Division of Animal Housing and Welfare
(Prof. Dr. A. Steiger)
Department Clinical Research and Veterinary Puplic Health
Vetsuisse Faculty of University of Bern

Arbeit unter der Leitung von Prof. Dr. A. Steiger und Dr. S. Gebhardt-Henrich

The influence of size and structure of shelters on the behaviour of female golden hamsters (*Mesocricetus auratus*)

Inaugural-Dissertation

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Esther Gerber
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INHALTSVERZEICHNIS

1 ZUSAMMENFASSUNG

Goldhamster (*Mesocricetus auratus*) sind einerseits beliebte Heimtiere und werden andererseits auch in Laboratorien für die Forschung eingesetzt. Trotzdem sind diverse Bedürfnisse der kleinen Nager unbekannt und viele Fragen zur richtigen Haltung offen.

Wildlebende Hamster wurden im nördlichen Syrien gefunden. Dort leben sie einzeln in einem Tunnelsystem mit einer durchschnittlichen Gesamtlänge von 200 cm in der Erde. Vom Eingang führt ein Tunnel vertikal in eine Schlafkammer, von welcher mindestens zwei Tunnels abzweigen. Der eine wird zum Urinieren benutzt, einer oder mehrere andere zur Futterablagerung (Gattermann *et al* 2001). Goldhamster graben auch in Gefangenschaft, wenn sie die Möglichkeit dazu haben (Kuhnen 2002, Hauzenberger *et al* 2006) und entwickeln in tiefer Einstreu (80 cm) mit ausgeprägter Grabmöglichkeit kein stereotypes Gitternagen (Hauzenberger *et al* 2006).

Haltungsbedingungen beeinflussen das physiologische und psychologische Wohlbefinden von Nagern (siehe Reviews von Russel 2002, Sørensen *et al* 2005, Balcombe 2006 und Referenzen darin). So ist zum Beispiel bekannt, dass das Fehlen von Unterschlupf und Nestmaterial zu aggressivem Verhalten bei Goldhamstern führen kann (Lochbrunner 1956; McClure & Thomson 1992). Der Schweizer Tierschutz empfiehlt Unterschlüpfe aus Holz oder Korkrinde, gibt aber keine genaueren Beschreibungen zu Grösse und Struktur an (Lerch-Leemann 1997).

Ziel dieser Arbeit war die Erfassung des Verhaltens von Goldhamstern, die in Käfigen mit verschiedenen Unterschlupftypen gehalten wurden. Insbesondere interessierte uns, ob sich die Stellen, wo die Tiere schlafen, urinieren und Futterreservoirs anlegen, in den verschiedenen Unterschlupftypen unterscheiden. Ausserdem verglichen wir den Tunnelbau.

Dreissig Goldhamsterweibchen wurden nach dem Absetzen im Alter von etwa vier Wochen in drei Gruppen zu je zehn Tieren eingeteilt und einzeln in einen

Käfig (95 x 45 x 57 cm, Plastikunterteil mit Gitteroberteil) gesetzt. Die erste Gruppe erhielt ein kleines Holzhäuschen (20 x 14 x 14 cm), die zweite ein grosses, nicht unterteiltes (20 x 28 x 14 cm) und die dritte ein grosses und in der Mitte unterteiltes (20 x 28 x 14 cm) als Unterschlupf. Abgesehen davon wurde allen Tieren die gleiche Einrichtung zur Verfügung gestellt: Zwei Kartonrollen, ein Ast, Sandbad, Futterschale, Trinkflasche und ein Papiertuch als Nestmaterial. Die Einstreu bestand aus Hobelspänen und Heu (12 cm tief). Einmal pro Woche wurden der Käfig und der Unterschlupf während der Schlafperiode der Hamster untersucht und unter anderem der Schlafbereich, die Urinecken, Futterdepots und allfällige Tunnels aufgezeichnet. Danach wurden schmutzige Einstreu durch saubere ersetzt, Futterreservoirs entfernt und Tunnelsysteme zerstört. Diese Prozedur wurde insgesamt fünf Mal durchgeführt.

Alle Hamster schliefen ausnahmslos im Unterschlupf, bevorzugt in den Ecken, welche am weitesten entfernt vom Eingangsloch lagen und somit wenig belichtet waren. Dementsprechend wurde auch nie ein Hamster mit einem grossen, unterteilten Unterschlupf im vorderen Raum schlafend gefunden. Favorisieren von dunklen Unterschlüpfen wurde auch in anderen Studien mit Nagern beschrieben (Warden & Sachs 1974, Pratt & Goldman 1986, Van Den Broeck *et al* 1995, Würbel *et al* 1998, Waiblinger & König 2004).

Futterreservoirs wurden in 96.7% der Fälle gefunden, mit einer Ausnahme immer in mindestens einem Bereich innerhalb des Unterschlupfs. Meistens verteilten die Hamster die Nahrung in mehrere Unterschlupfecken, selten zusätzlich an einen Ort ausserhalb. Ebenfalls wurde Harn meistens innerhalb des Unterschlupfes abgesetzt, zum Teil aber gleichzeitig auch ausserhalb. Dabei urinierten Hamster mit kleinem Unterschlupf signifikant am häufigsten zusätzlich oder ausschliesslich ausserhalb des Unterschlupfs. Meist platzierten sie den Harn am Ende eines Tunnels, welcher im Unterschlupf begann.

Gelegentlich schliefen die Hamster in Ecken, wo sie auch urinierten, wobei in der Häufigkeit keine bedeutenden Unterschiede zwischen den drei Gruppen auszumachen waren. Dagegen fanden wir in der Gruppe mit grossem,

unterteiltem Unterschlupf signifikant häufiger Futter und Urin zusammen als in den beiden anderen Gruppen. Tiere, denen zwei Räume zur Verfügung standen, nutzten diese somit nicht, um ihren Schlafplatz, Urin und Futter klar zu trennen. Dies könnte damit zusammenhängen, dass sie die ersten Lebenswochen in einem nicht unterteilten Unterschlupf verbracht hatten, oder vielleicht weil der vordere Raum zu wenig dunkel war, um als Teil des Baus akzeptiert zu werden.

Kot wurde überall im Unterschlupf abgelegt und zusätzlich an verschiedenen Orten ausserhalb.

Die meisten Tunnels begannen innerhalb des Unterschlupfes und endeten blind. Regelmässig befanden sich Urin und/oder Futter am Ende der Tunnels. Bei der Hälfte der Tiere war nie ein Tunnel erkennbar und nur fünf Tiere gruben öfters beständige Tunnels. Wie bereits in anderen Studien mit Nagern illustriert (Wiedenmayer 1997a, Waiblinger & König 2004), konnten wir auch bei Goldhamstern einen Zusammenhang zwischen dem Unterschlupf und dem Grabverhalten erkennen. So bauten Hamster mit grossen und unterteilten Unterschlüpfen signifikant weniger und kürzere Tunnels als jene mit grossen, nicht unterteilten. Offenbar motiviert nicht die Aktivität an sich zum Graben, sondern das Ergebnis, das heisst eine gute Rückzugsmöglichkeit.

Folgende Empfehlungen lassen sich aus dieser Arbeit ableiten: Goldhamstern sollte immer ein Unterschlupf zur Verfügung gestellt werden. Dieser sollte eine dunkle und gut versteckte Rückzugsmöglichkeit bieten. Ein unterteilter Unterschlupf scheint zudem das Bedürfnis zum Graben zu reduzieren und ist deshalb empfehlenswert, insbesondere in Haltungsformen mit geringer Einstreutiefe.

