History, Husbandry, General Pathology

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History and Cytogenetics of Hamsters[1]

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Contents

I. Introduction

When a species attains the rank of an inbred laboratory specimen, an accurate historical account of events leading to this status is, as many

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will agree, a useful and timely undertaking. Such documentations become even more significant when individuals, heretofore unrecognized for their earlier roles, are revealed in the course of compiling the facts. The end result is a composite of the available literature, personal experiences wherever applicable, and informative highlights of communications with individuals generally excluded from one's immediate sphere of research interest. Building on documented statements gathered principally from investigators stationed in China conducting field and laboratory studies on Leishmaniasis during the mid-twenties, I intend to clarify the circumstances and experiences of these heretofore unrecognized individuals, who ultimately influenced Adler to seek native species of hamsters.

A number of earlier investigators were unaware of the roles they had played that led to domestication of both Syrian and Chinese hamsters until informed years later by the writer. I must emphasize this delay, since they had relocated to other parts of the world following their departure from China during the late twenties through the late forties. As field and laboratory scientists while in China, their tasks were complicated by constant exposure to natural and man-made events. For example, American and British participants in the Kala-azar Expeditions of the mid-twenties had to adjust their daily activities repeatedly to compensate for civil uprisings while canvassing outbreaks of Leishmaniasis and, later, the Japanese invasion of 1937. Soon after World War II and the major political upheaval in China, the 2 scientists who arranged for the last trappings and transport of Chinese hamsters to the United States during late 1948 were accused of being enemies of the new government. The native professor was sentenced to a detention camp where he underwent some 6 months of brainwashing for 'passing information to an enemy', while the American scientist was court-martialed and sentenced *in absentia* for an event that took place while transporting the animals to Shanghai. Several years later, this incident may have served as the basis for the People's Republic of China's Germ Warfare Commission to condemn the American scientist for having obtained the hamsters primarily for the purpose of establishing a colony to provide animals for germ warfare. Supposedly, once bred in captivity, animals were to be infected with cholera and plague and parachuted into Manchuria.

In contrast to the deeds of individuals who remained silently in the background until contacted by the writer and recognized at this time, I was present when a contemporary (while appraising his findings based upon cultured Chinese hamster cells) openly described himself to the audience as the 'Father of the Chinese Hamster'. On such occasions, I cannot help but feel highly gratified in having sought, met, and corresponded with the earlier investigators who, in the course of conducting their duties under very trying conditions, took a moment to consider the needs of others and, as a result of their unselfish responses, fostered the development of several species of hamsters as laboratory specimens.

While in the process of gathering the contents of this review, the writer was decidedly impressed by the repetitive nature of human inadequacies leading to either negative mating trials with wild-type animals or to difficulties with the outcome and future status of the colony, once successfully bred in captivity. In the first instance, wild-type animals would most likely have bred, given the extra care and attention needed to overcome initial physiological disturbances following their capture. In other instances, human relations, both individual and political in motivation, were reflected as delays, omissions, and negative decisions. An example of the latter has been the recent demise of several inbred strains of hamsters, supposedly due to economic cutbacks now in effect in the United States. In reality, the situation reflects the overall lack of policies regarding long-range maintenance of genetic stocks for the proper conduct of many forms of research. Needless to say, many years will be required to duplicate current advances in hamster inbreeding – a matter which has received virtually no consideration by grant review systems, which continue to assign priorities and to encourage studies employing biologicals stemming from random-bred animals.

Presently, 3 of the 6 species of Old World hamsters being bred in the laboratory qualify as inbreds. These are the Syrian hamster *(Mesocricetus auratus),* Chinese hamster *(Cricetulus griseus),* and the Armenian hamster *(Cricetulus migratorius).* This review is primarily concerned with these species, since details of the more recently introduced species, such as the Transcaucasian or Kurdistan hamster *(Mesocricetus brandti),* Rumanian hamster *(Mesocricetus newtoni),* and the Djzungarian hamster *(Phodopus songorus)* will, most likely, be provided in the near future by the laboratories which have introduced them.

I trust this documentation of chronological events covering half a century will finalize the historical relationship between the 2 older species of laboratory hamsters, the Chinese and the Syrian hamster, as well as serve to record the events leading to domestication of the Armenian hamster. The reader is urged to refer to ADLER's 'Origin of the Golden Hamster, *Cricetus auratus,* as a Laboratory Animal' [1948], for a more effective evaluation of the contents.

