratories. Since wild rabbits live in groups containing at least one other rabbit of the same sex (Cowan 1987), it seems sensible to suggest that they should at least be housed in pairs, with the exception of mature males (unless they have been castrated - Gunn 1994). Whether grouping rabbits in pairs in cages, in floor pens, or in breeding groups, they should have opportunities for "exercise" and social interaction (BVAAWF/FRAME/RSPCA/UFAW 1993, Batchelor 1991), allowing them more control over their immediate environment. As they are social animals they mix well at an early age, although there may be problems with removal or replacement of adults in an established group (Hammond and Love 1989, Love and Hammond 1991). Males can also be group-housed until they reach sexual maturity, but may then have to be castrated to be housed successfully in stable groups for lengthy periods. If rabbits must be caged individually for experimental reasons, enriching the cage environment has been shown to be beneficial. The cages should be, as a minimum, large enough to enable the rabbits to sit upright and lie out at full stretch (Gunn 1994), have visual contact with other rabbits, an area to withdraw to, a shelf for resting on (Stauffacher 1992) as well as an improved visual field. The provision of roughage such as hay (Gunn 1994), and straw, a varied diet and objects to gnaw on (Stauffacher 1992) or manipulate (e.g., wooden shapes - Huls et al. 1991) have been suggested to alleviate boredom and stereotypic activities (Brooks et al. 1993, Gunn 1994) and thus substantially improve welfare. Some of these enrichments apply equally to rabbits grouped in pens. It is recommended from an animal welfare point of view that whenever possible rabbits should be group-housed (Home Office 1989, Batchelor 1991) unless the experimental design prohibits it.

**References**


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Descriptors: housing, breeding, normal behavior, handling.

NAL call number: aZ5071.N3
Descriptors: housing, husbandry, welfare, management, behavior.

NAL call number: Z5055 U49D53
Descriptors: estradiol, testosterone, progesterone, group composition, sexual, maternal, social.

NAL call number: 410 B393
Descriptors: gestation, sexual activity, group vs. solitary housing, handling, social isolation.

NAL call number: QL737 L3206
Descriptors: water, cage design, slaughter, housing, welfare, code.

Descriptors: housing, husbandry, production, behavior, welfare.
NAL call number: QL55.I5
Descriptors: social groups, solitary housing, hierarchy, space, behavioral repertoire, environmental enrichment, group housing.

NAL call number: QL55.A1I43
Descriptors: artificial appliances, social peers, foraging, environmental control.

NAL call number: QP456 C5
Descriptors: pheromone, urine, social behavior, chemical cues, secretion, odors, scent-marking, dominance, flehmen behavior.

NAL call number: QL55 I5
Descriptors: welfare, housing, husbandry, rabbit, mouse, rat, gerbil, hamster, optimal living conditions.

NAL call number: 500 P383
Descriptors: social behavior, dominance, hierarchy, aggression.

NAL call number: QL55 A1L33
Descriptors: paired housing, single housing, enrichment objects, behavior, social contact, activity, PVC pipe.

NAL call number: QL750 A6
Descriptors: welfare, stimuli, preference-test, environment, indicators, behavior, physiology.

Descriptors: photoperiod, illumination, behavior, resting periods, time of day, cage.

NAL call number: 49 J82
Descriptors: stereotypy, environment, behavioral repertoire, behavior, endogenous brain opioid peptides, catecholamine, neurotransmitter, dopamine, norepinephrine.

NAL call number: QP1 P4
Descriptors: psychology, social activity, nesting, housing, genetics, maternal care, infancy, handling.

NAL call number: QP1 P4
Descriptors: resting behavior, daily activity, physiological effects, sleep, infancy, handling.

NAL call number: QH301 C63
Descriptors: feeding behavior, sleeping behavior, locomotor activity, social stimulation, isolation.

NAL call number: 10 Ou8
Descriptors: productivity, behavior, diet, environment, confinement, population density, selective breeding.

NAL call number: 449.9 Am3J
Descriptors: rabbits, acoustic stimulus, stressors, sleep, behavior, environmental noise.

Descriptors: social behavior, testosterone, estradiol, androstenedione, corticotropin, dominance, submission.

NAL call number: QL750 B4
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NAL call number: SF451 R5
Descriptors: colony cage, nesting, breeding, social interactions, productivity, paddock system, communal nest box.

NAL call number: 41.8 Ad9
Descriptors: management, psychological needs, environmental enrichment, age, trauma, stress, exploratory activity.

NAL call number: QL737 L32J6
Descriptors: ambient temperature, photoperiod, spatial needs, stress, social behavior, acoustic environment.

NAL call number: QL55 A1L33
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NAL call number: QL55 I5
Descriptors: social behavior, floorpen, cage, feeding, exercise, groups.

NAL call number: QH301.L54
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NAL call number: 410 B77
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Descriptors: intestinal stasis, intestinal rupture, handling, stress.

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Descriptors: chronobiology, locomotor activity, food intake, water consumption, defecation, noise, feed restriction, diurnal, nocturnal.

Descriptors: husbandry, production, pens, manage, management systems, housing, cage.

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Descriptors: social activity, dominance, breeding, spatial behavior, wild.

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Descriptors: home cage odor, strange cage odor, preference testing, avoidance, age, social relationships, maternal presence.

NAL call number: QL750 A6
Descriptors: social relationships, colony management, distance, husbandry, behavior, free-range, spacing behavior.

NAL call number: QL55 A1L3
Descriptors: exercise, social contact, group housing, single housing, environmental enrichment, behavior.

NAL call number: QP351 D4
Descriptors: psychology, social activity, exploratory activity, open-field test, handling, infancy.
Environments of laboratory animals have often been designed on the basis of economic and ergonomic aspects, with little or no consideration for animal welfare. Laboratory housing conditions can deprive animals the possibility of performing a full repertoire of normal behavior. As a response to this lack of stimulation animals may show abnormal behaviors, such as stereotypies or passiveness (Wemelsfelder 1990).

The living conditions and therefore the well-being of captive animals can be improved through environmental enrichment. Environmental enrichment can be defined as altering the living environment of captive animals in order to provide opportunities to express more of their natural behavioral repertoire. It is widely acknowledged that allowing animals to perform the widest possible range of behaviors is likely to be beneficial and, furthermore, providing environmental enrichment has been shown to reduce stereotypic behavior in captivity (e.g., bank voles: Ödberg 1987).

The environment of an animal consists of a wide range of stimuli, including the social environment of conspecifics, contraspecifics and humans, and the physical environment such as the cage and its contents (See Figure 1). Currently used caging for rodents restricts various behaviors (O'Donoghue 1993) and it is recommended that the cage environment should be improved to cater for physiological and ethological "needs" including resting, grooming, exploring, hiding, searching for food, and gnawing.

[Note: Figure 1 is not available in electronic format. Caption: "Stimuli in the environment of laboratory animals..."
Social environment

Conspecifics, contraspecifics, and humans

The social environment of animals can be enriched by housing them together with conspecifics in pairs or in groups. This will only be successful if the groups or pairs formed are harmonious and stable. Mice and rats are social animals and often housed in groups, although this is not a natural situation for the males. In some strains, especially in mice, aggression may be a problem and the males need to be separated. In contrast, hamsters are not social, which eventually can lead to problems when housing such animals together.

Housing together several animal species in the same room is often common practice. It is not known whether contraspecifics housed in one animal room are affected by the olfactory and auditory cues from each other. Humans are part of the social environment of laboratory animals and handling the animals is a very important aspect of this daily care routine. It is also beneficial to train animals to become used to routine handling and procedures (Biological Council 1992).

Nutritional environment

Supply and type

In the wild, rodents spend a major proportion of their time searching for and consuming food. In the laboratory food is mostly provided ad libitum and easily obtained by the animals. For enrichment purposes food items can be scattered in the substrate or bedding so that the animals spend time searching for it. Carder and Berkowitz (1970) found that rats preferred earned food although free food was available, when the work demands were not too high. For hamsters who naturally hoard their food, scattering food pellets into the cage is an easy source of stimulation.

The type of food given to laboratory animals is usually standardized in the form of pellets but additional food such as hay or straw can be supplied to satisfy the need for roughage.

Sensory environment

Auditory, visual, olfactory and tactile

Sensory enrichment can be provided in many forms. Animals such as guinea pigs, which are easily frightened, react to noises in their environment; a radio which plays softly during the day can mask sudden background noises.
In many animal facilities, light intensity is usually too high. This may have deleterious effects on eyes such as retinal degeneration (Williams et al. 1985), especially in albinos. Rodents, who are essentially nocturnal animals, should be given the opportunity to hide from light.

### Psychological environment

**Control of the environment**

It is important that animals have a certain degree of control over their environment, as a lack of control may cause stress. Rats reared in an environment in which they could control lighting, food and water supply were less emotional compared to controls (Joffe et al. 1973). In the laboratory cage the possibilities for animals to control their environment are restricted. However providing a shelter or refuge gives them the opportunity to withdraw from frightening stimuli outside or inside their cage as well as hide from too much light. Plastic tubes (Peters and Festing 1990) or old drinking bottles (Ward and DeMille 1991) are simple solutions for shelters.

### Physical environment

**Cage size, structure and accessories**

Sometimes enlarging the available space for an animal can enhance well-being. Small cages may increase the incidence of stereotyped movements and other non-locomotor abnormal behaviors (Ödberg 1987). Enlarging the available space can be achieved by providing climbing accessories, shelters/refuges and exercise devices. When mice were given a divided cage with a bedding section and a wire mesh section, they deposited almost all excreta on the wire mesh floor, thus keeping their sleeping area clean (Blom 1993).

Nesting material such as tissues, hay or wood-wool enables rodents to perform nest-building behavior. Softwood sticks can be provided to guinea pigs for manipulation and gnawing (Sharmann 1991).

### Evaluation of an enrichment program

When introducing enrichment to an animal's environment, it is very important to evaluate the enrichment program used, by assessing whether or not the animals respond to the enrichment and maintain interest.

*Assess baseline behavior; introduce enrichment; monitor behavior; analyze responses; long term effects*

Reactions of the animals to the enrichment should be monitored and compared with baseline behavior, which was
assessed before introduction of enrichment. An increase in species-typical behavior or a decrease in abnormal behavior may be seen. Different strains of animals can respond differently to enrichment as has been observed in mice (van de Weerd et al. 1994). It is also important to assess whether the changes in behavior are short or long term effects, as the animals may be interested in the enrichment for a short period only. Physiological variables can also be monitored to assess responses to changes in laboratory environments, e.g., body-weight, heart rate, hormonal levels, immune status and reproductive function (Markowitz and Line 1990).

When introducing enrichment in the laboratory, costs and the practical use of enrichment items are also important. Objects introduced into the cage should be stimulating for the animals, but they should also be easy to remove, clean, and replace, so that personnel are willing to work with them. If it is clear to those responsible for animals that environmental enrichment is beneficial to the animals, their motivation to work with and to improve the enrichment program should increase.

References


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**Rodent Bibliography**

**Gerbils and Hamsters**


NAL call number: QL55 A1L33
Descriptors: hamster, Golden, male, socialization, solitary nature, caging, Habitrail tunnels, bedding, handling, group housing.


NAL call number: 447.8 Am3
Descriptors: hamster, Golden, female, adult, isolation, socially reared, bedding, body weight, body fat.


NAL call number: QL55 I5
Descriptors: welfare, housing, husbandry, rabbit, mouse, rat, gerbil, hamster, optimal living conditions.


NAL call number: QP1 P4
Descriptors: gerbil, adult, old, locomotor activity, outdoor experience vs. laboratory rearing, novel objects, odors, food.


NAL call number: QP85 B73
Descriptors: gerbil, body weight, lifespan, behavior.


NAL call number: QP1 P4
Descriptors: gerbil, male, female, motor behavior, somatic growth, seizures, indoor vs. outdoor.


NAL call number: QP1 P4
NAL call number: QH301 C63
Descriptors: hamster, Golden, female, group housing, weaning age.