2 THE INFLUENCE OF SIZE AND STRUCTURE OF SHELTERS ON THE BEHAVIOUR OF FEMALE GOLDEN HAMSTERS (*MESOCRICETUS AURATUS*)

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The influence of size and structure of shelters on the behaviour of female golden hamsters (*Mesocricetus auratus*)

E. Gerber, S.G. Gebhardt-Henrich, A. Steiger

University of Bern
Vetsuisse Faculty, Division of Animal Housing and Welfare,
Bremgartenstrasse 109a, CH-3012 Bern, Switzerland

Correspondence to: Esther Gerber
Department Clinical Research and Veterinary Public Health
Division of Animal Housing and Welfare
Vetsuisse Faculty, University of Bern
Bremgartenstrasse 109a
CH-3012 Bern, Switzerland

Tel.: +41 (0)31 631 23 66
Fax: +41 (0)31 631 26 40

e-mail: esther.gerber@itz.unibe.ch

2.1 Abstract

Thirty female golden hamsters (*Mesocricetus auratus*) were provided with three different shelter types (small, large undivided and large divided) and were observed for their favoured sleeping place and where they placed food, urine and faeces. In addition, their tunnel building was registered. Once a week, each shelter and cage was examined and cleaned afterwards. This routine was repeated five times. The hamsters slept inside the shelter without exception. Hamsters in all three groups preferred to sleep in areas away from the entrance hole of the shelter and animals with large divided shelters avoided the front compartment. Shelters were also used frequently for food storing and urination. Hamsters in small shelters urinated significantly more often additionally or exclusively outside the shelter than those in large divided shelters. Food and urine at the same place was found most often in large divided shelters. In comparison with the large undivided shelters, the hamsters with large divided shelters built significantly fewer and shorter tunnel systems. This study demonstrates that golden hamsters use the shelter, whatever structure it has, above all for sleeping, but also for urinating and food storing. It seems that the hamsters prefer to sleep in the darkest places. This experiment contradicts the expectation that hamsters, which have a shelter with two compartments, may separate the places for sleeping, urinating and hoarding their food. However, a divided shelter seems to be a comfort for the animals, because they show less need for building tunnel systems.

Keywords: animal welfare, behaviour, enrichment, golden hamster, shelter, tunnel

2.2 Introduction

The natural habitat of golden hamster is a fertile, agricultural and densely populated area in northern Syria, around the city of Aleppo. The hamsters live solitarily in subsoil burrow systems. Burrow depths were found to range from 36 to 106 cm, and their structure was simple, consisting of a single vertical entrance that proceeded to a nesting chamber and at least two tunnels divided from this chamber. One blind-ending tunnel was apparently used for urination. The remaining tunnels ran deeper at varying angels and were partially used for food storage. Faeces were found throughout the entire burrow. The mean length of the entire gallery system measured 200 cm and could extend up to 900 cm. Occupied burrows were plugged with a lump of earth. No general differences between female and male burrows were detected (Gattermann et al., 2001).

Tunnel building is a behaviour also performed in captivity whenever possible (Kuhnen, 2002; Hauzenberger et al., 2006). Furthermore, Hauzenberger et al. (2006) found that hamsters kept in 80 cm deep bedding, and thus having the possibility to build extensive tunnel systems, did not gnaw at the wire stereotypically and used the running wheel less compared with animals kept in 10 cm deep bedding.

It is known that housing conditions affect the physiological and psychological well-being of captive rodents (see reviews by Russell, 2002; Sørensen et al., 2005; Balcombe, 2006 and references therein). The presence of dark shelters in particular proved to be decisive in reducing stereotypies in gerbils (Wiedenmayer, 1997a,b; Waiblinger, 2002; Waiblinger & König, 2004). Without shelters and nesting material golden hamsters can be very aggressive and the aggressive behaviour decreases when shelters and nesting material are provided (Lochbrunner, 1956; McClure & Thomson, 1992). The Swiss Animal Protection recommends a shelter for hamsters, but does not specify how it should look like (Lerch-Leemann & Griffin, 1997).

Hamsters are common laboratory animals in biochemical research as well as popular pet animals. Nevertheless, little work has been done with the specific

intent of improving their housing conditions and we are not aware of any study investigating the size or structure of the shelter and the usage by captive rodents. Shelters may differ profoundly from natural burrows, especially under laboratory conditions. The separation of urine and sleeping position might be important to avoid the irritating ammonia gas (Kuhnen, 1986).

In order to learn more about their shelter preferences, we investigated the behaviour of female golden hamsters provided with shelters of two different sizes and structures. In particular, we wanted to examine whether the animals make use of two compartments to separate sleeping position and places for urination and food storing.

2.3 Methods

2.3.1 Animals and husbandry

All 30 female golden hamsters used in this study were bred at our facility. Two of the animals were progeny of the strain Crl: LVG (SYR) from Charles River, Germany. The remaining 28 hamsters belonged to the strain RjHan: AURA from Centre d'Elevage R. Janvier, France. Hamsters were kept in wire cages with plastic bottoms (95 x 45 x 57 cm including the wire top). Wood shavings (Allspan®, 12 cm deep) mixed with hay were provided as bedding. Commercial hamster food (www.ericschweizer.ch) and water were offered ad libitum. In addition, a small piece of fresh fruits or vegetables was given each day. During the experiment the hamsters were housed in a room with natural daylight from the top of the room. Temperature was unregulated, but well balanced over the different levels of the room and the experimental treatments. It ranged from 19 to 26°C (except once was measured 29°C) dependent on the outdoor temperature and increased steadily during the experiment. Humidity was also unregulated.

The animals were weaned between days 27 and 35 and within a litter randomly assigned to three experimental groups with different shelter types (small, large undivided, large divided), each group consisting of ten animals. The hamsters were placed singly in a cage as described above with a particular type of shelter. Before weaning, all had a shelter of the type 'small'. Three to six weeks (balanced for treatments) to acclimatise were given before the start of the experiment.

The cages were put in a rack with four different levels, whereas the cages of one group were distributed on all different levels. The position of the cages stayed the same over the weeks of examination.

2.3.2 Material

All shelters were bottomless, made of fir wood and had a circular entrance of 5 cm in diameter on one side (Figure 1). They were positioned on the bedding surface. One group got a small shelter (SM: 20 x 14 x 14 cm), the second a

large one (L1: 20 x 28 x 14 cm) and the third a large one, which was divided in the middle (L2: 20 x 28 x 14 cm). The wall, which divided the large shelter into two rooms, had a passage (5 cm in diameter) at the opposite side of the entrance (Figure 1).

Each cage as described above was equipped with two cardboard tubes, a branch, a sand bath and a paper towel as nesting material. Figure 2 shows a clean cage.

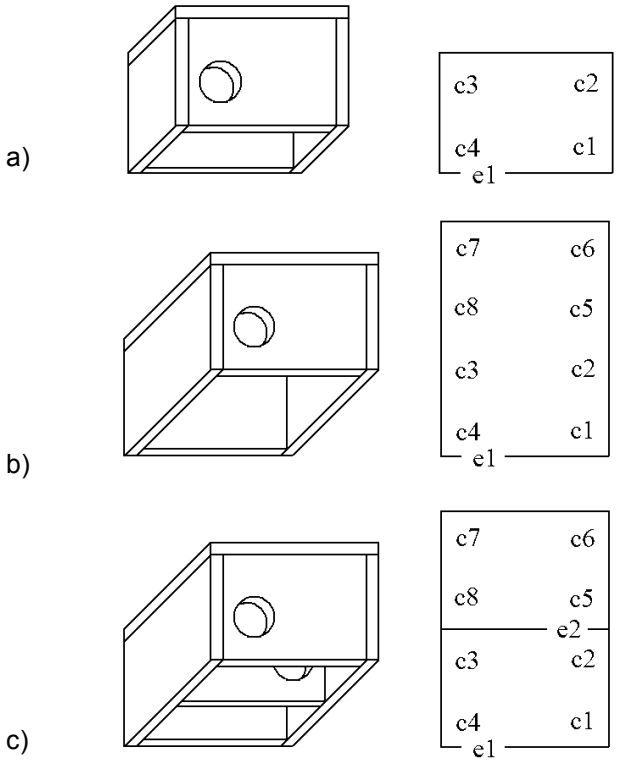


Figure 1 Three different shelter types were provided and the space inside was divided into four or eight areas (c1 – c4 / c8): (a) small, (b) large undivided and (c) large divided. The shelters had one entrance (e1) and the partition in large divided shelters had a hole (e2) opposite of the entrance.