II. Events Leading to Introduction of the Syrian Hamster (Mesocricetus auratus, Waterhouse)

The use of 'hamsters' as laboratory specimens is generally associated with the introduction of the Syrian hamster *(Mesocricetus auratus)* by ADLER in 1931. Lack of a chronological documentation of recorded events and roles played by various individuals interested in hamsters continues to foster the impression that hamster history began with ADLER's studies. Many investigators will agree that ADLER's choice was an eventful one, as evidenced by the program of this conference. Actually, the Syrian hamster *(Mesocricetus auratus)* may have been his second choice, since the specimen he considered initially was the endemic *Cricetulus phaeus*, a close relative of the Chinese hamster *(Cricetulus griseus)* which he had to import from the Far East for use in his studies on Mediterranean Kala-azar. The experienced person, aware of the problems that can arise during early phases of domesticating wild rodents, will agree with the writer that ADLER's contribution was readily attained with minimal complications and hindrances, both biological and human in nature. The latter aspect is certain to become more evident as we proceed further into this review. Nevertheless, many contemporaries are totally unaware of the actual timings of unpublished events which preceded and, ultimately, led to the introduction of the Syrian hamster. The personalized description by ADLER [1948] fails to mention the contributions of earlier investigators who were active in the Far East during the decade prior to his association with AHARONI, the naturalist who provided him with the endemic species of hamster.[2]

The following is a copy of a letter sent to the writer by Dr. MARSHALL HERTIG of the Gorgas Memorial Laboratory, Panama Canal Zone, dated 25 January, 1962. Its contents definitely link ADLER's interests in procuring an endemic species of hamster to earlier activities of various members of the Kala Azar Studies Unit stationed at the Peking Union Medical College during the mid-twenties.

Dear Dr. YERGANIAN,

Your letter of 15 January [1962] has just reached me.

My attempts to breed the Chinese striped hamster, *Cricetulus griseus*, are easily summed up. They were all flat failures. I had not heard of any successful breeding until your own work, by which, I might add, I have been mightily impressed. I knew of no success by any Britishers during the time I was still interested in these animals.

You probably know about the early history of this animal at Peking Union Medical College, but here are a few items dredged out of my recollection without looking up any published references, most of which are not readily available here:

I arrived in China in January 1924, to be a member of the 'Kala Azar Field Studies' unit, PUMC, under DR. CHARLES. W. YOUNG. At that time he had already shown that the striped hamster (and then or later also the giant hamster, *C. triton*) was very susceptible to infection with *Leishmania donovani*, the etiological

2 Memoirs of a Hebrew Zoologist, see addendum on page 35.

agent of kala azar. I believe the first report of this success was by Smyly and Young (1923), but it was the work of YOUNG's group. Incidentally, this hamster was the first really satisfactory laboratory animal for the study of leishmaniasis. (This discovery led to the finding and world-wide introduction of the Syrian hamster, as indicated below.)

The striped hamster had already been in extensive use at PUMC for typing pneumococci, as I recall it, by Robertson, later of Chicago. The supply was always ample. Farmers dug them up in the grain fields and were given so many coppers per live hamster. We ourselves used a number of thousands. I don't remember any attempt by anyone to breed them in Peking. In the laboratory they had to be kept isolated in individual cages since otherwise there was an immediate fight to the death. The diet was boiled black beans and Chinese cabbage.

When I went to Boston in September, 1927, I brought along about 150 hamsters and someone else brought another batch some months later. I made several attempts at breeding. In one of the downstairs rooms in Comparative Pathology we made a pen about three feet deep and five or six feet long with walls of cemented hollow tiles, filled it nearly full with earth and turned loose several pairs. They burrowed in the earth and survived well but produced no progeny. I don't remember how long this indoor pen was maintained, but the next spring we sunk a large hardware-cloth cage, perhaps a three foot cube, in the grassy yard back of the building. Hamsters survived but nothing else happened. This is about all I can tell you about my hamster-breeding efforts.

With regard to the Syrian hamster, here is the story as told to me by Dr. SAUL ADLER, of the Hebrew University, Jerusalem [italics mine]. Dr. YOUNG passed through Jerusalem in 1926 on his way to the States on home leave, and told Dr. ADLER about our kala azar work. ADLER was also working on leishmaniasis and the transmission problem. (He still is.) At the end of 1927 Dr. YOUNG returned to the States for good and this time he may have had Chinese hamsters with him. I am pretty sure that he had hamsters with him as far as Calcutta, where he attended the 7th Congress of the Far Eastern Tropical Medicine Association and gave a paper on our work. Also he took with him as far as Calcutta our chief Chinese technician, who demonstrated at the Congress the technique of artificially feeding sandflies developed by ARTHUR HERTIG and myself. At any rate, the people in India working on kala azar later got hamsters from Peking, how many and over what period of time I don't know. Also there was a British kala azar team (Patton and Hindle) in Shantung Province from mid-1925 to 1927, who were furnished some equipment by PUMC along with briefing on some phases of technique, and were probably given initial stock of hamsters. They, of course, soon got hamsters locally and used them in their studies. To return to Dr. ADLER: whether he ever saw a Chinese hamster or not he was eager to get any rodent of the hamster group for his own leishmaniasis work. Some time later – I have forgotton the date but ADLER published a note in 'Nature' – a naturalist passed through Jerusalem on his way to Syria. ADLER asked him to be on the lookout for anything related to the hamsters and to get them back to him alive if possible. This man dug up a litter in Syria and managed to get back to Jerusalem at least three of the litter, which fortunately contained a pair. The entire laboratory and household hamster population of the world for a time at least, was descended from these three surviving litter-mates.