NAL call number: QP1 P4
Descriptors: gerbil, male, female, weaning, adult, crowding, social interaction, cortisol, testosterone, testes weight, adrenal weight, behavior, reproduction.

NAL call number: BF575 A3A57
Descriptors: hamster, Golden Syrian, male, isolation, play.

NAL call number: SF405.5 A23
Descriptors: hamster, aggression, anorexia, cotton nestlets, wire cages, PVC pipe, toys, seclusion.

NAL call number: QL55 A1L3
Descriptors: gerbil, male, female, cage density, body weight, vaginal opening, age.

Descriptors: hamster, Golden, young, isolation, aggression.

NAL call number: BF575 A3A57
Descriptors: hamster, Syrian Golden, male, weanling, young, adult, aggression, submission, play, rat.

NAL call number: 410 B77
Descriptors: hamster, Golden, female, male, olfaction, pheromones, litter size, pregnancy rate.

NAL call number: 447.8 Am3
Descriptors: hamster, Siberian, male, ambient temperature, body temperature, gonadectomized, running wheel, body mass.

NAL call number: HV4701 A557
Descriptors: housing, preference test, light intensity, Mongolian gerbils.
Guinea Pigs

NAL call number: QL55 A1L3
Descriptors: guinea pig, female, pregnant, nonpregnant, transport simulator, ACTH, zinc.

NAL call number: QH301 C63
Descriptors: guinea pig, female, neonate, lactating, virgin, behavior, silence, nonvocal sounds, communication, maternal behavior.

NAL call number: 410 Z35
Descriptors: guinea pig, male, female, behavior, activity, social group, dominance, aggression, vocal communication.

NAL call number: QL55 I5
Descriptors: welfare, housing, husbandry, rabbit, mouse, rat, gerbil, hamster, optimal living conditions.

NAL call number: 410 B393
Descriptors: guinea pig, male, female, isolation, maternal care, exploratory behavior, activity, play, open-field behavior.

NAL call number: 410 B393
Descriptors: guinea pig, male, dominance, aggression, behavior, territory.

Descriptors: guinea pig, male, female, weanling, adult, auditory stimuli.

NAL call number: QP351 B45
Descriptors: guinea pigs, male, female, maternal separation, isolation, cortisol, inanimate surrogates.

NAL call number: 410.9 P94
Descriptors: guinea pig, male, female, reproduction, bedding.

Descriptors: guinea pigs, noise.
NAL call number: QP1 P4
Descriptors: guinea pig, male, female, isolation, group-housed, body weight, tyrosine hydroxylase, activity, aggression.

NAL call number: QL55 A1L3
Descriptors: guinea pig, male, female, spatial behavior, caging, activity.

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**Mice**

NAL call number: Z5055.U49 D53
Descriptors: mouse, environmental enrichment, impoverishment, open field, activity.

Descriptors: mouse, Swiss, aversive stimuli, environmental enrichment, darkness, handling, open field, defecation, activity.

NAL call number: 410 B63
Descriptors: mouse, male, testes, prostate, adrenal gland, stress.

NAL call number: 410 Z36
Descriptors: mouse, female, caging, preference testing, shelter.

NAL call number: 410 Z36
Descriptors: mouse, male, female, cage changing, weight gain, activity.

NAL call number: QP351 S6
Descriptors: mouse, learning, behavior.

NAL call number: QP1 P4
Descriptors: mouse, dwarf, locomotor activity, learning.
NAL call number: QH301 C63
Descriptors: mouse, weanling, dwarf, open-field, habituation, behavior.

NAL call number: QP1 P4
Descriptors: mouse, DW/Orl-dw, inbred strain, male, maze, spatial information, behavior.

NAL call number: QL55 I5
Descriptors: welfare, housing, husbandry, rabbit, mouse, rat, gerbil, hamster, optimal living conditions.

NAL call number: 442.8 L62
Descriptors: mouse, isolation, caging, socially reared, adrenal medullary function, adenocortical function, reproduction, neurochemistry, defeat experiments, review.

NAL call number: 470 Sci25
Descriptors: mouse, running wheel, burrow, reproduction, foraging, temperature, social cues, behavior, review.

NAL call number: QL55 A1L3
Descriptors: mouse, caging, partitions, activity, stress, adrenal glands, behavior, complexity.

NAL call number: BF671 J6
Descriptors: mouse, Swiss CD-1, isolation, olfaction, agonistic behavior, dominance.

Descriptors: mouse, Quackenbush albino, male, strychnine, chlorpromazine, activity, socialization.

NAL call number: QP351 D4
Descriptors: mouse, neonate, weanling, aging, occipital cortex, neuronal development, metabolic activity.

NAL call number: QH301 C63
Descriptors: mouse, BALB/c, young, maze, open field, exploration, aversive response, swimming, induced grooming, whole brain, cerebellum, brain stem, diencephalon, telencephalon, prosencephalon.

NAL call number: Z5055.U49D53
Descriptors: mouse, cortex, discrimination tasks.

restriction effects on reactivity, exploration and maze learning in mice with septal lesions. *Physiology and Behavior* 29(5):885-893.

NAL call number: QP1 P4
Descriptors: mouse, Binghamton, heterogenous, male, handling-reactivity test, open-field, water-maze, learning, behavior.

NAL call number: S543.V5V5
Descriptors: mouse, ICR-albino, female, prebreeding, postbreeding, embryo survival, density, corticosteroids.

NAL call number: QL55 A1L3
Descriptors: mouse, BALB/c, TO, CD-1, Laboratory Animal Breeders Association Guidelines, housing, male, female, breeding, litter size.

NAL call number: 12 N3892
Descriptors: mouse, male, female, weanling, liver weight, P-450 enzymes, polychlorophenols, bedding.

Ferrer, I. et al. (1983). Morphological changes in the cerebral cortex of mice subjected to enriched and impoverished environments and its later reversal. [Cambios morfológicos en la corteza cerebral de retones somtidos a medios enriquecidos y a medios empobrecidos en stimulos sensoriales y su posterior recuperacion.]* Archivos de Neurobiologia* 46(3):177-182.
Descriptors: mouse, visual cortex, maze, neuronal plasticity.

NAL call number: QP1 P4
Descriptors: mouse, Binghamton, heterogenous, septal lesions, handling reactions.

Descriptors: mouse, behaviorally deficient mutant, environmental enrichment, vestibular, muscular, and visual stimulation.

NAL call number: 447.8 Am3
Descriptors: mouse, noise, stress, temperature, gastrointestinal transit.

NAL call number: QL737 R638M68
Descriptors: mouse, high fat content, plastic vs. aluminum caging.

NAL call number: QH301 B45
Descriptors: mouse, genetic variance, genotype, housing, environmental enrichment.

NAL call number: QP1 P4
Descriptors: mouse, male, caging, tumors, in vitro, cytolytic activity.

NAL call number: 410 B77
Descriptors: mouse, male, bedding, olfaction, isolation, interaction.

NAL call number: SF406 I52
Descriptors: mouse, age, noise, test interval, seizure-prone, drugs, non-auditory stimuli.

NAL call number: 410.9 P94
Descriptors: mouse, female, behavior, cellulose, nesting.

NAL call number: 176.622 J82
Descriptors: mouse, SWJ/Jac, male, female, hepatoma, cedar shavings, bedding.

Descriptors: mouse, environmental enrichment, impoverished, aggression, caging, animal welfare.

Descriptors: mouse, male, environmental enrichment, standard caging, impoverished, dominance, submission, fighting, olfaction, benefits.

Descriptors: mouse, inbred, male, keyhole limpet hemocyanin, isolation, group-reared, IgM, IgG.

NAL call number: QP351 D4
Descriptors: mouse, weanling, environmental enrichment, impoverishment, behavior.

NAL call number: QL750 J68
Descriptors: mouse, isolation, group-reared, dominance, territorial dominance, behavior.

NAL call number: QL750 J68
Descriptors: mouse, isolation, dominance, behavior.

Descriptors: mouse, BALB/c, rat, Wistar, activity, circadian rhythm.

NAL call number: QP901 P4
Descriptors: mouse, C57BL/6, male, female, young, old, passive avoidance tasks, $^3$H-QNB, muscarinic receptor binding, benzodiazepine binding, cortex, striatum, hippocampus, cerebellum, brain stem.

NAL call number: 442.8 Am3
Descriptors: mouse, ST/bJ, CBA/J, male, socially reared, isolation, behavior.

NAL call number: 410 J822
Descriptors: mouse, C57BL/6J, cage size, surface texture, wire, Plexiglas, body weight, open-field, defecation, running-wheel, exploration, water consumption.

NAL call number: 410 J822
Descriptors: mouse, inbred, genotype, genotype/environment interactions.

NAL call number: 410 J822
Descriptors: mouse, open field, defecation, running wheel, exploration, hoarding, activity, adrenal gland, body weight, behavior.

NAL call number: 410 J822
Descriptors: mouse, open field, running wheel, food competition, defecation.

NAL call number: 410 J822
Descriptors: mouse, A/J, C3H/HeJ, C57BL/10J, neonate, weanling, open field, exploration, running wheel, activity.

NAL call number: BF575 A3A57
Descriptors: mouse, male, isolation, socially housed, behavior, exploration, activity, abstract.

NAL call number: QL750 A6
Descriptors: mouse, male, aggression, caging, objects, dominance, submission, fighting, animal welfare, environmental enrichment, anthropocentric view, olfaction.

NAL call number: QL750 A6
Descriptors: mouse, CFLP, male, behavior, caging.
NAL call number: 410 B393
Descriptors: mouse, Swiss albino, male, novel environment, familiar environment, contacts, behavior.

NAL call number: QH301 C63
Descriptors: mouse, male, adult, inbred, behavior, aggression, exercise wheel.

Descriptors: mouse, female, bedding.

NAL call number: 410 Z36
Descriptors: mouse, bedding, spruce/pine shavings, pinene, P-450 enzymes, anesthesia.

NAL call number: 410 Z36
Descriptors: mouse, male, female, wood shavings.

Descriptors: mouse, ICR, social behavior, isolation-induced aggressiveness, group housing, tumor development, natural killer cells, T cells, B cells.

NAL call number: 410.9 P94
Descriptors: mouse, mycotoxins, dietary proteins, liver metabolism.

Descriptors: mouse, New Zealand Black, male, discrimination learning, spatial maze, shuttlebox, autoimmune disease.

Descriptors: mouse, behavior, feed.

NAL call number: 448.8 C16
Descriptors: mouse, CF-1, male, bedding, Douglas fir sawdust, body weight, organ weight, hepatomas, hepatocellular enzymes.

NAL call number: QP351 D4
Descriptors: mouse, outbred CD-1, male, female, weanling, isolation, pair housing, play behavior, social interactions, exploration, activity, affiliative behavior.

NAL call number: 442.8 L62
Descriptors: mouse hepatoma cell line, Hepa-1, hardwoods (aspen and alder), softwoods (pine and pine-spruce), cellulose materials, cytochrome P450I1A, aldehyde dehydrogenase.

Descriptors: behavior, environment design, housing, Inbred BALB C, Inbred C57BL, species specificity.

NAL call number: 176.622 J82
Descriptors: mouse, C3H-AVY, female, bedding, pine shavings, cedar shavings, mammary gland tumors.

Descriptors: mouse, male, female, pregnancy, weaning, nutrition, brain composition, Morris water maze, learning.

Descriptors: mouse, cortex, body weight, water maze, learning.

NAL call number: QL55 I5
Descriptors: mouse, environmental enrichment, cages, bottles, toys.

NAL call number: QP351 D4
Descriptors: mouse, C57BL/6J, male, old, behavior, brain chemistry, toys, housing, females, cerebral cortex, maze, tasks.

NAL call number: 448.9 R813
Descriptors: mouse, bedding, softwood sawdust, Schistosoma mansoni.

NAL call number: QP1 P4
Descriptors: mouse, Swiss Webster, male, female, weanling, young depression, immobility, body weight, reserpine.

Descriptors: mouse, male, isolation, copulation, imipramine, chlordiazepoxide, anti-psychotic drugs.