Figure 2 A clean cage with an L2-shelter. The wire top is removed (a branch is missing because it was fixed at the wire top).

2.3.3 Procedure

The cage was examined every week during the sleeping period of the hamsters between the hours 8:00 am and 4:00 pm. For that, cages were removed one after the other from the rack and the wire tops were removed. In each examination, first the shelter was lifted to locate the hamster. After that, the bedding was searched for urine, faeces, food and the paper towel. The shelter was mapped imaginary into four (SM) or eight (L1, L2) areas named c1, c2 etc. (Figure 1). In addition, tunnel systems in the bedding were mapped and divided into four categories: no tunnel (score 0), short (up to 20 cm; score 1), medium long (21 – 40 cm; score 2) and long (41 cm and longer, score 3).

Afterwards, the cage was cleaned by exchanging only the bedding in the shelter and in places where urine, faeces or food were found. The experiment lasted five weeks, therefore five positions per animal were registered.

After the experiments all hamsters were given to private owners. The experiment was approved by the Cantonal Office of Agriculture (No 37/06).

2.3.4 Statistics

In order to obtain one measure for the sleeping position for each animal the most frequent location out of the five recorded locations per item was taken. In case there was no most frequent location this data point was considered missing. The data were analysed using the Kruskal-Wallis-test, except for the analysis of the frequency of the sleeping positions and urine deposition outside the shelter, for which Fisher's exact test was used. Results were considered statistically significant when $P < 0.05$. Analyses and plots were performed using NCSS and SAS.

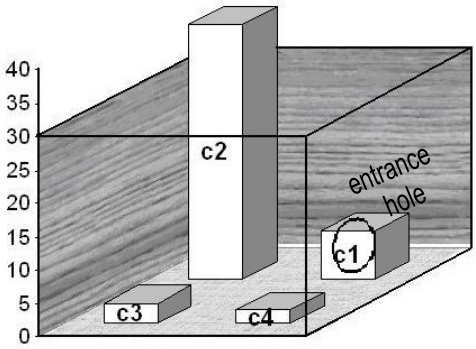
2.4 Results

2.4.1 Sleeping positions

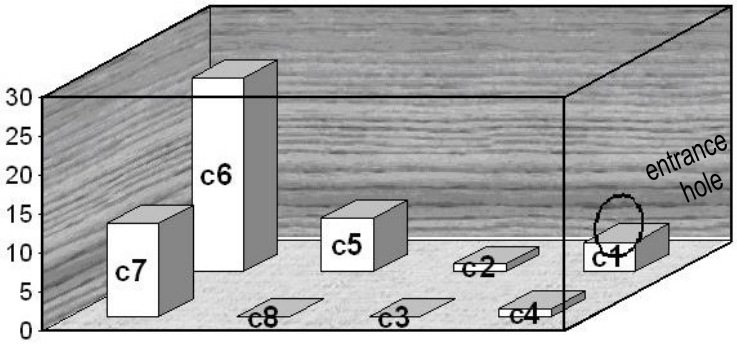
All hamsters slept inside the shelter without exception. Some lay on the surface of the bedding, others were buried a few centimetres. Only four out of 30 animals (13.3%) took the offered paper towel regularly (at least three times in five examinations) into the shelter and used it as nesting material. Seldom, the entrance of the shelter was plugged with bedding.

The sleeping positions are summarized in Figure 3. The hamsters in SM shelters were found by far most often in c2, diagonally to the entrance. The corresponding position (c6) was preferred by the hamsters in L1 shelters. However, the animals in L2 shelters favoured c7. This corner was again situated diagonally to the hole (passage between the two rooms). The places near the entrance (c4) and near the passage in L2 shelters (c5) were usually avoided. Similarly, no hamster was ever found in the front room (c1 – c4) in the L2 group. When positions of the small shelters were recoded as the corresponding areas in the large shelters (c2 => c6, c3 => c7) the positions between the treatments were significantly different (Table 1, $\chi^2_6 = 23.0$, $P < 0.0001$). In detail, the sleeping position of the L2 group was significantly different to that of the SM group ($\chi^2_3 = 20.0$, $P < 0.0001$) and the L1 group ($\chi^2_2 = 11.4$, $P = 0.004$), but there was no significant difference between groups SM and L1.

The selection of a sleeping position was compared with the choice in the following week. Only two hamsters were observed in a different position every week (four times). Both lived in L1 shelters. Animals in the SM group were found in changed sleeping places 1.2 times on average, those with L1 and L2 shelters 2.3 and 2.2 times, respectively (Figure 4). In large shelters (L1 and L2), hamsters were registered in varied position significantly more often than animals in SM shelters ($\chi^2_1 = 4.93$, P: 0.026).



a)



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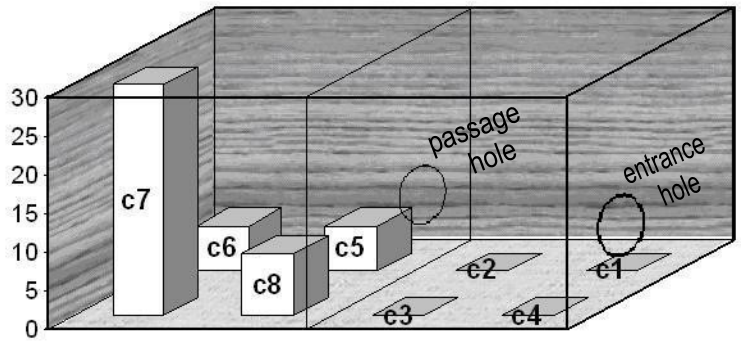


c)

Figure 3 Schematic representation of three shelter types with the entrance on the right side: (a) SM-shelter, (b) L1- and (c) L2-shelter. All sleeping positions recorded at five observations which were at weekly intervals are summarized for each area (c1 – c4 / c8) inside the shelters (n = 10 for each group).

		c1	c5	c6	c7	sum
SM	frequency	1	0	9	0	10
	percentage	10	0	90	0	100
L1	frequency	0	0	6	2	8
	percentage	0	0	75	25	100
L2	frequency	0	1	0	9	10
	percentage	0	10	0	90	100

Table 1 Sleeping positions of golden hamsters with different shelters. The commonest position of each hamster during five weeks was used. The areas of the small shelters were recorded (c2 = c6; c3 = c7) in order to compare all three treatments. Two animals did not have a commonest position and are missing.

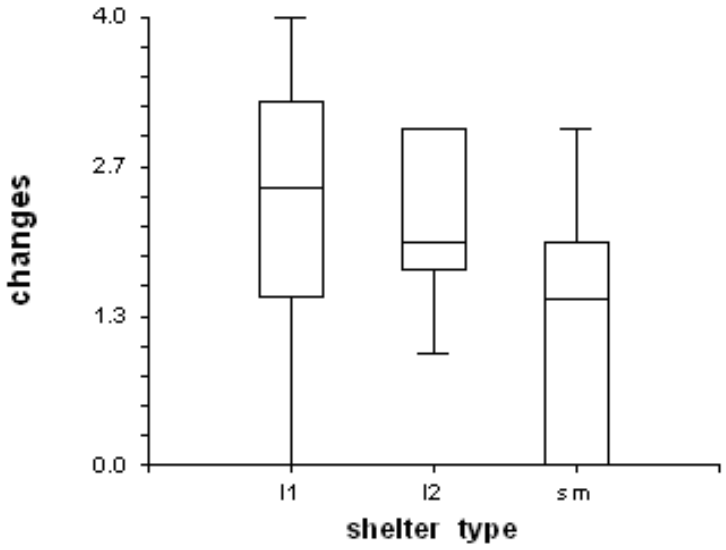


Figure 4 Number of changes of the sleeping position in three different shelter types. The length of the box is the interquartile range (IQR). Thus, the box represents the middle 50% of the data. The horizontal line inside the box is the median. The T-shaped lines show 1.5 times the interquartile range.