I would be glad to have one of your reprints setting forth the magic you use in breeding hamsters.

With best regards to yourself and Mazzone, I am

Sincerely yours,

MARSHALL HERTIG

Referring once again to ADLER's description of events leading to the introduction of the Syrian hamster after receiving HERTIG's letter, I sensed that ADLER may have had to settle for second best, since his goal was to substitute an endemic species related to the Chinese hamster which he imported for his studies. The following excerpts of ADLER's description in Nature could substantiate the writer's deductions regarding which of the two species of hamster Aharoni trapped was the initially desired form.

'In 1930 the late Prof. Aharoni, of the Department of Zoology of the Hebrew University, Jerusalem, went on a zoological expedition to Syria (he was particularly interested in the fauna of Antioch). We were engaged on investigations for the Royal Society on Mediterranean kala azar, and the only suitable experimental animal then known was the Chinese hamster, which had to be imported from the Far East and had the additional disadvantage of not breeding in captivity.

Professor Aharoni undertook to bring specimens of *Cricetulus phaeus* for our work. In addition to specimens of *Cricetulus phaeus* (which were also unsatisfactory because they did not breed in captivity), Professor Aharoni brought back a litter of eight golden hamsters collected near Aleppo which he reared and presented to the Department of Parasitology in July 1930.

Four of the animals escaped, one female was killed by a male and only three animals – one male and two females (all litter mates) – remained. From these three animals Mr. H. BEN MENAHEM succeeded in raising litters, and it was quickly established that this species breeds readily in captivity.

Returning once again to Dr. HERTIG's description of his conversation with Dr. ADLER, several heretofore unknown, but interrelated, historical links can be ascertained regarding three of the present-day laboratory specimens, namely, *Cricetulus griseus, Mesocricetus auratus,* and *Cricetulus phaeus* (syn. for *C. migratorius*). It is reasonable to assume that Aharoni would have regarded *C. phaeus* as the principal specimen to seek because of its close taxonomic relationship with the Chinese hamster, and that *M. auratus* was considered only after *C. phaeus* failed to breed in captivity.

The latter possibility is supported by field experience in trapping hamsters. *C. Phaeus* is relatively easy to trap in large numbers as compared *M. auratus*. It is quite reasonable to assume that the 8 litter-mates referred to by ADLER had to be dug from their mother's deep burrow which, undoubtedly, traversed the difficult rocky subterrain. Since we are unaware of any adult *M. auratus* trapped on that occasion, breeding attempts were most likely limited to adult *C. phaeus* until the litter of *M. auratus,* reared by Aharoni, was presented to ADLER's group. Judging from personal experiences, adult wild-type rodents require a number of months in captivity before responding favorably to mating trials. If mating trials with *C. phaeus* were conducted soon after delivery to ADLER, this could explain their negative results. In addition, if the newly captured specimens of *C. phaeus* were housed in the same animal room as the imported *C. griseus,* the chances of successful matings under these conditions would have been reduced still further.

In the event *C. phaeus* happened to be successfully bred in captivity, in all likelihood it would have received the common name, 'Syrian hamster', since the breeding of *M. auratus* had to be delayed until the surviving members of the litter were reared to adulthood by Aharoni. Successful breeding of *C. phaeus* might have led ADLER's group to abandon breeding trials with *M. auratus*. If I may continue altering the course of history, I sense the successful breeding of *M. auratus* at a later date would have led to naming it the 'Palestinian hamster'.

Thus, the introduction of the Syrian hamster, *Mesocricetus auratus,* by ADLER's group is an afterthought of the interest generated by the Chinese hamster as a highly suitable host for various Leishmanae. I venture to guess that the tedious practice of ordering Chinese hamsters from China and the time to deliver them to Palestine *via* ocean transport could have also influenced ADLER to seek endemic species. In so doing, reference is made to *Cricetulus migratorius phaeus* which, more recently, has been described as being readily bred in captivity and is known as the Armenian hamster, *Cricetulus migratorius migratorius,* Pall. [YERGANIAN and PAPOYAN, 1965].