NAL call number: 410.9 P94
Descriptors: mouse, Swiss Webster, female, temperature, noise, reproduction, embryos, gestation.
Rats

Descriptors: rat, environmental enrichment, learning, abstract.

NAL call number: aHV4701 A952
Descriptors: rat, Sprague-Dawley, male, caging, platforms, decks, cage dividers, spatially enhanced.

NAL call number: QP1 P4
Descriptors: rat, male, stress, insulin, noise, behavior.

NAL call number: QL55 I5
Descriptors: rat, Wistar, male, sleep, activity, caging, isolation, socially reared, ladders, climbing frame, funnel, tubes, boxes, nesting container, film canisters, foraging devices.

NAL call number: QL55 I5
Descriptors: rat, rabbit, housing, social groups, behavior, ladders, shelves, tubes, funnels, climbing frame, boxes.

Descriptors: rat, male, female, weanling, young, isolation, striatum, handling.

NAL call number: QP1 P4
Descriptors: rat, Berkeley S1, environmental enrichment, impoverished, cerebrum, brain weight, acetylcholinesterase, cholinesterase, interlaboratory comparison.

NAL call number: 470 Sci2
Descriptors: rat, Berkeley S1, male, cortex, brain weight, impoverished.

Descriptors: rat, environmental enrichment, isolation, learning.

Descriptors: rat, learning, problem solving, environmental enrichment.

NAL call number: QP351 J68
Descriptors: rat, fetus, neonate, adult, nutrition, visual cortex, histology.

NAL call number: QP801 H7H64
Descriptors: rat, male, female, testosterone anti-serum, progestin anti-serum, medroxyprogesterone.

Descriptors: rat, old, capillaries, synaptogenesis, visual cortex, toys.

Descriptors: rat, male, neonate, adult, behavior, social interactions.

NAL call number: QP1 A2
Descriptors: rat, Sprague-Dawley, Wistar, Lancing horns, long term study.

NAL call number: RM315 N4
Descriptors: rat, male, environmental enrichment, impoverished, nucleus accumbens, striatum, *in vivo*, *in vitro*.

NAL call number: QL55 I5
Descriptors: welfare, housing, husbandry, rabbit, mouse, rat, gerbil, hamster, optimal living conditions.

NAL call number: RC231 E96
Descriptors: rat, Wistar, bilateral ICV injection, 6-hydroxydopamine, brain growth.

NAL call number: QP351 D4
Descriptors: rat, CD, Long-Evans, male, female, neonate, olfaction, behavior, hyperactivity.

NAL call number: 447.8 J825

Descriptors: rat, Sprague-Dawley, male, female, adult, neonate, bedding, corncobs, aspen shavings, cedar shavings, mortality.


Descriptors: rat, postweaning, toys, maze, barriers, occipital cortex, neuronal development.


Descriptors: rat, male, neonate, malnutrition, dendrites, occipital cortex, toys.


Descriptors: rat, Sprague-Dawley, male, female, weanling, environmental enrichment, isolation.


Descriptors: rat, environmental enrichment, impoverished, neural activity.


Descriptors: rat, male, female, visible burrows, dominance, interactions, behavior, neuroendocrine effects, corticosterone, glucocorticoid receptor, mineralocorticoid receptor, mRNA, growth-associated protein, preproenkephalin.


Descriptors: rat, cortex, environmental enrichment, learning, Hebb-Williams maze, methamphetamine, brain weight, activity.


Descriptors: rat, Wistar, male, female, environmental enrichment, impoverishment, operant chambers, feed acquisition.


Descriptors: rat, partial reinforcement, extinction effect, sodium amylobarbitone, chlordiazepoxide, anxiolytics.


Descriptors: rat, Wistar, male, female, weanling, imipramine, environmental enrichment, impoverished, brain histology, behavior.

Coyle, I.R. and G. Singer (1975). **The interaction of postweaning housing conditions and prenatal drug effects on...**
Descriptors: rat, Wistar, male, female, weanling, imipramine, Vitamin A, environmental enrichment, impoverished, Henderson-type maze, swimming maze.

NAL call number: Z5055.U49D53
Descriptors: rat, adrenal glands, hypothalamo-pituitary-adrenal axis.

NAL call number: QP351 D4
Descriptors: rat, Sprague-Dawley, female, malnutrition, environmental enrichment, behavior, open field, passive-avoidance performance.

Descriptors: rat, environmental enrichment, isolation, malnutrition, behavior, biochemical deficits.

NAL call number: 472 N21
Descriptors: rat, Wistar, male, female, weanling, old, environmental enrichment, isolation, toys, maze, brain weight, behavior, plasticity.

NAL call number: 470 Sci2
Descriptors: rat, male, brain development, environmental enrichment, deprivation.

Descriptors: rat, male, weanling, behavior, open field, radial maze.

NAL call number: QH301 C63
Descriptors: rat, male, weaning, adult, behavior, open field, radial maze.

Descriptors: rat, Holtzman, male, environmental enrichment, impoverished, feed acquisition, learning.

NAL call number: 442.9 S1
Descriptors: rat, female, cardiomyopathy, streptozotocin, diabetes mellitus, treadmill.

Descriptors: rat, Hooded Lister, male, Hebb-Williams maze, learning activity, exploratory behavior.

Descriptors: rat, female, virgin, pregnant, cortical depth, enrichment.

NAL call number: QP1 P4

Descriptors: rat, female, behavior, pre-pregnancy, pregnancy.


Descriptors: rat, Norway, male, female, neonate, contact behavior, ultrasonic vocalizations, olfaction.


NAL call number: QH301 C63

Descriptors: rat, male, brain weight, adrenalectomy, corticosterone.


NAL call number: RC321 E96

Descriptors: rat, Long-Evans, male, toys, frontal cortex, parietal cortex, occipital cortex, histology.


NAL call number: QH301 C63

Descriptors: rat, Long-Evans, male, neonates, old, brain thickness, brain development, memory.


NAL call number: RC321 E96

Descriptors: rat, male, medial occipital cortex, toys, caging.


NAL call number: QP351 D4

Descriptors: rat, Sprague-Dawley, post-weaning, socialization, isolation, handling, aversive stimuli, taste aversion, open field, gustatory-visceral sensory system, telereceptor-cutaneous sensory system.


NAL call number: 447.8 J824

Descriptors: rat, Sprague-Dawley, old, environmental enrichment, impoverished, learning.


NAL call number: HV4761 A5

Descriptors: rat, social groups, behavior, caging, handling, identification, exercise, gnawing, running wheel, toys, nest building, psychology experiments.


NAL call number: Film S-1779

Descriptors: rat, Sprague-Dawley, male, neocortex, nucleus basalis lesions, hippocampus, fimbria-fornix lesions.


Descriptors: rat, Sprague-Dawley, male, environmental enrichment, cortical potentials.


NAL call number: BF575 A3A57

Descriptors: rat, male, isolation, pairs, defense, tonic immobility, social threat.


Descriptors: rat, Long-Evans, male, young, hippocampal lesions, learning, memory tasks, motor tasks.


Descriptors: rat, Sprague-Dawley, neonate, adult, postnatal handling, active avoidance task, learning.


NAL call number: 410.9 P94

Descriptors: rat, Sprague-Dawley, abstract.


NAL call number: QP351 N3

Descriptors: rat, water maze, learning, memory, brain-derived neurotrophic factor.


NAL call number: QP1 P4

Descriptors: rat, shuttlebox avoidance, exploratory behavior, Greek Cross apparatus, brain weight.


NAL call number: 410 j822

Descriptors: rat, Berkeley S1, interaction with environment, environmental enrichment, isolation, impoverished, brain weight, behavior.


NAL call number: QP901 P4

Descriptors: rat, occipital cortex, cortex, subcortex, cerebellum, DFMO, spermidine, spermine, putrescine.


NAL call number: QH301 B46

Descriptors: rat, Sprague-Dawley, impoverished housing, diet, cortex, neurons, body weight, size, motor pyramids, dendrites.
NAL call number: QH301 C63
Descriptors: rat, Holtzman-derived, male, female, environmental enrichment, isolation, shock thresholds, open field, behavior.

NAL call number: QP351 D4
Descriptors: rat, Long-Evans, male, female, weanling, toys, isolation, socialization, boredom, body weight, feed consumption, water consumption.

NAL call number: QP1 P4
Descriptors: rat, hooded, male, blinding, home-cage aggression, shock-induced aggression, lighting.

Descriptors: rat, male, environmental enrichment, isolation, operant procedure, dopaminergic agonists, learning.

Descriptors: rat, preference test, cage size, behavior, Canadian Council on Animal Care.

NAL call number: QL750 B4
Descriptors: rat, Wistar, male, female, young, adult, odors, dominance, behavior, urine, alpha male.

NAL call number: QP1 P4
Descriptors: rat, Long-Evans, perceptually enriched, socially enriched, impoverished, open field, learning, avoidance training, electric shock.

NAL call number: RC963 A1A7
Descriptors: rat, Sprague-Dawley, adrenal ascorbic acid, auditory stress, brain, eosinophils.

NAL call number: QH301 C63
Descriptors: rat, male, CD, sensorimotor cortex, exercise wheel, environmental enrichment.

NAL call number: QP1 P4
Descriptors: rat, male, isolation, socially reared, hyperactivity, fear, taste neophobia.

Descriptors: rat, isolation, socially reared, behavior, housing.

Descriptors: rat, Sprague-Dawley, female, treadmill, knees, femoral cartilage, degeneration, fibrosis.

Descriptors: rat, cerebral blood flow, T-maze, environmental enrichment.

Descriptors: brain, postnatal handling, environmental enrichment, learning, cognition.

Descriptors: rat, Long-Evans, male, activity, Lashley III maze, straight alley.

NAL call number: 500 N484
Descriptors: rat, Brattleboro, male, heterozygous, homozygous, diabetes insipidus, neocortex, telencephalon, diencephalon, hippocampus, brain size, age.

NAL call number: Film S-1805
Descriptors: rat, Brattleboro, brain morphology.

NAL call number: Z5055.U49D53
Descriptors: rat, male, female, environmental enrichment, isolation, impoverished, foster mothers, play.
NAL call number: QP84 M4
Descriptors: rat, Long-Evans, female, young, old, running wheels, aging, citrate synthase, hexokinase, heart, epitrochlearis, flexor digitorum brevis.

Descriptors: rat, young, deafness, aminoxyacetic acid, kanamycin, acoustic startle.

NAL call number: QH301 C63
Descriptors: rat, Long-Evans, female, pregnant, nonpregnant, brain thickness, environmental enrichment, sex, hormonal state.

Descriptors: rat, postweaning, isolation, groups, ataxia, Morris maze, postnatal environmental enrichment.


Descriptors: rat, Fischer, male, sheep red blood cells, inflammation, voluntary exercise, feed intake, activity, body weight, blood chemistry, liver function.

NAL call number: QL785 A725
Descriptors: rat, female, neonates, handling, Hebb-Williams maze, vision.

Descriptors: rat, plasticity, cerebral artery.

NAL call number: QH301 C63
Descriptors: rat, Wistar, hippocampus, cortex, cell physiology, preweaning, postweaning, toys, multifamily groups, isolation.

Descriptors: rat, female, isolation, socialization, visual discrimination, learning, appetitive behavior, cerebral cortex, dopamine.

NAL call number: QP351 D4
Descriptors: rat, male, female, adult, environmental enrichment, running wheel, open field, maze, noxious stimuli.

NAL call number: 447.8 J824
Descriptors: rat, Fischer 344, female, young, old, sedentary, treadmill, body weight, wall thickness, collagen, elastin.

Descriptors: rat, hooded Lister, male, undernourishment, brain growth spurt, forebrain, cortex, hippocampus, brain development.

Descriptors: rat, Sprague-Dawley, male, emotionality, environmental enrichment, impoverished, handling, bedding, open field, activity.


NAL call number: QP1 P4
Descriptors: rat, female, housing conditions, memory, radial maze.