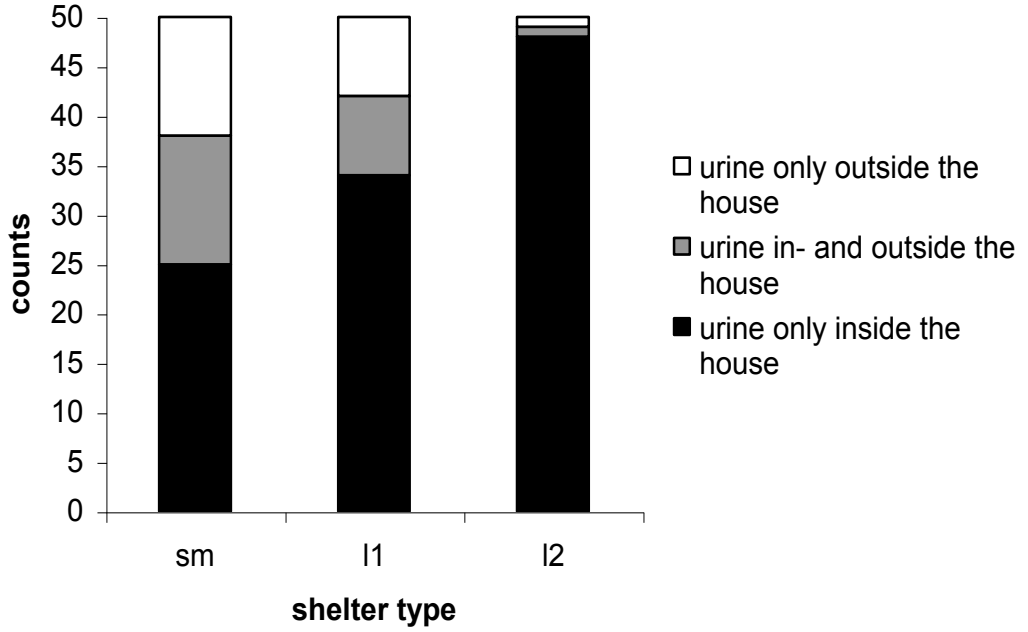
2.4.2 Urine and food

Urine was found for the most part inside the shelters (Figure 5a), often distributed in more than one places (up to seven places; average: 2.4). In some cages, one (usually) to three (rarely) additional places to urinate outside the shelter were identified. Ten hamsters urinated regularly (at least three times in five examinations) outside the shelter, regardless of whether there was urine in the shelter or not. Six of them belonged to the SM group, four to the L1 group and none to the L2 group. These differences were statistically significant (χ^2_2 = 8.4, *P*: 0.01). In only three animals (two of the SM, one of the L1 group) the shelter was registered free of urine in most examinations, that means at least in three of five.

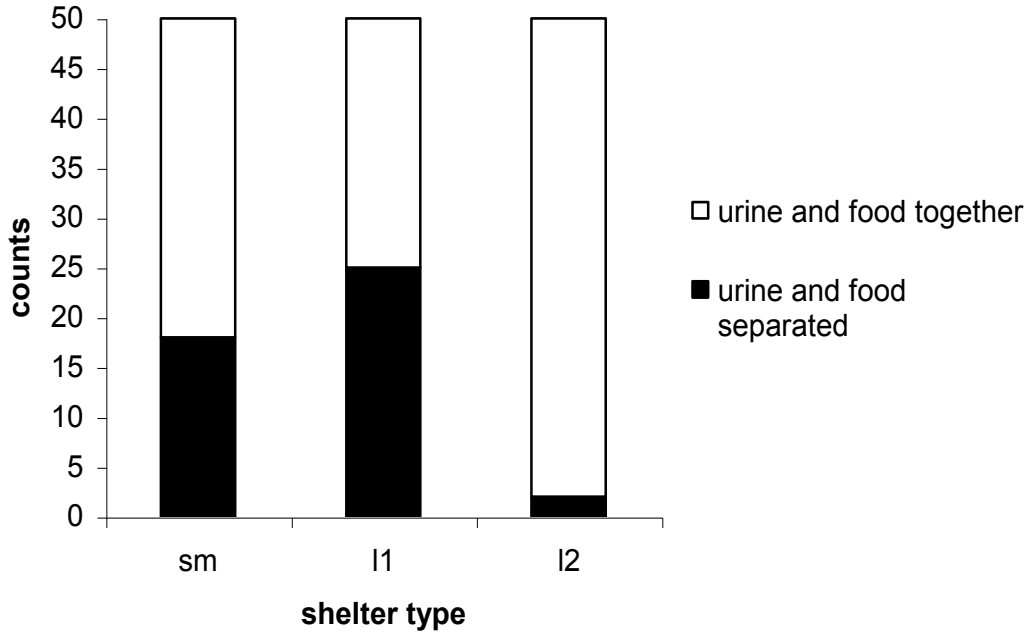
In a total of 150 data records only in five (3.3%) no food storage was found. The food was always put inside the shelter with just one exception. Inside the shelter, hamsters distributed the food in two different corners on average (maximum five). Few animals hoarded food in places outside the shelter at the same time, but no member of the L2 group was registered among them (SM: 12%; L1: 14%; L2: 0%).

Additionally, it was determined, whether the animals urinated in the places, where they slept or stored food. Hamster and urine were found in the same place in 18% (L1 group) to 34% (L2 group) and there was no significant difference among the groups. However, animals with L2 shelters placed urine and food significantly more often in the same spot (96%) than residents of an L1 (50%) and an SM (64%) shelter (X^2_2 = 16.34, *P*: 0.0003, *N* = 30; Figure 5b).

In all groups faeces were found all over the shelter and also at different sites outside the shelter.



(a)



(b)

Figure 5 The location of urine (a) and its relation to food storing (b) found at five observations, each one week after previous cage cleaning for hamsters provided with three different shelter types (n = 10 for each group).

2.4.3 Tunnel building

Each week, tunnels were mapped and destroyed afterwards while the bedding was partially exchanged, thus the hamsters had to rebuild them. Most registered tunnels started in a corner of the shelter (67%) and ended blindly somewhere in the cage. In a little less than half of the burrows (47%) there was urine at the end. Food was placed in one fourth (25%) of the tunnels, sometimes alone (45%) and sometimes together with urine (55%).

In 15 of 30 animals there was never detected any tunnel after cleaning the bedding one week before (Figure 6). Six among them belonged to the SM group, two lived in an L1 and seven in an L2 shelter. In the cages of five animals, tunnels were found regularly (at least three times in five examinations). Two of them were members of the SM, three of the L1 group. Analysis of the mean of the tunnel scores revealed, that it was significantly lower in the L2 group compared with the L1 group ($\chi^2_1 = 4.8$, $P = 0.03$).

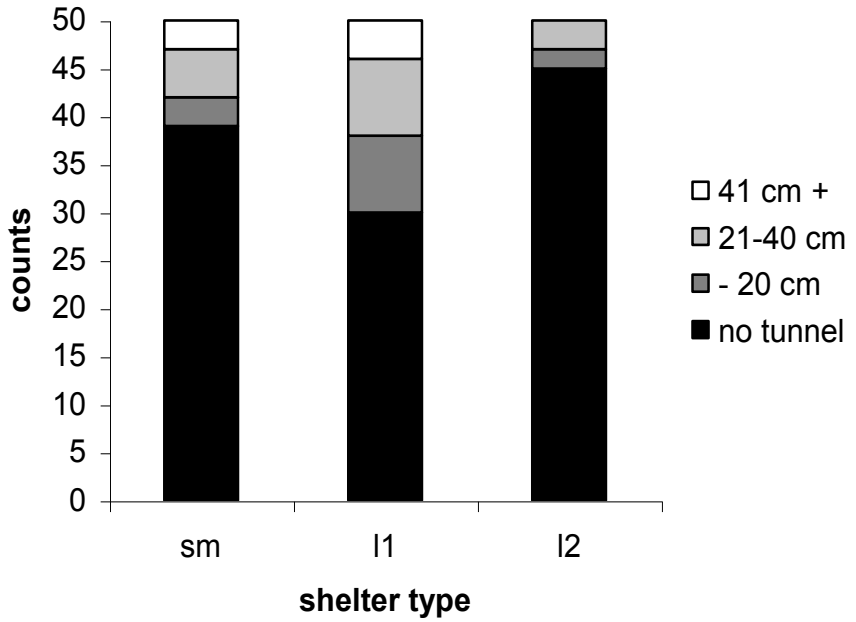


Figure 6 Tunnel building found at five observations, each one week after cage cleaning for hamsters provided with three different shelter types. If a tunnel existed, its length was divided into three groups: 20 cm and shorter, 21 to 40 cm or longer than 40 cm (n = 10 for each group).

2.5 Discussion

Hamsters used the shelter without exception. In the wild, living in burrows offers a relatively stable ambient temperature and humidity to the inhabitants and protects against predation (Kuhnen, 1986). Obviously, the need to retreat persists under laboratory conditions. Hauzenberger et al. (2006) found that golden hamsters in deep bedding (40 and 80 cm) used an artificial shelter only as an occasional cover. Therefore, it may not be necessary to provide a shelter when there is enough bedding to dig tunnels. However, when this possibility does not exist, this study leads to the recommendation to offer a shelter.

In general, in every shelter type the most preferred sleeping corner was the one diagonally from the hole (entrance in SM and L1 shelters and passage between the two rooms in L2 shelters). We suggest that the hamsters chose this place because it was the most hidden and little light reached them during sleeping hours. This result is confirmed by the observation that every animal of the L2 group always slept in the back room. Several burrow-dwelling rodents, including hamsters, were found to prefer dark areas (Warden and Sachs, 1974; Pratt and Goldman, 1986; van den Broek et al., 1995; Würbel et al., 1998). Waiblinger and König (2004) illustrated the importance of a dark retreating possibility in gerbils by showing that gerbils reared with access to an opaque artificial burrow developed less stereotypic digging than those reared in transparent artificial burrows.

In all three groups we found animals of the SM group least often in a changed sleeping place compared with the previous week. These hamsters had just four positions to choose, whereas the animals of the other groups had eight. Nevertheless, this does not explain the difference compared to the animals of the L2 group, since they never used the front room and consequently also changed between four corners. However, in SM shelters the best-hidden place was obviously c2, while the back room of L2 shelters was generally dark and therefore the difference between the areas was smaller than in SM shelters.

Hamsters of the SM group were noticed to urinate most frequently outside the shelter. Probably, this was simply because they had less space in the shelter.

All hamsters usually stored food inside their shelter. Hamsters need to eat small meals at regular two-hour intervals. Therefore, the food caches serve not only as an emergency store, but hamsters also eat from them during daytime (Toates, 1978). In addition to a tunnel for urination, wild hamsters build one or more tunnels and store food in there (Gattermann et al., 2001). However, the hamsters in our study often put urine and food in the same places. In particular, animals living in L2 shelters did not use the two rooms to separate urine and food. Contrary to our expectation, we found urine of these animals even more frequently together with food. The fact that they grew up in a small shelter without division may have influenced this behaviour. Possibly, they did not change a habit, which they learnt in early days. Therefore, it would be interesting to repeat the experiments with animals, which were already born in different shelter types.

Several of our findings indicate that hamsters in large structured shelters build less extensive tunnels than animals with large unstructured shelters: 1. The tunnel score of the L2 group was significantly lower than that of the L1 group. 2. We registered no hamster with an L2 shelter building tunnels regularly, but three of the L1 group doing this. 3. Lack of a tunnel in all five examinations occurred more often in animals of the L2 group (seven) than in the L1 group (two). 4. All tunnels found in animals with an L2 shelter were shorter than 40 cm, in contrast to these in L1 shelters. Therefore, we suppose that shelter type and digging behaviour are connected. Wiedenmayer (1997a) suggested that stereotypic digging develops in housing conditions in which young gerbils cannot achieve their essential goal, i.e. cannot retreat into a dark space. In our study, the back room of the L2 shelters was obviously darker than the room of L1 shelters. This may be a reason why we found more tunnel building in hamsters of the L1 group and if so, it indicates that also in golden hamsters digging behaviour is more goal oriented than activity oriented. To

prove that a suitable shelter reduces stereotypic behaviour in golden hamsters requires further examinations.

Although hamsters in large divided shelters built tunnels least frequently, a majority (60% and 78%) of the L1 and SM group did not build burrows either. The unnatural bedding and the limited digging depth may have influenced the digging behaviour. Besides, sometimes it was difficult to determine the tunnels clearly, because the bedding did not allow building very stable burrows. Anyway, the level of inaccuracy was the same in all three groups.

2.6 Conclusion

This study shows that female hamsters used a shelter, independent of its size and structure. They frequently used it for urinating or food storing, and always for sleeping. Therefore, a shelter should always be provided, except when deep bedding is available. Golden hamsters prefer to sleep in well hidden and dark places. This needs to be considered when choosing a shelter.

2.7 Acknowledgements

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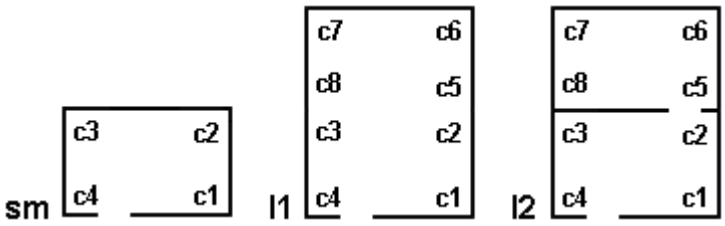
3 ANHANG

3.1 Zusätzliche Daten

3.1.1 Aufenthaltsorte der Hamster

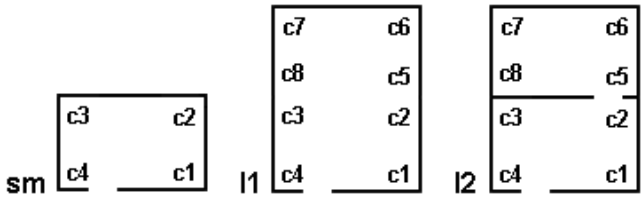
Tab. 1: Einmal pro Woche wurde der Aufenthaltsort der Goldhamster während ihrer Schlafperiode kontrolliert, fünf Mal für jedes Tier insgesamt. Dabei unterteilten wir den Raum innerhalb des Unterschlupfes in vier (SM-Unterschlupf: c1 - c4) resp. acht (L1- und L2-Unterschlüpfe: c1 - c8) Bereiche.