Kelche, C. and B. Will (1982). Effects of post-operative environments following dorsal hippocampal lesions on
NAL call number: Film S-1779
Descriptors: rat, Long-Evans, male, bilateral hippocampal lesions, pyramidal cells, morphology, behavior.

NAL call number: QP1 P4
Descriptors: rat, August, male, learning, bilateral lesions, hippocampus, Hebb-Williams maze.

Descriptors: rat, Holtzman, male, female, water consumption, food consumption, activity levels, open field, avoidance test, sex differences.

Descriptors: rat, Sprague-Dawley, weanling, environmental enrichment, impoverished, passive-avoidance problem, emotions.

Descriptors: rat, environmental enrichment, impoverished, exploration, learning.

NAL call number: QP1 P4
Descriptors: rat, female, pregnant, foster mothers, male offspring, Hebb-Williams maze, postnatal learning.

NAL call number: QP1 P4
Descriptors: rat, male, female, cat avoidance apparatus, stress, stomach, adrenal glands, thymus, defensive behavior.

Descriptors: rat, Holtzman, male, female, neonate, caging, play, stress.

Descriptors: rat, caging, physiology.

NAL call number: QP1 P4
Descriptors: rat, Wistar, male, swimming, exercise, superoxide dismutase, glutathione, diethyl maleate, emotions, maze, norepinephrine, epinephrine, lactate, stress.

NAL call number: QP1 P4
Descriptors: rat, male, apparatus, learning, maze, feed acquisition, water acquisition, behavior.


Descriptors: rat, Carworth, fear, open field, defecation, anesthetized rat, toy car, pair interaction, gregariousness.


NAL call number: QP351 B52

Descriptors: rat, Wistar, male, enriched environment, isolation.


Descriptors: rat, Sprague-Dawley, female, aging, constant estrus, isolation, group rearing, lordosis reflex, ovarian steroids.


Descriptors: rat, environmental enrichment, impoverished, NMDA receptor, open field, $[^3]$H]MK-801 binding sites, cortex, learning, activity, cognitive changes.


NAL call number: BF712 D46

Descriptors: rat, Long-Evans, environmental enrichment, impoverished, candle, nose-flame contacts, emotions, perceptual deficits.


NAL call number: Z5055.U49D5

Descriptors: rat, undernutrition, learning, biochemistry.


NAL call number: 410 J822

Descriptors: rat, male, female, isolation socially reared, aggression, behavior, body weight, stress.


NAL call number: 410 J822

Descriptors: rat, Sprague-Dawley, weanling, visual enrichment, auditory enrichment, electrodes.


Descriptors: rat, Wistar, Brown-Norway, male, environmental enrichment, behavioral tests.


NAL call number: SF406 I46 1993

Descriptors: rat, handling, behavior, learning, aggressiveness, stress, fear, physiological responses.
NAL call number: QH301 F3
Descriptors: rat, housing, cardiovascular system, abstract.

NAL call number: QP351 N3
Descriptors: rat, paraventricular nucleus, locomotor activity, novel environments, housing, ricin A toxin, stress.

NAL call number: 442.9 So1
Descriptors: rat, Wistar-Kyoto, normotensive, spontaneously hypertensive, Sprague-Dawley, epinephrine, isolation, group-reared, fatty acid desaturase.

Descriptors: rat, female, REM sleep, clonidine, brain weight, cortex.

Descriptors: rat, male, environmental enrichment, cage size, toys, open field, activity, body weight, urination, defecation.

NAL call number: Film S-1779

Descriptors: rat, adult, old, neuronal plasticity, environmental enrichment, handling, glucocorticoid receptors, hippocampus, nerve growth factor.

NAL call number: QP351 D4
Descriptors: rat, Norway, female, neonate, mothers, maternal anogenital licking, licking, time in nest, nursing, zinc sulfate, dietary saline.

Descriptors: rat, male, visual pattern discrimination, maze, spatial delayed alternation, cortex.

NAL call number: QP1 P4
Descriptors: rat, Wistar, male, weanling, isolation, socially reared, ascorbic acid, corticosterone, cortex, stress.


Descriptors: rat, Long-Evans, weaning, young, pinning behavior, isolation, dominance.

NAL call number: QP901 P4
Descriptors: rat, male newborn, weanling, 6-OHDA, maturation, Lashley maze, Hebb-Williams maze.

Descriptors: rat, neonate, abstract.

NAL call number: QP901 P4
Descriptors: rat, male, water maze, 6-OHDA, cognition.

Descriptors: rat, hypertensive, Wistar-Kyoto, running wheel, genetics.

NAL call number: QP351 N3
Descriptors: rat, weanling, water maze, caudate, training.

NAL call number: 410 J822
Descriptors: rat, Sprague-Dawley, female, weanling, adult, handling, avoidance learning, electric shock, memory.

NAL call number: RG600 E27
Descriptors: rat, Sprague-Dawley, male, female, neonate, morphometrics, pyramidal neurons, dendrites, cortex, malnutrition.

Descriptors: rat, neonate, water maze, hippocampus, protein kinase C, learning, memory.

NAL call number: BF575 A3A57
Descriptors: rat, male, dominance, behavior, play.

NAL call number: QP351 N3
Descriptors: rat, male, female, young, 6-hydroxydopamine, striatum, play fighting, allogrooming, sexual mounting.
NAL call number: QP351 D4
Descriptors: rat, Holtzman, female, post-weaning, toys, cerebellum, brainstem, protein turnover.

Descriptors: rat, male, female, environmental enrichment, active avoidance learning, muscarinic receptors, acetylcholinesterase, choline acetyltransferase.

NAL call number: QH301 C63
Descriptors: rat, Berkeley S1, binding assays, membrane fractions, cerebellum, subcortex, cortex.

NAL call number: QP351 D4
Descriptors: rat, male, female, littermates, isolation, pairs, mouse-killing, intraspecific aggression, shock-induced fighting, thresholds.

Descriptors: rat, adult, chemically induced micrencephaly, Hebb-Williams maze.

NAL call number: BF712 D46
Descriptors: rat, female, pregnant, neonate, weanling, bovine growth hormone, reflex maturation, environmental enrichment, isolation, open field, Lashley III maze, shuttle box, learning.

NAL call number: QL55 A1L3
Descriptors: rat, male, female, caging, bedding, floor type, ammonia, aerosols, temperature, humidity.

NAL call number: QP351 D4
Descriptors: rat, Berkeley S1, brain weight, behavior, social factors.

Descriptors: rat, environmental enrichment, impoverished, observations, training.

Descriptors: rat, vitamin B1, complete diet, Hebb-Williams maze.

NAL call number: QP351 D4
Descriptors: rat, Sprague-Dawley, male, female, weanling, adult, orienting response, auditory stimulus, heart rate, isolation, socially reared.
NAL call number: QP1 P4
Descriptors: rat, Sprague-Dawley, feed restriction, running wheel, body weight, exercise, anorexia nervosa, vasopressin, blood chemistry.

NAL call number: 410 J822
Descriptors: rat, Berkeley S1, Fischer, tumbling stress, norepinephrine, dopamine, serotonin, environmental enrichment, impoverished, adrenal glands, cortex, hypothalamus, midbrain, brain weight.

Descriptors: rat, environmental enrichment, impoverished, handling, emotionality, exploration.

NAL call number: QP901 P4
Descriptors: rat, male, weanling, ethanol.

NAL call number: QP901 P4
Descriptors: rat, male, weanling, isolation, water consumption.

Descriptors: rat, weanling, immobilization, ulcers.

NAL call number: QH301 C63
Descriptors: rat, male, weanling, immobilization, ulcers.

NAL call number: QP1 P4
Descriptors: rat, male, female, depression, emotional stress, physical stress, motor activity, exploration, corticosterone, prolactin.

Descriptors: rat, prelesion performance vs. postlesion performance, water maze, escape response, bilateral occipital lesions.

Descriptors: rat, cortex, brain damage, water maze, learning.

Descriptors: rat, bilateral lesions, occipital cortex, water maze, environmental enrichment, learning.
Descriptors: rat, compensation vs. recovery, bracelet removal test, postoperative.

Descriptors: rat, male, Lister hooded, reward, behavior, operant learning.

Descriptors: rat, behavior, methods.

Descriptors: rat, male, open field test, attention test, grip test, new learning vs. established learning.

Descriptors: rat, operant task, behavior, hemidecorticate deficit.

Descriptors: rat, Hooded Lister, male, auditory discrimination, learning.

NAL call number: QP1 P4
Descriptors: rat, learning, lever-press training, response-contingent events.

Descriptors: rat, male, Skinner box, differential reinforcement, error inhibition.

NAL call number: 410 J822
Descriptors: rat, Berkeley S1, male, methamphetamine, brain weight, brain enzymes, light vs. dark.

NAL call number: 410 J822
Descriptors: rat, Fischer, Long-Evans, male, environmental enrichment, impoverished, brain weight, cortex, lesions, acetylcholinesterase, cholinesterase, pituitary.

NAL call number: QP351 N3
Descriptors: rat, male, neonates, premature weaning, Golgi study, dendrites, isolation, postsynaptic structures, stress.

Descriptors: rat, female, learning, behavior.

NAL call number: QP1 P4
Descriptors: rat, male, electrodes, medial forebrain bundle, lateral hypothalamus, group reared, isolation, handling, locomotion, unconditioned behavior.

NAL call number: QL55 H8
Descriptors: rat, caging, space requirements, animal welfare.

Descriptors: rat, S3, Charles River, Wistar, synchronized shuttling, pair housing, isolation, behavior, learning.

Descriptors: rat, isolation, housing, pain reception, electric shock, stress-induced hypoalgesia, stress.

Descriptors: rats, male, young, attack, male copulation, maternal behavior, fear.

NAL call number: QP351 S6
Descriptors: rat, old, behavior, memory.

NAL call number: QP351 B45
Descriptors: rat, young, old, dentate gyrus, evoked responses.

NAL call number: QH301 C63
Descriptors: rat, Long-Evans, male, young, pinning behavior, socialization, activity, play behavior.

Descriptors: rat, adolescent, toys, enrichment, angiogenesis.

NAL call number: QP351 D4
Descriptors: rat, Long-Evans, somatosensory input, xylocaine, local anesthesia, dorsal body, pinning, play motivation.

NAL call number: QP351 D4
Descriptors: rat, young, indirect calorimetry, energy expenditure, play, play restricted, body weight, feed consumption.


Strupp, B.J. and D.A. Levitsky (1984). **Social transmission of food preferences in adult hooded rats (Rattus norvegicus).** *Journal of Comparative Psychology* 98(3):257-266.


the infant rat: The role of feeding and stroking. Developmental Brain Research 75(2):185-192. 
Descriptors: rat, female, neonate, corticosterone, maternal separation, feeding, stroking.

NAL call number: 442.8 AC8 
Descriptors: rat, Long-Evans, male, dorsal hippocampus, brain weight, granule cells, plasticity.

NAL call number: QL750 B4 
Descriptors: rat, Wistar, male, female, neonate, young, growth, sexual maturation, behavior, brain weight, toys.

NAL call number: 442.8 J8222 
Descriptors: rat, Wistar, male, female, handling, toys, ladders, ropes, tubes, isolation, socially reared, behavior, sexual behavior, body weight, organ weight.

NAL call number: QP351 D4 
Descriptors: rat, male, environmental enrichment, cauterization vs. plucking, tactile stimuli, visual stimuli.

Descriptors: rat, Sprague-Dawley, malnutrition, environmental enrichment, isolation, runway.

NAL call number: Film S-1779 
Descriptors: rat, weanling, electro-oculogram, EEG, EMG, slow wave, REM.

NAL call number: QP1 P4 
Descriptors: rat, male, female, siblings, juvenile, social play, foot shock, tonic immobility, corticosteroids.

NAL call number: BF712 D46 
Descriptors: rat, Wistar, male, female, pregnancy, lactation, malnutrition, isolation, learning.

Descriptors: rat, allergens, occupational exposure.