ID (box)	treatment	week 1	week 2	week 3	week 4	week 5	most frequency	changes
12	SM	c2	c2	c2	c2	c2	**c2**	**0**
21	SM	c4	c3	c2	c2	c2	**c2**	**2**
52	SM	c1	c2	c2	c1	c2	**c2**	**3**
57	SM	c2	c2	c2	c1	c2	**c2**	**2**
66	SM	c1	c2	c1	c1	c1	**c1**	**2**
75	SM	c2	c2	c2	c2	c2	**c2**	**0**
76	SM	c2	c2	c2	c2	c3	**c2**	**1**
80	SM	c4	c2	c2	c2	c3	**c2**	**2**
83	SM	c2	c2	c2	c2	c2	**c2**	**0**
86	SM	c2	c2	c2	c2	c2	**c2**	**0**
4	L1	c6	c5	c7	c6	c6	**c6**	**3**
9	L1	c1	c5	c7	c5	c7	**c5;c7**	**4**
15	L1	c1	c6	c6	c5	c2	**c6**	**3**
16	L1	c6	c6	c6	c6	c6	**c6**	**0**
23	L1	c6	c6	c6	c6	c6	**c6**	**0**
29	L1	c7	c7	c7	c6	c7	**c7**	**2**
56	L1	c6	c6	c6	c5	c6	**c6**	**2**
62	L1	c5	c6	c5	c6	c7	**c5;c6**	**4**
74	L1	c1	c7	c7	c7	c4	**c7**	**2**
82	L1	c6	c6	c7	c6	c1	**c6**	**3**
10	L2	c7	c8	c7	c7	c6	**c7**	**3**
18	L2	c7	c8	c5	c7	c7	**c7**	**3**
22	L2	c6	c7	c7	c5	c7	**c7**	**3**
26	L2	c7	c8	c8	c7	c7	**c7**	**2**
42	L2	c6	c5	c5	c5	c6	**c5**	**2**
58	L2	c7	c8	c7	c7	c7	**c7**	**2**
70	L2	c8	c8	c7	c7	c7	**c7**	**1**
72	L2	c7	c7	c7	c7	c6	**c7**	**1**
73	L2	c8	c7	c6	c7	c7	**c7**	**3**
77	L2	c7	c7	c5	c7	c7	**c7**	**2**

3.1.2 Urinabsatz und Futterreservoirs

Tab. 2: Einmal pro Woche und insgesamt fünf Mal suchten wir die Boxen sämtlicher Goldhamster nach Urin (ur) und Futter (fo) ab. Dabei unterteilten wir den Raum innerhalb des Unterschlupfes in vier (SM-Unterschlupf: c1 - c4) resp. acht (L1- und L2-Unterschlüpfe: c1 - c8) Bereiche. Die Fundorte ausserhalb des Unterschlupfes wurden zusammengefasst (nc).



ID (box)	treat-ment	week	c1		c2		c3		c4		c5		c6		c7		c8		nc	
			ur	fo	ur	fo	ur	fo	ur	fo	ur	fo	ur	fo	ur	fo	ur	fo	ur	fo
12	SM	1		x	x		x													
		2		x			x		x	x										
		3		x		x	x		x	x										
		4		x			x		x											
		5	x	x	x		x		x	x										
21	SM	1				x		x											x	x
		2		x		x		x		x									x	x
		3		x				x											x	
		4		x				x		x									x	
		5				x		x											x	
52	SM	1	x																	
		2					x	x	x										x	x
		3		x			x		x											
		4		x															x	
		5	x	x			x												x	
57	SM	1				x	x													
		2		x	x	x	x	x	x										x	x
		3					x	x	x											
		4					x	x	x	x									x	
		5					x	x											x	
66	SM	1				x													x	x
		2			x	x													x	
		3		x		x													x	
		4																	x	x
		5				x													x	x
75	SM	1		x			x													
		2	x		x		x	x	x	x									x	
		3					x	x											x	
		4		x			x		x	x									x	
		5					x	x	x	x										
76	SM	1					x	x												
		2		x	x	x	x	x												
		3					x			x										
		4					x	x	x	x										
		5		x			x													
80	SM	1		x			x												x	
		2	x	x															x	
		3					x	x												
		4						x											x	
		5						x											x	

ID (box)	treat-ment	week	c1		c2		c3		c4		c5		c6		c7		c8		nc	
			ur	fo	ur	fo	ur	fo	ur	fo	ur	fo	ur	fo	ur	fo	ur	fo	ur	fo
83	SM	1	x	x	x	x	x		x											
		2	x	x	x	x													x	
		3	x	x		x														
		4		x		x	x	x												
		5	x	x	x														x	
86	SM	1	x					x		x										
		2	x	x	x	x	x	x	x											
		3	x		x		x	x	x											
		4	x	x	x		x	x	x											
		5					x	x	x	x										
4	L1	1	x	x										x						
		2		x							x	x	x	x					x	x
		3										x		x					x	x
		4				x						x							x	
		5	x	x	x		x	x	x			x	x						x	
9	L1	1	x											x						
		2	x											x					x	
		3			x		x	x										x		
		4					x									x		x	x	
		5										x		x		x			x	
15	L1	1													x	x			x	x
		2				x		x							x				x	x
		3														x			x	x
		4				x								x					x	
		5										x							x	
16	L1	1	x		x							x		x						
		2	x		x	x						x	x	x						
		3	x	x	x	x														
		4	x		x						x	x		x						
		5	x		x	x					x	x								
23	L1	1					x					x			x	x	x	x		
		2	x		x						x					x				x
		3	x		x		x				x					x				
		4	x		x		x		x		x		x				x			
		5	x		x		x		x		x		x				x			
29	L1	1					x							x						
		2			x	x					x									
		3			x									x						
		4			x						x					x				
		5	x		x															
56	L1	1	x													x				
		2	x	x												x				
		3	x													x				
		4	x		x	x														
		5	x									x		x						
62	L1	1									x		x	x		x				
		2	x		x				x	x					x	x				
		3	x		x											x				
		4	x		x						x	x				x		x		
		5	x		x						x		x			x		x		
74	L1	1					x	x	x	x			x	x					x	
		2										x	x	x						
		3										x		x					x	
		4	x						x			x		x					x	x
		5		x		x						x		x					x	

ID (box)	treat-ment	week	c1		c2		c3		c4		c5		c6		c7		c8		nc	
			ur	fo	ur	fo	ur	fo	ur	fo	ur	fo	ur	fo	ur	fo	ur	fo	ur	fo
82	L1	1					x		x			x		x						
		2				x						x	x	x	x		x			
		3																		
		4				x	x	x				x						x		
		5	x		x									x						
10	L2	1									x		x		x					
		2			x		x				x	x	x	x	x	x	x	x		
		3									x		x	x	x		x			
		4									x		x	x	x		x			
		5									x		x						x	
18	L2	1									x	x	x	x		x		x		
		2									x	x	x	x						
		3										x	x	x	x					
		4									x	x	x	x	x	x				
		5									x		x	x	x		x			
22	L2	1									x		x	x						
		2			x	x					x	x	x	x				x		
		3		x			x	x			x					x	x	x		
		4			x						x	x	x	x			x			
		5									x	x	x	x						
26	L2	1			x						x	x	x	x		x		x		
		2	x	x	x	x					x	x	x	x				x		
		3			x						x	x	x	x		x				
		4			x		x				x	x		x			x			
		5			x						x	x		x						
42	L2	1										x				x	x	x		
		2									x	x	x	x	x	x	x	x		
		3									x				x	x	x	x		
		4									x		x	x	x		x			
		5									x	x	x		x		x			
58	L2	1									x	x	x	x						
		2			x	x					x	x	x	x						
		3									x	x	x	x						
		4									x	x	x	x						
		5									x	x	x	x						
70	L2	1									x	x	x	x						
		2			x						x	x	x	x	x					
		3									x		x	x						
		4			x						x	x	x	x			x			
		5									x	x	x	x						
72	L2	1									x	x	x	x						
		2			x	x					x	x	x	x						
		3			x						x	x	x	x					x	
		4			x						x	x	x	x			x			
		5									x		x	x						
73	L2	1									x	x	x	x		x				
		2					x	x							x	x	x	x		
		3									x		x	x	x	x	x			
		4									x		x	x				x		
		5			x		x				x		x	x						
77	L2	1									x		x	x			x			
		2									x	x	x	x						
		3									x	x	x	x						
		4									x	x	x	x						
		5			x						x	x	x	x						

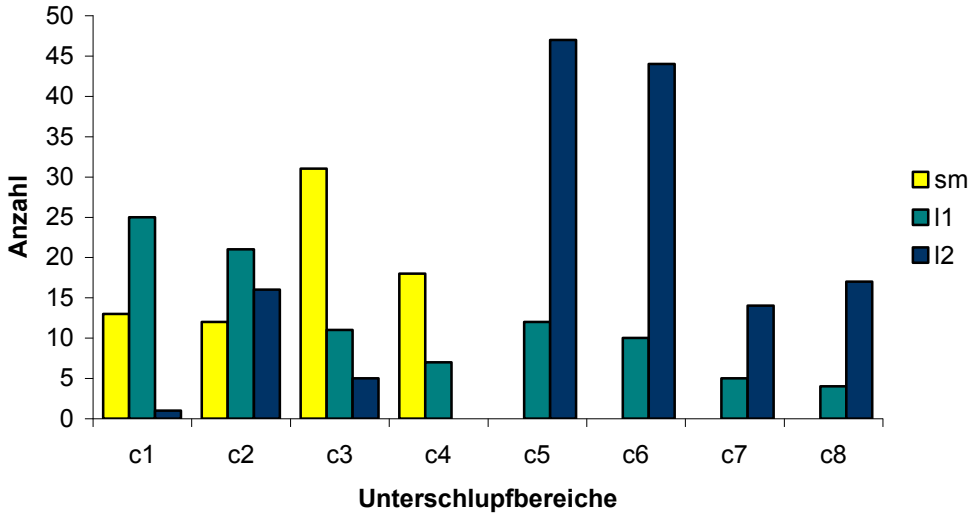


Abb. 1: Urinabsatz: Die Fundorte von Urin innerhalb des Unterschlupfes sind hier von allen Goldhamstern zusammengefasst und nach den Bereichen des Unterschlupfes (SM: c1 - c4; L1 und L2: c1 - c8) unterteilt aufgeführt.

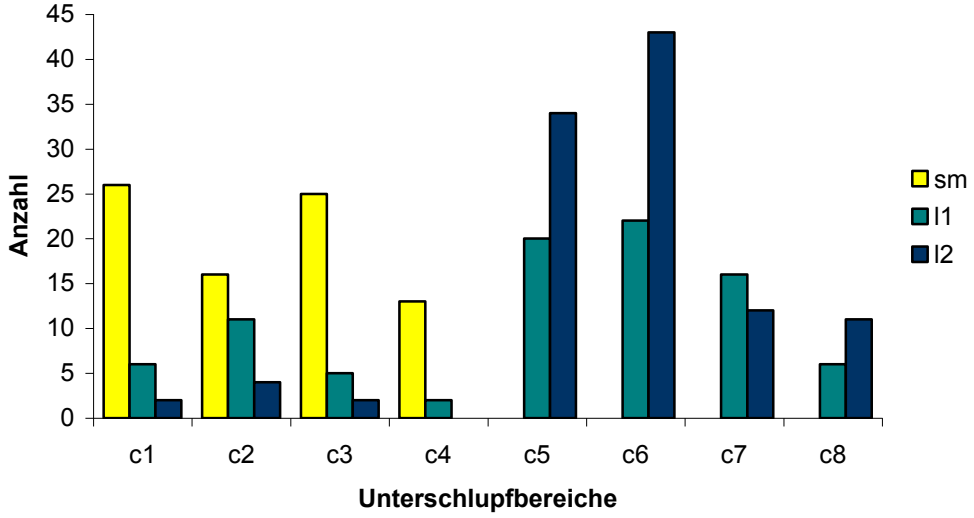


Abb. 2: Futterreservoirs: Alle Fundorte von Futter innerhalb des Unterschlupfes sind für alle Goldhamster zusammengefasst und nach den Bereichen des Unterschlupfes (SM: c1 - c4; L1 und L2: c1 - c8) unterteilt aufgeführt.

Tab. 3: Für jeden Goldhamster haben wir die Fundorte von Urin jede Woche nach folgendem Schema gruppiert: Urin ausschliesslich innerhalb des Unterschlupfes (x), Urin sowohl inner-, als auch ausserhalb des Unterschlupfes (xx) und Urin ausschliesslich ausserhalb des Unterschlupfes (xxx).

ID (**box)**	**treatment**	**urine**					**house free**
		week 1	week 2	week 3	week 4	week 5	
4	L1	x	xx	xxx	xxx	xx	**2**
9	L1	x	xx	x	xx	xxx	**1**
10	L2	x	x	x	x	xx	**0**
12	SM	x	x	x	x	x	**0**
15	L1	xx	xx	xxx	xxx	xxx	**3**
16	L1	x	x	x	x	x	**0**
18	L2	x	x	x	x	x	**0**
21	SM	xxx	xxx	xxx	xxx	xxx	**5**
22	L2	x	x	x	x	x	**0**
23	L1	x	x	x	x	x	**0**
26	L2	x	x	x	x	x	**0**
29	L1	x	x	x	x	x	**0**
42	L2	x	x	x	x	x	**0**
52	SM	x	xx	x	xxx	xx	**1**
56	L1	x	x	x	x	x	**0**
57	SM	x	xx	x	xx	xx	**0**
58	L2	x	x	x	x	x	**0**
62	L1	x	x	x	x	x	**0**
66	SM	xxx	xx	xxx	xxx	xxx	**4**
70	L2	x	x	x	x	x	**0**
72	L2	x	x	xxx	x	x	**0**
73	L2	x	x	x	x	x	**0**
74	L1	xx	x	xxx	xx	xxx	**2**
75	SM	x	xx	xx	xx	x	**0**
76	SM	x	x	x	x	x	**0**
77	L2	x	x	x	x	x	**0**
80	SM	xx	xx	x	xxx	xxx	**2**
82	L1	x	x	x	x	x	**0**
83	SM	x	xx	x	x	xx	**0**
86	SM	x	x	x	x	x	**0**

3.1.3 Tunnelbau

Tab. 4: Einmal pro Woche und insgesamt 5 Mal zeichneten wir für jeden Goldhamster allfällige Tunnels auf und bildeten daraus 4 Kategorien: kein Tunnel (0), ein Tunnelsystem mit einer Gesamtlänge von bis zu 20 cm (1), zwischen 21 und 40 (2) und länger als 40 cm (3).