Descriptors: rat, male, female, ontogenetic descriptions, rough and tumble play, sexual maturity, aggression.

Descriptors: rat, training, exercise, growth, diet.
NAL call number: RC321.E96
Descriptors: rat, male, Berkeley S₁, cortex, dendrites, length, branching, environmental enrichment.

Descriptors: rat, male, adult, old, slow wave, desynchronized sleep, adaptation.

NAL call number: QH301 C63
Descriptors: rat, adult, old, radial maze, paired flashes, visual sensitivity, hippocampal changes.

NAL call number: RC321 E96
Descriptors: rat, adult, old, caging, toys, cortical plasticity.

Descriptors: rat, adult, aging, environmental enrichment, social deprivation, memory loss, problem solving, circadian activity.

Descriptors: rat, neonates, cortical dendrites, Golgi-Cox-Sholl stain.

Descriptors: rat, adult, Hebb-Williams maze, development.

NAL call number: BF712 D46

NAL call number: Z5055.U49D53
Descriptors: rat, hypothalamus, cerebellum, caudate nucleus.

NAL call number: QL750 B4
Descriptors: rat, novel places, exploration, home cage, lighting.

NAL call number: QP1 P4
Descriptors: rat, Long-Evans, bilateral lesions, environmental enrichment, closed field, open field, illumination, vision.
NAL call number: Z5055.U49D53
Descriptors: rat, neonate, environmental enrichment, impoverished.

Descriptors: rat, Holtzman, male, neonate, foster mothers, dietary protein, environmental enrichment, spatial, visual, tactile, impoverished, Hebb-Williams maze.

NAL call number: QH301 C63
Descriptors: rat, Long-Evans, neonate, adult, hemidecortication, noradrenaline, environmental enrichment.

NAL call number: QP351 B45
Descriptors: rat, neonate, adult, cortex, Morris water maze, outdoors.

NAL call number: 410.9 P94
Descriptors: rat, Long-Evans, male, bedding, air pollution.

NAL call number: QP1 P4
Descriptors: rat, female, male, devocalized, intact, darting.

NAL call number: QP1 P4
Descriptors: rat, male, stress, operant tasks, pavlovian tasks, learning.

NAL call number: QP1 P4
Descriptors: rat, male, object exploration test, environmental exposure.

NAL call number: 410 J822
Descriptors: rat, Fischer, Berkeley S1, male, bilateral lesions, occipital cortex, hippocampus, Hebb-Williams maze, methamphetamine, brain weight, RNA, DNA.

NAL call number: QH301 C63
Descriptors: rat, young, bilateral lesions, entorhinal cortex, Hebb-Williams maze, learning.

Will, B.E., F. Deluzarche, and C. Kelche (1983). Does post-operative environment attenuate or exacerbate

Descriptors: rat, hooded, female, spontaneous alternation, hippocampus.


Descriptors: rat, deprivation, brain, biochemistry.


Descriptors: rat, Wistar, male, adult, ethanol, diazepam, quinine, open field, isolation, group housing, activity, body weight.


Descriptors: rat, recording device, digging behavior, time.


Descriptors: rat, Berkeley S1, neonate, brain weight, cortex, superior colliculi, acetylcholinesterase, butyrylcholinesterase.


Descriptors: rat, weanling, adolescent, sensory stimuli, Hebb-Williams maze, learning.


Descriptors: rat, black-hooded, male, weanling, cross-modal transfer, visual discrimination, learning.


Descriptors: rat, male, treadmill, training, body mass, feed intake, glycogen, muscle fibers, heart, diaphragm, liver, hypoglycemia, urea.


Descriptors: rat, male, female, social isolation, self-administration, d-amphetamine sulfate, sodium barbital.

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**Wild Rodents**


NAL call number: QC180 A1M52

Descriptors: tree squirrels (*Sciurus sp.*), den boxes, tire nest structures, housing.


NAL call number: 410 B77
Descriptors: bank vole, preference test, perception, aversive conditions.

NAL call number: 500 C125Z v.110
Descriptors: Bushy-tailed wood rat, social behavior.

NAL call number: 442.8 J8222
Descriptors: naked mole-rats, male, female, chemical cues, reproductive suppression, olfactory cues, gustatory contact, luteal phase, androgens.

NAL call number: QL750 A6
Descriptors: capybara, alarm response, flight or fight response, behavior.

Descriptors: bank voles, behavior, conflicts.

NAL call number: QP351 D4
Descriptors: ground squirrel, brain weight, behavior, social factors.

NAL call number: 410 B77
Descriptors: bank voles (Clethrionomys glareolus), environmental enrichment, impoverished, perceptions, adverse environments.

NAL call number: QL55 J55
Descriptors: woodchuck, Japanese, English abstract, housing, reproduction.

NAL call number: 470 C16D
Descriptors: white-footed mouse (Peromyscus leucopus noveboracensis), huddling, isolation, radiotelemetry, body temperature, frequency of torpor, euthermic.

NAL call number: SF405.5 C36
Descriptors: ground squirrel, housing, social groups, burrows, nests, vocalization, visual communication, tactile communication, olfactory communication.

Journal Listing
and
Subscription Information for Selected Publications


This section is a listing of journals that appear in the bibliography. It is further categorized by species or class of animal with all entries appearing in alphabetical order. Each entry lists the journal title, place of publication, language, International Standard Serial Number (ISSN) listing, brief description of contents, the NAL Call Number (if available at NAL), and the electronic databases that index the journal.

During the production of this publication, we found ourselves routinely going to several publications because of their excellent coverage of environmental enrichment research or applied programs. Consequently, we felt it important to include information on how to subscribe to these publications.

The following links access other chapters in Environmental Enrichment Information Resources for Laboratory Animals:

- [Main Contents]
- [Main Introduction]
- [How to Use This Document]
- [Birds]
- [Laboratory Cat]
- [Dogs and Dog Housing]
- [Farm Animals]
- [Ferrets]
- [Rabbits]
- [Rodents]
- [Journal Listing]
- [Subscription Information for Selected Publications]
- [Organizations]
- [Suppliers and Products]
- [Common Devices and Programs]
- [Main Subject Index]
- [Document Delivery Information]

The following is a partial listing of journals that contain environmental enrichment and/or behavior articles covering the various species listed.

- **Cats, Dogs, Rabbits**
- **Farm Animals**
- **Mice and Rats**
- **Subscription Information for Selected Publications**

**Cats, Dogs, Rabbits**

**Title:** American Journal of Veterinary Research (American Veterinary Medical Association).
**Place of Publication:** United States, Illinois
**Language:** English
**International Standard Serial Number:** 0002-9645
**Descriptors:** veterinary medicine periodicals.
**NAL Call Number:** 41.8 Am3A
**Databases Indexed In:** AGRICOLA, CAB ABSTRACTS, AGRIS

**Title:** Animal Behaviour (Association for the Study of Animal Behaviour).
**Place of Publication:** United Kingdom, England
**Language:** English
**International Standard Serial Number:** 0003-3472
**Descriptors:** animal behavior periodicals.
Farm Animals

Title: Animal Production (British Society of Animal Production).
Place of Publication: United Kingdom, England
Language: English
International Standard Serial Number: 0003-3561
Descriptors: Livestock-Periodicals, Animal-Industry-Great-Britain
NAL Call Number: 49 An55
Databases Indexed In: AGRICOLA, AGRIS, CAB ABSTRACTS

Title: Animal Welfare (Universities Federation for Animal Welfare)
Place of Publication: United Kingdom, England
Title: Animal Welfare Information Center Newsletter (United States Department of Agriculture).
Place of Publication: United States, Maryland
Language: English
International Standard Serial Number: 1050-561X
Descriptors: animal welfare periodicals.
NAL Call Number: aHV4701.A952
Databases Indexed In: AGRICOLA

Title: Applied Animal Behaviour Science.
Place of Publication: Netherlands
Language: English
International Standard Serial Number: 0168-1591
Descriptors: animal behavior periodicals, domestic animals periodicals.
NAL Call Number: QL750.A6
Databases Indexed In: AGRICOLA, CAB ABSTRACTS

Title: British Poultry Science (Poultry Education Association).
Place of Publication: United Kingdom, Scotland
Language: English
International Standard Serial Number: 0007-1668
Descriptors: poultry periodicals.
NAL Call Number: 47.8 B77
Databases Indexed In: AGRICOLA, CAB ABSTRACTS

Title: Canadian Journal of Animal Science (Canadian Society of Animal Production).
Place of Publication: Canada, Ontario
Language: Includes Some Text in French, Abstracts in English and French
International Standard Serial Number: 0008-3984
Descriptors: animal industry periodicals.
NAL Call Number: 41.8 C163
Databases Indexed In: AGRICOLA, CAB ABSTRACTS

Title: Journal of Animal Science (American Society of Animal Science).
Place of Publication: United States, Wisconsin
Language: English
International Standard Serial Number: 0021-8812
Descriptors: livestock periodicals, animal culture periodicals.
NAL Call Number: 49 J82
Databases Indexed In: AGRICOLA, AGRIS, CAB ABSTRACTS

Title: Journal of Dairy Science (American Dairy Science Association).
Place of Publication: United States, Pennsylvania
Language: English
International Standard Serial Number: 0022-0302
Descriptors: dairying periodicals.
NAL Call Number: 44.8 J822
Databases Indexed In: AGRICOLA, AGRIS, CAB ABSTRACTS
Title: *Poultry Science* (Poultry Science Association).
Place of Publication: United States, Illinois
Language: English
International Standard Serial Number: 0032-5791
Descriptors: poultry periodicals.
NAL Call Number: 47.8 Am33p
Databases Indexed In: AGRICOLA, AGRIS, CAB ABSTRACTS

To: Top of Document | Cats, Dogs, Rabbits | Farm Animals | Mice and Rats | Subscription Information for Selected Publications

## Mice and Rats

Place of Publication: United Kingdom, England
Language: English
International Standard Serial Number: 0003-3472
Descriptors: animal behavior periodicals.
NAL Call Number: 410 B77
Databases Indexed In: BIOSIS, PSYCINFO, PASCAL, AGRICOLA, CAB ABSTRACTS

Title: *Animal Technology* (Institute of Animal Technology).
Place of Publication: United Kingdom, Wales
Language: English
International Standard Serial Number: 0264-4754
Descriptors: laboratory animals periodicals.
NAL Call Number: Ql55.I5
Databases Indexed In: AGRICOLA, CAB ABSTRACTS

Title: *Animal Welfare* (Universities Federation for Animal Welfare)
Place of Publication: United Kingdom, England
Language: English
International Standard Serial Number: 0962-7286
Descriptors: animal welfare periodicals.
NAL Call Number: HV4701 A557
Databases Indexed In: CAB ABSTRACTS, BIOSIS PREVIEWS

Title: *Animal Welfare Information Center Newsletter* (United States Department of Agriculture)
Place of Publication: United States, Maryland
Language: English
International Standard Serial Number: 1050-561X
Descriptors: animal welfare periodicals.
NAL Call Number: aHV4701.A952
Databases Indexed In: AGRICOLA

Title: *Behavioral and Neural Biology*.
Place of Publication: United States, New York
Language: English
International Standard Serial Number: 0163-1047
Descriptors: animal behavior periodicals, neurobiology periodicals.
NAL Call Number: QH301.C63
Databases Indexed In: MEDLINE, BIOSIS, PASCAL, CAB ABSTRACTS
Subscription Information for Selected Publications

Animal Ethics Update
A quarterly newsletter for members of animal care and ethics committees published by the Animal Research Review Panel and the Animal Welfare Unit, New South Wales Agriculture, Australia. This publication contains a variety of information on animal welfare topics and practical suggestions for environmental enrichment programs. For information contact Rebecca Larkin, Editor, Animal Welfare Unit, NSW Agriculture, Locked Bag 21, Orange 2800, New South Wales, AUSTRALIA. Tel: (063) 91 3670, Fax: (063) 91 3570, e-mail: larkinr@agric.nsw.gov.au
Animal Keepers' Forum
Monthly journal of the American Association of Zoo Keepers, Inc. contains a regular feature--"Enrichment Options"--which highlights psychological stimulation, behavioral enrichment, activity manipulation, and occupational husbandry in zoo and aquarium environments. Subscription information can be obtained at 635 S.W. Gage Blvd., Topeka, KS (Kansas) 66606-2066 USA. Tel: 1-800-242-4519, Fax: (913) 273-1980.

Animal Technology
A journal published three times a year by the Institute of Animal Technology. Routinely features short articles, technical notes, or reviews pertaining to enriched housing/caging options or enrichment strategies for various laboratory and farm animals including birds and other non-mammalian species. G.E. Ward, Editor, School of Molecular and Medical Biosciences, University of Wales College of Cardiff, P.O. Box 911, Cardiff, Wales CF1 1ST, UK.

Animal Welfare
Quarterly journal produced by Universities Federation for Animal Welfare. "Brings together the results of scientific research and technical studies related to the welfare of animals kept on farms, in laboratories, as companions, in zoos or managed in the wild." Often includes enrichment articles. Subscription information can be obtained from UFAW, 8 Hamilton Close, South Mimms, Potters Bar, Herts, England EN6 3QD, UK. Tel: 01707 658202, Fax: 01707 649279.

Applied Animal Behaviour Science
This journal deals with the behaviour of domesticated and utilized animals. The principal subjects include farm animals (including poultry) and companion animals. Other species covered include rabbits and fur-bearing animals, deer, and animals in forms of confinement such as zoos, safari parks, and other forms of display. Laboratory animals are occasionally included. Requests regarding subscriptions may be sent to Elsevier Science B.V., Journal Department, P.O. Box 211, 1000 AE Amsterdam, THE NETHERLANDS. Tel: 31-20-4853642, Fax: 31-20-4853598. In the USA and Canada, write to Elsevier Science Inc., Journal Information Center, 655 Avenue of the Americas, New York, NY (New York) 10010, USA. Tel: (212) 633-3750, Fax: (212) 633-3764, Telex: 420-643 AEP UI.

Guide to the Care and Use of Experimental Animals Volume 1, 2nd edition
Published by the Canadian Council on Animal Care in 1993. This publication contains a 40 page section on the social and behavioral requirements of experimental animals including wildlife kept in a laboratory setting. Other sections discuss facilities, the physical environment, occupational health and safety, surgical standards, control of pain, anesthesia, euthanasia, and guidelines for the use of animals in neuroscience research. To obtain a copy of this guide, write to Canadian Council on Animal Care, 1000-151 Slater Street, Ottawa, Ontario K1P 5H3, CANADA.

Lab Animal
This journal is published 11 times a year and emphasizes proper management and care of laboratory animals. It routinely contains articles dealing with environmental enrichment techniques and occasionally devotes an issue to the topic. Last issue of the year is the next year's Lab Animals Buyers Guide. Send subscription orders to Lab Animal Subscriptions Department, P.O. Box 1710, Riverton, NJ (New Jersey) 08077-7310 USA, Tel: (212) 726-9200.

Laboratory Animals: The International Journal of Laboratory Animal Science and Welfare
The official journal of the Laboratory Animal Science Association, Gesellschaft für Versuchstierkunde, Nederlandse Vereniging voor Proefdierkunde, Schweizerische Gesellschaft für Versuchstierkunde, and the Federation of European Laboratory Animal Science Associations. A quarterly publication devoted to the "advancement of public education in laboratory animal science, technology, and welfare.... The Editorial Board wishes to give especial encouragement to papers describing work which... represents a significant refinement in methodology, leading to improvements in the welfare or well-being of the animals used." Subscription orders should be sent to Publications Subscription Department, Royal Society of Medicine Press Ltd., 1 Wimpole Street, London, England W1M 8AE, UK. Articles should be sent to Editorial Manager, Laboratory Animals, Royal Society of Medicine Press Ltd., 1 Wimpole Street, London, England W1M 8AE, UK. Tel: 071-290-2923.

The Shape of Enrichment
A quarterly bulletin featuring ideas for environmental and behavioral enrichment written mostly by zoo and aquarium researchers, keepers, and trainers. Topics covered include design and evaluation of enrichment devices and programs.
Organizations


There are many organizations that produce extremely useful materials for their members and other interested parties. In this section, organized by world regions, you will find information on how to contact these organizations via a variety of electronic means and that old standby, the postal service. You will also find World Wide Web addresses for those organizations that have posted homepages on the Web. However, readers are cautioned that because the WEB is a very dynamic media, these addresses may change. You will also find information on the type of organization, the resources or services offered, requestor priority, and fees (if any).

The following links access other chapters in Environmental Enrichment Information Resources for Laboratory Animals:

- American Association for Laboratory Animal Science (AALAS)
- American Society of Laboratory Animal Practitioners
- Animal Welfare Information Center (AWIC)
- Canadian Association for Laboratory Animal Science
  - L'Association Canadienne Pour La Technologies des Animaux de Laboratoire
- Canadian Council on Animal Care (CCAC)
- Institute of Laboratory Animal Resources (ILAR)
- National Library of Medicine (NLM)
- Scientists Center for Animal Welfare (SCAW)
- The Shape of Enrichment Video Library

North American Resources

- Australian and New Zealand Council for the Care of Animals in Research and Teaching, Limited (ANZCCART)
- British Laboratory Animals Veterinary Association
- Federation of European Laboratory Animal Science Associations (FELASA)
- Gesellschaft für Versuchstierkunde
  - Society for Laboratory Animal Science (GV-SOLAS)
- Institute of Animal Technology
- Institut für Labortierkunde der Universität Zürich
- Institute of Laboratory Animal Science
- Japanese Association for Laboratory Animal Science (JALAS)
- Laboratory Animal Science Assoc. (LASA)
- Nederlandse Vereniging voor Proefdierkunde (NVP)
- Scandinavian Federation for Laboratory Animal Science
- Schweizerische Gesellschaft für Versuchstierkunde (SGV)
  - Société Suisse pour la Science des Animaux de Laboratoire
- Swiss Laboratory Animal Science Association
- Universities Federation for Animal Welfare
North American Resources:

American Association for Laboratory Animal Science (AALAS)
70 Timber Creek Drive
Cordova, TN (Tennessee) 38018, USA

TELEPHONE: (901) 754-8620
FAX: (901) 753-0046
E-MAIL: info@aalas.org
WORLD WIDE WEB: http://www.aalas.org
CONTACT: Michael Sondag, Executive Director
TYPE OF INSTITUTION/ORGANIZATION: Non-profit, professional
RESOURCES/SERVICES: International in scope. Serves as a clearinghouse for collection and exchange of information on all phases of laboratory animal care and management, use and procurement of laboratory animals used in biomedical research. Educational materials, guides, and audiovisuals. Hold annual meetings that have workshops or seminars on environmental enrichment. Publish Contemporary Topics - a bimonthly journal with an expanded peer reviewed section on topics such as clinical management and husbandry. Also publish Laboratory Animal - a monthly, peer reviewed journal covering a diverse array of applied and experimental topics in the laboratory animal sciences.
REQUESTOR: Anyone.
COSTS: Charge for materials (members are charged a lower rate).

American Society of Laboratory Animal Practitioners
University of Texas Medical School
6431 Fannin Street, Room 1132
Houston, TX (Texas) 77030, USA

TELEPHONE: (713) 792-5127
FAX: (713) 792-5127
E-MAIL: bgoodwin@admin4.hsc.uth.tmc.edu
CONTACT: Bradford S. Goodwin, Jr., Secretary-Treasurer
TYPE OF INSTITUTION/ORGANIZATION: Private group of veterinarians
RESOURCES/SERVICES: Personal knowledge of veterinarians.
REQUESTOR: Anyone.
COSTS: None.

Animal Welfare Information Center (AWIC)
Agricultural Research Service
National Agricultural Library
10301 Baltimore Boulevard
Beltsville, MD (Maryland) 20705, USA

TELEPHONE: (301) 504-6212
FAX: (301) 504-7125
E-MAIL: awic@nal.usda.gov
WORLD WIDE WEB: http://www.nal.usda.gov/awic
CONTACT: Jean Larson, Coordinator
TYPE OF INSTITUTION/ORGANIZATION: Public, non-profit, government agency
RESOURCES/SERVICES: Vast collection of serials, monographs, and audiovisuals within the National Agricultural Library (NAL). Documents may be borrowed through an interlibrary loan. For more information on document delivery, contact (301) 504-5755. The Center performs brief complimentary searches of AGRICOLA and other relevant databases. The Center can also assist you in formulating your own database searches, provides conference facilities and
host training sessions, and can make available speakers and/or a tabletop exhibit for training sessions, conferences, and workshops. The Center produces bibliographies on topics such as stress, analgesia, animal testing alternatives, training materials and other relevant topics to animal welfare. Publishes the *Animal Welfare Information Center Newsletter*.

**REQUESTOR:** Anyone.

**COSTS:** All publications are available for free; literature searches on a cost recovery basis; NAL may charge for certain services such as providing photocopies, document delivery, etc.

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**Canadian Association for Laboratory Animal Science**  
*L'Association Canadienne Pour La Technologies des Animaux de Laboratoire*

c/o CALAS National Office  
Biosciences Animal Service  
University of Alberta  
Edmonton, Alberta T6G 2E9, CANADA

**TELEPHONE:** (403) 492-5193  
**FAX:** (403) 492-7257  
**E-MAIL:** dmckay@gpu.srv.ualberta.ca  
**CONTACT:** Donald McKay  
**TYPE OF INSTITUTION/ORGANIZATION:** Non-profit, professional  
**RESOURCES/SERVICES:** Produces educational materials, videos, and a monthly newsletter (*CALAS/ACTAL Newsletter*). Hold annual meetings with workshops, seminars, and poster sessions.  
**REQUESTOR:** Laboratory animal professionals.  
**COSTS:** Vary according to materials.

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**Canadian Council on Animal Care (CCAC)**  
350 Albert Street, Suite 315  
Ottawa, Ontario K1R 1B1, CANADA

**TELEPHONE:** (613) 238-4031  
**FAX:** (613) 238-2837  
**E-MAIL:** lroach@bart.ccac.ca  
**CONTACT:** Dr. James Wong, Director of Assessments  
**TYPE OF INSTITUTION/ORGANIZATION:** Private, non-profit  
**RESOURCES/SERVICES:** Establishment and enforcement of standards and guidelines (in Canada) concerning the use of animals in research, testing and teaching. Maintain active, expert committees on all aspects of animal care and use. The Council's program is based on its major publication "Guide to the Care and Use of Experimental Animals," Volume 1, 2nd Edition (1993) and Volume 2 (1984). Within these two documents the subject of environmental enrichment is addressed. CCAC conducts workshops and training courses on various aspects of the care and use of experimental animals, as well as the training of personnel working with these animals. The Council addresses alternative methods and conducts a course on tissue culture. Semi-annually publishes the newsletter, *Resource*.  
**REQUESTOR:** Anyone.  
**COSTS:** Vary according to materials.

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**Institute of Laboratory Animal Resources (ILAR)**  
National Academy of Sciences  
2101 Constitution Avenue, N.W.  
Washington, D.C. (District of Columbia) 20418, USA

**TELEPHONE:** (202) 334-2590  
**FAX:** (202) 334-1687  
**E-MAIL:** twolfle@nas.edu
CONTACT: Tom Wolfle
TYPE OF INSTITUTION/ORGANIZATION: ILAR is a unit of the National Research Council's (NRC) Commission on Life Sciences (CLS). The NRC is the working arm of the National Academy of Sciences (NAS), a private, non-governmental, non-profit organization.

RESOURCES/SERVICES: Information on a wide variety of topics related to laboratory animals and emerging adjuncts and alternatives to animal use. Assignments of genetic identification for unique colonies. Guidelines that assist in the implementation of national policies or laws. Information to teachers and students about animals in science and careers in biology. ILAR's information database, which is published as *Animals for Research: A Directory of Sources*. This assists scientists in locating specific animals and models, including nonhuman primates. Produce *ILAR NEWS* - a quarterly journal, available free-of-charge to institutional animal care and use committees, scientists, and veterinarians. Reports specific to nonhuman primates such as *Laboratory Animal Management: Nonhuman Primates*. A study on the well-being of nonhuman primates is currently underway by an ILAR committee. Manage *Animal Models and Genetic Stocks Information Exchange Program*.