ID (box)	Unter-schlupftyp	Woche	Kategorie
04	L1	1	2
		2	0
		3	3
		4	2
		5	0
09	L1	1	0
		2	2
		3	0
		4	0
		5	2
10	L2	1	2
		2	0
		3	0
		4	2
		5	0
12	SM	1	0
		2	0
		3	0
		4	0
		5	0
15	L1	1	2
		2	2
		3	2
		4	1
		5	3
16	L1	1	0
		2	0
		3	0
		4	0
		5	1
18	L2	1	0
		2	0
		3	0
		4	0
		5	0
21	SM	1	2
		2	0
		3	1
		4	0
		5	0
22	L2	1	0
		2	0
		3	0
		4	0
		5	0
23	L1	1	0
		2	1
		3	0
		4	0
		5	1
26	L2	1	0
		2	0
		3	0
		4	0
		5	0
29	L1	1	0
		2	0
		3	0
		4	0
		5	0
42	L2	1	0
		2	0
		3	0
		4	0
		5	0
52	SM	1	0
		2	0
		3	0
		4	0
		5	0
56	L1	1	0
		2	0
		3	0
		4	0
		5	1
57	SM	1	2
		2	0
		3	0
		4	0
		5	0

ID (box)	Unter-schlupftyp	Datum	Kategorie
58	L2	1	0
		2	0
		3	0
		4	0
		5	0
62	L1	1	0
		2	0
		3	0
		4	0
		5	0
66	SM	1	2
		2	1
		3	0
		4	3
		5	2
70	L2	1	0
		2	0
		3	0
		4	0
		5	0
72	L2	1	0
		2	0
		3	0
		4	0
		5	0
73	L2	1	1
		2	0
		3	0
		4	0
		5	2
74	L1	1	1
		2	0
		3	2
		4	3
		5	3

ID (box)	Unter-schlupftyp	Datum	Kategorie
75	SM	1	0
		2	0
		3	0
		4	0
		5	0
76	SM	1	0
		2	0
		3	0
		4	0
		5	0
77	L2	1	0
		2	0
		3	0
		4	0
		5	1
80	SM	1	1
		2	2
		3	0
		4	3
		5	3
82	L1	1	1
		2	0
		3	0
		4	1
		5	0
83	SM	1	0
		2	0
		3	0
		4	0
		5	0
86	SM	1	0
		2	0
		3	0
		4	0
		5	0

3.1.4 Temperaturen

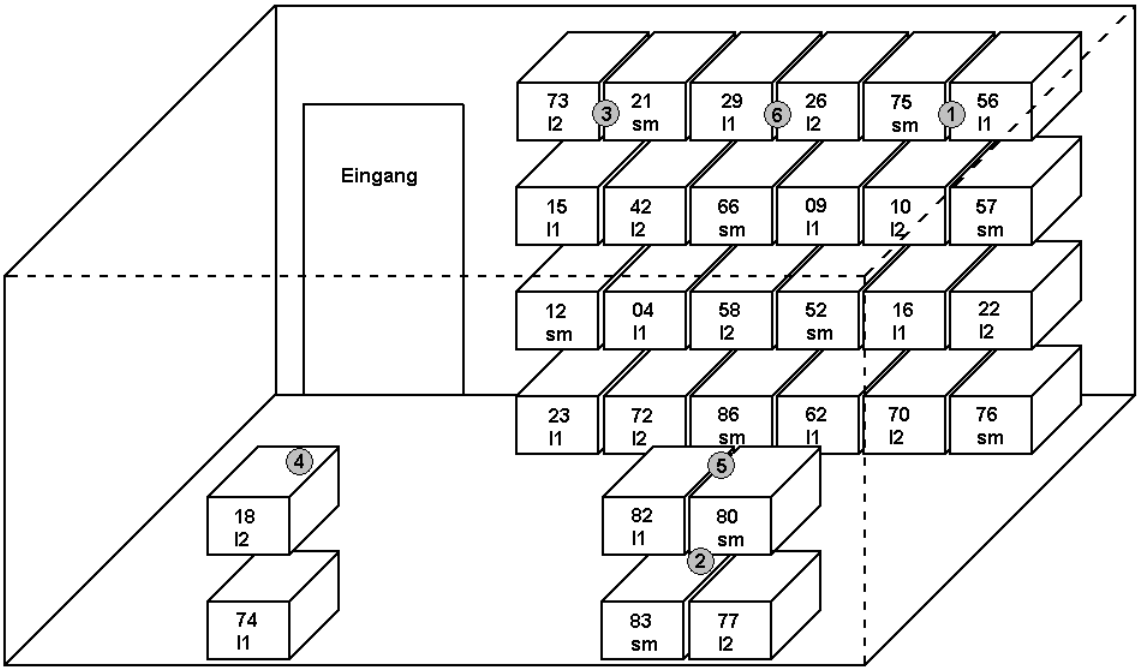


Abb. 3: Schematische Darstellung des Hamsterraumes: Anordnung der Boxen mit ID-Nummer (Zahl oben) und Gruppenzugehörigkeit (SM, L1 resp. L2) und die Orte, wo die Temperaturen (① – ⑥) gemessen wurden (siehe Tab. 5).

Tab. 5: Temperaturen an verschiedenen Orten im Raum mit den Hamsterboxen (1 - 6, siehe Abb. 3) und zu unterschiedlichen Zeitpunkten. Die Temperaturhöchst- (Max. Temp.in °C) und -tiefstwerte (Min. Temp.) sind jeweils über ca. 24 Stunden gemessen.

Datum	Ort	Zeit	Temp. (°C)	Max. Temp. (°C)	Min. Temp. (°C)
7.6.06	1	16:25	20.4		
7.6.06	2	16:25	19.3		
8.6.06	1	16:15	20.6	20.9	19.4
8.6.06	2	16:15	19.8	19.8	18.9
8.6.06	3	16:15	20.7		
9.6.06	1	15:15	21.0	21.4	19.7
9.6.06	3	15:15	20.9	20.9	19.8
9.6.06	4	15:55	20.7		
9.6.06	5	15:55	20.7		
12.6.06	4	14:55	22.7	22.7	20.1
12.6.06	5	14:55	22.7	22.8	20.0
12.6.06	1	15:00	24.2		
13.6.06	1	14:30	24.2	24.3	22.6
13.6.06	5	14:30	23.5	23.5	22.2
14.6.06	1	16:15	24.9	24.9	23.5
14.6.06	5	16:15	24.0	24.9	22.9
14.6.06	4	16:20	25.1		
14.6.06	6	16:20	25.5		
15.6.06	4	16:45	24.8	25.3	23.9
15.6.06	6	16:45	25.5	29.2	24.0
16.6.06	4	16:45	24.8	25.6	24.4
16.6.06	6	16:45	25.6	25.8	24.6
26.6.06	7	08:30	24.6		

3.2 Abbildungen

Abb. 1: Hamsterraum

Abb. 2: Käfigeinrichtung mit kleinem Unterschlupf

Abb. 3: Käfigeinrichtung mit einem grossen, nicht unterteilten Unterschlupf

Abb. 4: Angebotenes Futter

Abb. 5: Kleiner Unterschlupf (SM)

Abb. 6: Grosse Unterschlüpfe, links unterteilt (L2), rechts nicht unterteilt (L1)

Abb. 7: Nach einer Woche, Eingang verschlossen (L1-Unterschlupf)

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Abb. 8: Nach einer Woche (L1-Unterschlupf)

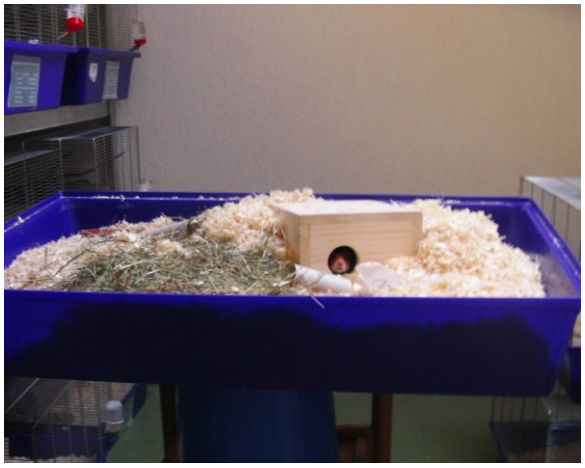

Abb. 9: Nach einer Woche (SM-Unterschlupf)

Abb. 10: Nach Entfernen des Unterschlupfes (SM-Unterschlupf)

Abb. 11: Nach Entfernen des Unterschlupfes (L2-Unterschlupf)

Abb.12: Schlafecke (mit Papier)

Abb. 13: Nach Entfernen des Unterschlupfes (L1-Unterschlupf)

Abb. 14: Futterecke

Abb. 15: Nach Entfernen des Unterschlupfes: Tunneleingang

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