REQUESTOR: Anyone.
COSTS: Vary according to materials.

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**National Library of Medicine (NLM)**
8600 Rockville Pike
Bethesda, Maryland 20894, USA

TELEPHONE: (301) 496-6095 or 1-800-272-4787
FAX: (301) 402-1384
E-MAIL: ref@nlm.nih.gov
WORLD WIDE WEB: http://www.nlm.nih.gov/

TYPE OF INSTITUTION/ORGANIZATION: Public
RESOURCES/SERVICES: Library - extensive collection of serials, monographs, audiovisuals can be accessed by anyone. Computer based systems of information retrieval include MEDLARS, MEDLINE, CANCERLIT, AVLINE, TOXLINE, and Grateful Med.
REQUESTOR: Anyone.
COSTS: $7.00 for each filled interlibrary loan.

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**Scientists Center for Animal Welfare (SCAW)**
Golden Triangle Building One
7833 Walker Drive, Suite 340
Greenbelt, Maryland 20770, USA

TELEPHONE: (301) 345-3500
FAX: (301) 345-3503
CONTACT: Lee Krulisch, Executive Director
TYPE OF INSTITUTION/ORGANIZATION: Private, non-profit
RESOURCES/SERVICES: Publications, including conference proceedings, training manuals, and materials from other organizations. Publications - *Canine Research Environment* and *Well-Being of Nonhuman Primates in Research*. Each contains proceedings from conferences sponsored by SCAW.
REQUESTOR: Anyone.
COSTS: Some services are free, others are fee-for-services basis.

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**The Shape of Enrichment, Inc.**
1650 Minden Dr.
San Diego, CA 92111-7124, USA
E-MAIL: shape@enrichment.org
WORLD WIDE WEB: http://www.enrichment.org/
**European, Asian, and Australian Resources:**

Australian and New Zealand Council for the Care of Animals in Research and Teaching, Limited (ANZCCART)

P.O. Box 19  
Glen Osmond SA 5064  
AUSTRALIA

P.O. Box 598  
5064 Wellington  
NEW ZEALAND

**TELEPHONE:** 61-08-303-7393 (Australia) 64-04-472-7421 (New Zealand)  
**FAX:** 61-08-303-7113 (Australia) 64-04-473-1841 (New Zealand)  
**E-MAIL:** anzccart@waite.adelaide.edu.au  
**WORLD WIDE WEB:** http://www.adelaide.edu.au/ANZCCART/

**CONTACT:** R.M. Baker

**TYPE OF INSTITUTION/ORGANIZATION:** private, non-profit

**RESOURCES/SERVICES:** Quarterly newsletter, and other publications on euthanasia, animal care and use committees, wellbeing of research animals, alternatives for undergraduate education, laboratory animal surveys, tumour cell lines available in Australia, humane care and use of animals in research, and animal pain.

**REQUESTOR:** Anyone.

**COSTS:** Vary according to materials.

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**British Laboratory Animals Veterinary Association**

Honorary Secretary  
C/O Site Services Department  
Zeneca Pharmaceuticals  
Mereside, Alderly Park  
Macclesfield, Cheshire SK10 4TG, UK

**TELEPHONE:** 01625 513536  
**FAX:** 01625 583074

**CONTACT:** D. Whitaker, Honorary Secretary

**TYPE OF INSTITUTION/ORGANIZATION:** Professional

**RESOURCES/SERVICES:** Slide programs on lab animal diseases, training materials, speakers notes and slides (eg., surgery and anaesthesia), and access to expert advice.

**REQUESTOR:** Veterinary surgeons with interests in laboratory animal health and welfare.

**COSTS:** None.

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**Federation of European Laboratory Animal Science Associations (FELASA)**

BCM Box 2989  
London WC1N 3XX, UK

**CONTACT:** P. Hardy, Secretary

**TYPE OF INSTITUTION/ORGANIZATION:** Professional

**RESOURCES/SERVICES:** Co-sponsor of Laboratory Animals: The International Journal of Laboratory Animal Science and Welfare. Sponsors annual animal welfare symposiums.
REQUESTOR: Laboratory animal users.
COSTS: Vary according to materials.
Laboratory Animal Science Assoc. (LASA)
P.O. Box 3993
Tamworth, Staffs B78 3QU, UK

TELEPHONE: 01827 260036
FAX: 01827 260036
CONTACT: B.R. Howard, Honorary Secretary
RESOURCES/SERVICES: Co-sponsor of *Laboratory Animals: The International Journal of Laboratory Animal Science and Welfare.*

Nederlandse Vereniging voor Proefdierkunde (NVP)
Dutch Association for Laboratory Animal Science
C/O Agricultural University Wageningen
CKP, P.O. Box 8129, 6700 EV
Wageningen, THE NETHERLANDS

CONTACT: F.A.R. van den Brock, Secretary
TYPE OF ORGANIZATION: Professional
RESOURCES/SERVICES: Co-sponsor of *Laboratory Animals: The International Journal of Laboratory Animal Science and Welfare.*

Scandinavian Federation for Laboratory Animal Science
Enheden för försöksdjursvetenskap och service
Medicinska Forskningsrådet
Box 7151
S-103 88 Stockholm, SWEDEN

TELEPHONE: +46 8454 4281/77
FAX: +46 8454 4303
CONTACT: Barbro Salomonsson
TYPE OF INSTITUTION/ORGANIZATION: Professional
RESOURCES: Publishes the quarterly journal *Scandinavian Journal of Laboratory Animal Science.* Conducts annual meetings and publishes conference papers and abstracts in its journal.
COSTS: Journal subscriptions are Dkr. 250/individual; library subscriptions are Dkr. 600 + postage.

Schweizerische Gesellschaft für Versuchstierkunde (SGV)
Société Suisse pour la Science des Animaux de Laboratoire
Swiss Laboratory Animal Science Association
c/o RCC Registration and Consulting Co.
Landstrasse 33
4452 Itingen, SWITZERLAND

CONTACT: Ludwig G. Ullmann, Secretary or Dr. Marianne Geiser Kamber, President (e-mail: geiser@ana.unibe.ch)

Resources/Services: Co-sponsor of *Laboratory Animals*, an international journal devoted to issues surrounding the care and use of laboratory animals. Sponsors seminars and conferences and publishes the resulting papers and abstracts.

Requestor: Laboratory animal users.

Costs: Vary according to material.

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**Universities Federation for Animal Welfare**

8 Hamilton Close  
South Mimms, Potters Bar,  
Hertfordshire, EN6 3QD, UK

**Telephone:** 01707-658202  
**Fax:** 01707-649279  
**E-mail:** trevor.poole@ucl.ac.uk

**Contact:** Victoria Taylor, Development Officer

**Type of Institution/organization:** Private, charitable

**Resources/services:** Publications, reprints, videos, educational brochures, and advisory services. Publishes a quarterly scientific journal entitled *Animal Welfare*, which brings together information from zoos, laboratories, farms, wild, and companion animals.

**Requestor:** Anyone.

**Costs:** Vary according to materials. Annual subscriptions to the journal *Animal Welfare* cost £50/US$100.

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[ Common Devices and Programs ] [ Main Subject Index ] [ Document Delivery Information ]

**The Animal Welfare Information Center**
U.S. Department of Agriculture  
Agricultural Research Service  
National Agricultural Library  
10301 Baltimore Ave.  
Beltsville, MD 20705-2351

Phone: (301) 504-6212  
Fax: (301) 504-7125  
E-mail: awic@nal.usda.gov

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**USDA**  
[ Image ]

*August 11, 1998*

To make it even easier for you to develop enrichment programs, we have put together a lengthy, but by no means exhaustive, listing of commercial vendors and the enrichment products they supply. This listing includes items as diverse as plastic tubes or tunnels for rodents to electric netting for free range chickens. All contact information is current as of September 1, 1995. Please note that "800" telephone numbers for U.S. companies may not be reached by all countries.

The following links access AWIC and other chapters in this publication:

Agri-Engineering, Inc. 2600 College Avenue, Goshen, IN (Indiana) 46526, USA. Tel: (219) 533-0497 or (800) 447-2751 (USA only).
Manufacturer of Plastic Piggy Playballs.

Ancare Corp. 2647 Grand Ave., P.O. Box 814, Bellmore, NY (New York) 11710-0814, USA. Tel: (800) 645-6379, Fax: (516) 781-4937.
Supplier of Nestlets, a rodent nesting material.

B & K Universal Ltd. The Field Station, Grimston Aldborough Hull, North Humberside HU11 4QE, UK. Tel: 01964 527555, Fax: 01964 527006.
Product line includes:
- disposable cardboard tubes for smaller mammals
- wooden chew blocks for rabbits and guinea pigs
- Beekay Litterite bedding
- different shaped food treats for primates

Big Dutchman International GmbH. P.O. Box 1163, D-49360 Vechta, GERMANY. Tel: +49 4447 8010, Fax: +49 4447 801237.
Manufacturer of Gather-all Breeder Nest System that is designed to safely handle eggs from the bird to the collection belt while providing comfort to the hen.

Bio-Serv. P.O. Box 450, Frenchtown, NJ (New Jersey) 08825, USA. Tel: (800) 473-2155, Fax: (800) 473-2167.
Manufacturer or distributor of a variety of environmental enrichment products for dogs, swine, rabbits, and primates.
Product line includes:
- Dogs
  - Pen Pals which are treats developed to enhance socialization programs
  - Certified Rawhide Bone is designed for toxicology labs performing strict diet studies. The bone is assayed and chemically screened to ensure it is 100 percent rawhide. The bone helps control tartar and serves as an enrichment tool.
  - distributor for Kong toys for dogs
- **Swine**
  - Oinkers which are treats developed to reduce stress associated with handling and other procedures
  - P.R.A.N.G. which is an oral rehydrator useful in post-operative care
  - distributor of Kong toys for swine

- **Rabbits**
  - Rabbit Stix which are treats containing papain to help prevent hairballs
  - distributor of Kong toys for rabbits

**Booda Products, Inc.** 26707 Agoura Road, Suite 110, Calabasas, CA (California) 91302, USA. Tel: (818) 878-3900, Fax: (818) 878-3909.
Makers of a variety of toys for dogs, cats, and birds. Product line includes:

- **Dogs**
  - rope tugs with different attached objects for chewing and pulling provide for dental health
  - Booda Velvets which are chew toys made from corn-derived products

- **Cats**
  - rope toys
  - scratching posts and mats
  - cat furniture
  - litter boxes

- **Birds**
  - perches for all cage sizes

**Boomer Ball.** 24171 West Route 120, Grayslake, IL (Illinois) 60030, USA. Tel: (703) 546-6125 or (800) 858-9529.
Makers of non-toxic, heavy-duty, polyethylene plastic balls, mazes, ice floes and other devices. For use with small mammals to large carnivores and apes.
Product line includes:

- Boomer Ball--intended for soccer-style play, to encourage healthful exercise as an alternative to destructive chewing, pacing, and other undesirable behaviors. The ball has a rigid sidewall which is resistant, but not impervious, to chewing and scratching. The roughened surface on a used ball may be smoothed with a carpenter's rasp, file, or rough sandpaper. The ball is hollow, and the 10 inch and 20 inch diameter balls have a screw-out plug which allows insertion of pebbles, bells, etc. to produce an enticing noise, or sand or water to add weight.

- Ferret and Small Animal Ball--a 10” diameter ball for use in cages for chinchillas, guinea pigs, ferrets, and hedgehogs. The ball provides a maze-like play area with plenty of ventilation if the animal chooses to sleep inside the ball.

- Ferret Hide "N" Seek Maze Logs--a 16” long, 4 ½ diameter log-shaped tube with 4” openings at each end and two 4” openings on the side. The units can be snapped together to form unlimited maze configurations for small animals, such as ferrets, chinchillas, and guinea pigs and other small rodents.

- Bobbins--a round, hollow, spool-shaped, heavy polyethylene play/exercise toy for larger breeds of dogs and exotic animals.

**Braden Industries.** P.O. Box 2010, Sulphur Springs, TX (Texas) 75483, USA. Tel: (903) 439-3233 or (800) 272-3361 (US only), Fax: (903) 439-1814.
Manufacturer of the Braden Start Dry Feed Bottle that allows calves to be weaned to dry feed by suckling a rubber nipple and receiving pelleted feed rather than liquid.

**Britz-Heidbrink, Inc.** P.O. Box 1179, Wheatland, WY (Wyoming) 82201-1179, USA. Tel: (307) 322-4040, Fax: (307) 322-4141.
Produces animal housing systems that include "enrichment panels" that use color, noise reduction, thermal neutral surfaces, and opportunities for animal exploration.

**Eisers.** 360 Kiwanis Boulevard, Hazelton, PA (Pennsylvania) 18201, USA. Tel: (800) 526-6987 (USA only) or (717) 450-6130, Fax: (800) 680-3926 (USA only) or (717) 455-1593. Manufacturer and distributor of the Giant Stallmate Apple, a scented toy for horses and pigs, and the Equi-Ball, a toy for horses.

**Ethical, Inc.** 216 First Street, Newark, NJ (New Jersey) 07107, USA. Tel: (201) 484-1000. Manufacturer of solid vinyl chew toys for dogs and Squish balls for cats.

**Jansen Engineering and Construction Company.** Mercuriusweg 25, 3771 NC Barneveld, THE NETHERLANDS. Tel: +31 3420 21020, Fax: +31 03420 21019. Manufacturer of Jansen automatic roll-away nests for hens. The shape, color, and floor material of the nest have been chosen according to the latest research in bird behavior.

**K.L.A.S.S.** 4960 Almaden Expressway, Suite 233, San Jose, CA (California) 95118, USA. Tel: (408) 266-1235. Distributor of environmental enrichment products including Kong Toys, Boomer Balls, Nylabone, mouse nesting box, and a variety of easily sanitized play objects for birds, cats, dogs, ferrets, pigs, and primates. Product line includes:

- **Birds** (all items made of acrylic)
  - rattles, swings, log 'n' chain, playring, hoops, chains, playhouse, mirrors, ladders and other toys

- **Cats**
  - Bizzy Kitty Home Entertainment Center
  - Sokker ball made of plastic
  - mini-Sox
  - Sparkel ball

- **Dogs, Pigs, and Primates**
  - Kong Toys in all varieties and shapes
  - Nylabone products such as plaque attacker dental ball, all sizes of nylabones, gumabones, nylarings, tug toys, rubber knots, and gumaballs.

- **Ferrets**
  - Ferret Ball

**Landmeco A/S.** DK-6870 Ølgod, DENMARK. Tel: +45 75 24 55 11, Fax: +45 75 24 43 53. Manufacturer of the Landmeco Nest. Each roll-away nest contains six nest pads that provide the hens with a warm and comfortable laying area.

**Wm. Lillico & Son (Wonham Mill) Ltd.** Wonham Mill, Betchworth, Surrey, RH3 7AD, UK. Tel: 01737 247666, Fax: 01737 246783. Produces a variety of forage mixes and is a distributor of Boomer Balls and the Scanbur A/S rabbit cage. Other products include:

- honey and sunflower rolls for rabbits
- paper wool for nesting, fine paper shavings for bedding or nesting, and Enviro-Dri which is a comfortable bedding designed specifically for large animals, canines, and primates.

**P.J. Murphy Forest Products Corp.** P.O. Box 300, 150 River Rd., Montville, NJ (New Jersey) 07045, USA. Tel: (201) 316-0800, Fax: (201) 316-9455. Produces "Sani-Chips" animal bedding. Hardwood and softwood products are available.

**Nylabone Products.** Third Avenue and Union St, Neptune, NJ (New Jersey) 07753, USA. Tel: (908) 988-8400.
Manufacturer of Nylabone, Nylaballs, Gumabone Plaque Attacker, Gumabone tugs, and Gumadisc Flying Disc chew toys for dogs and other animals.

**David Nunn Ltd.** Station Yard, Hadnall, Shrewsbury, Shropshire SY4 3DD, UK. Tel: 0939 210555, Mobile: 0836 224691.

Distributors of Sundown Livestock Bedding and Environmental Straw Products. Poultry bedding is available in 25 kg poly-wrapped bales of de-dusted, sterilized straw.

**R.J. Patchett, Ltd.** Queensbury, Bradford, Yorkshire BD13 1DS, UK. Tel: 0274 882331, Fax: 0274 816362.

Manufacturer of laying cages with perch frames designed to meet EC welfare requirements. Also make nest boxes.

**Primate Products.** 1755 East Bayshore Rd., Suite 28A, Redwood City, CA (California) 94063, USA. Tel: (415) 368-0663, Fax: (415) 368-0665.

Produces "Kong Toys" which are autoclavable hollow toys that are durable enough to withstand rough handling and biting. They can also be filled with treats. Recommended for primates, canines, pigs, and rodents.

**Rappa Fencing Ltd.** Steepleton Hill, Stockbridge, Hampshire SO20 6JE, UK. Tel: 01264 810665, Fax: 01264 810079.

Manufacturer of eight-line electric fence system designed specifically for free range poultry.

**Renco.** Unit K1A, Bath Road Trading Estate, Stroud, Glos, England GL5 3QF, UK. Tel: 01453 752154, Fax: 01453 752155.

Manufacturer of electric netting for free range poultry. Offers protection from predators and provides bird control.

**Scanbur A/S.** Gl. Lellingegård, Bakkeleddet 9, Lellinge, DK-4600 Køge, DENMARK. Tel: +45 56 82 02 21 or 020 79 52 44 (Sweden only), Fax: +45 56 82 14 05.

Manufacturer of environmentally enriched caging systems for rabbits. Allows for single, pair, or group housing of rabbits. This cage system increases the possibility of exercise and physical activity. Rabbits can obtain social contact with fellow rabbits, and they can retire and hide whenever they want to. Each cage contains a resting shelf and shelter. Scandinavian distributor for Special Diet Services.

**Shepherd Specialty Papers.** P.O. Box 804, Kalamazoo, MI (Michigan) 49005, USA. Tel: (616) 324-3017 or (800) 382-5001(USA only) , Fax: (616) 324-3026 or (800) 222-5170 (USA only) .

Manufacturer of ALPHA-dri (alpha cellulose) which is a loose animal bedding of precisely defined composition. Also produce Enviro-Dri which is a bedding developed for pen-housed primates, large animals, and canines. Enviro-Dri is also recommended for the nesting of all animals.

**Société Parisiennes des Sciures.** 33, rue de Gode, 95100 Argenteuil, FRANCE. Tel: 39 80 15 09, Fax: 39 80 66 64, Telex: 688214 F.

Distributor of Litalabo bedding for laboratory animals.

**Special Diet Services.** P.O. Box 705, Witham, Essex, CM8 3AD, UK. Tel: 01376 511260, Fax: 01376 511247.

Manufacturers of diets in mixed shapes and sizes.

**Tapvei.** 73600 Kaavi, FINLAND. Tel: +358 71 688 88 99, Fax: +358 71 663 234.

Manufacturer of Tapvei bedding, bedding dispensers and waste removal systems, items for cage enrichment and Aspen bricks for dogs, rabbits, and rodents.

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August 11, 1998
This page's URL is http://www.nal.usda.gov/awic/pubs/enrich/supplier.htm
In an effort to show the wide variety of items or strategies commonly employed in enrichment programs, we searched through articles for toys, devices, feed items, socialization programs, etc. and listed them according to the species or class of animal for which they are used.

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[ Common Devices and Programs ] [ Main Subject Index ] [ Document Delivery Information ]

**Birds**

Balls (leather, rubber, plastic or tennis)
Cage space to allow wing flapping
Cocoa husks
Colored objects
Dustbaths
Foraging litter or substrate
Grain blocks
Litter
Mirrors
Music
Nest building material
Nest boxes
Operant feeders (singly housed birds)
Pecking targets
Perches
Pre-formed nests
Roll-away nest box
Roosting shelves
Shredded paper
Social groups
Straw substrate
Wood shavings

Cats

Balls
Bedding materials
Bells
Catnip toys
Climbing frames
Colony housing
Sheepskin mice
Perches
Climbing poles
Human interaction
Movable toys
Music
Puzzle boxes
Elevated resting spaces
Ropes
Scratching posts
Shelves
Social housing
Stuffed toys
Vertical space
Viewing panels

Dogs

Balls
Bedding
Bones
Chew toys
Exercise
Gumabone chews
Human interaction
Knotted cloth
Novel objects
Nylabone frisbees
Nylabones
Plastic decoys
Rawhide
Resting boards
Ropes
Socialization
Tug toys
Walks

Farm Animals

Cattle
Bedding
Fitting barriers
Human-Animal Interaction
Manipulable objects
Novel objects
Operant Food Devices
Social Housing

**Horses**

Foraging material
Grazing areas
Hanging Balls
Human-animal interaction
Novel objects
Social housing
Substrates (straw, wood shavings, etc.)

**Sheep and Goats**

Social or natural grouping
Bedding or substrate (straw)
Mirrors
Climbing structures (rocks or wood structures)

**Swine**

Balls
Bedding (straw, wood chips)
Chains
Edinburgh Foodball
Forage material (hay)
Free-range
Group housing
Heated floor mats
Hoses
Human-animal interaction
Knotted cloth
Manipulatable devices
Music
Novel objects
Plastic jugs
Pre-formed nests
Ropes
Scented plastic apples
Substrates (straw, wood chips, sand, etc)
Tires
Turn-around farrowing crate

**Ferrets**

Balls
Bite cups
Cricket
Foraging devices
Fur covered movable toys
Hide-and-seek tunnels
Mazes
Moving prey-models
Music
Nest boxes
Plastic burrows
PVC tubes
Shelters
Swimming pans

Rabbits

Balls
Bedding (straw, wood chips)
Burrows
Free range
Fresh fruits or vegetables
Gnawing objects
Group housing
Hide-boxes
Manipulatable objects (wood)
Music
Nest boxes
Nesting material
Pair housing (except adult males)
PVC pipe
Resting shelf
Roughage or Forage (hay, straw)
Varied diet

Rodents

Bedding
Burrows
Cage dividers
Climbing accessories
Climbing frame
Exercise devices (running wheels)
Film canisters
Foraging devices
Funnel
Gnaw blocks or sticks
Group or social housing (not hamsters or adult males)
Hide boxes
Ladders
Mazes
Music
Nest boxes or nest-building material - (hay, tissues, or wood-wool)
Platforms
PVC pipe
Ramps
Shelves
Shuttle box
Tubes
Tunnels

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The Animal Welfare Information Center
U.S. Department of Agriculture
Agricultural Research Service
National Agricultural Library
10301 Baltimore Ave.
Beltsville, MD 20705-2351

Phone: (301) 504-6212
FAX: (301) 504-7125
E-mail: awic@nal.usda.gov

Policies and Links

August 11, 1998
This page's URL is http://www.nal.usda.gov/awic/pubs/enrich/devices.htm
Environmental Enrichment Information Resources for Laboratory Animals: Subject Index

Note:
The index for the publication was generated primarily from the descriptors that accompany each entry. In some instances, index words may have been taken from the title. Because people are more likely to be interested in a particular animal, indexes were generated for each species or class covered. The number associated with each index term corresponds to the *printed page number* on which the index term can be found. Although the page numbers referenced in this index refer to the original printed publication, the subject terms may be helpful when searching text in the electronic version. Each subhead also is linked to the chapter and bibliography related to that topic.

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**Birds**

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  by Christine Nicol, Bristol University, pages 1-4
- *Bird Bibliography*, pages 5-26

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