III. Events Leading to Introduction of the Chinese Hamster (Cricetulus griseus, Milne-Edwards)

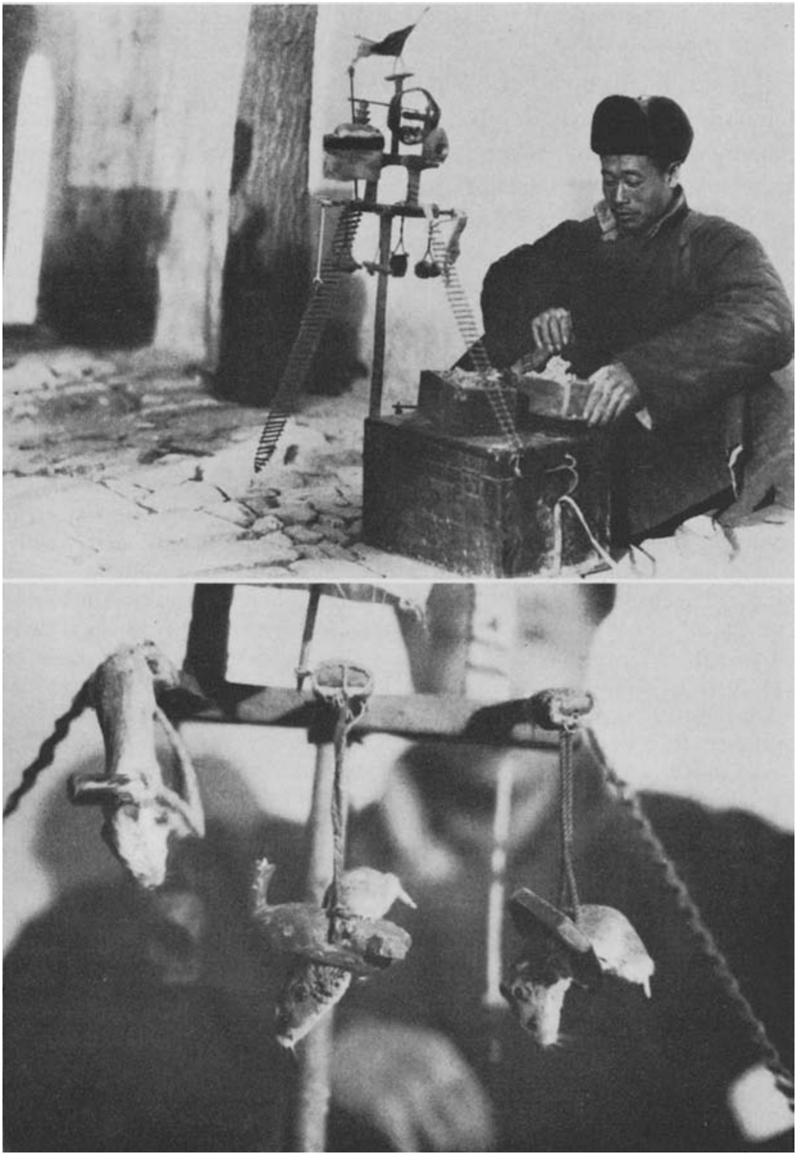
The initial report on the successful use of Chinese hamsters as a laboratory specimen was by HSIEH [1919]. He encountered them in the streets of Peking where youngsters were selling captured animals as pets. Mice happened to be scarce at the time and he substituted the Chinese hamster for the identification of pneumococcal types by Avery's method: such tests were necessary before selective treatment was administered to patients at the Peking Union Medical School. Thereafter, for some 20 years, captured Chinese hamsters were used routinely, both locally and in other countries, in a variety of studies pertaining to Leishmaniasis, tuberculosis, diphtheria, rabies, equine encephalitis, influenza, pneumonia, Monilia, relapsing fever, and drug evaluations. In proposing the use of Chinese hamsters for behavioral studies, JÖCHLE [1963] reproduced photographs taken in 1930, by Dr. B. KÖRNER of Berlin and Mr. G. MONTELL of Stockholm, showing a street circus conducted by a Mandarin with Chinese hamsters, trained to perfection, performing various acrobatics (fig. 1a, b).

The Chinese hamster received world-wide attention when it was considered as a possible reservoir host for *Leishmania donovani,* the etiological agent for kala-azar. Since the initial report of YOUNG *et al.* [1923], a complete list of references on this subject was published at the time of the Kala-Azar Prevention Conference [1949]. From the very beginning, a number of Chinese, American, and British teams utilized this species in varied attempts to reveal the cyclic transmission of kala-azar among its biological hosts. The supply of captured animals maintained at the Peking Union Medical College was apparently inexhaustible; many thousands were employed annually throughout the mid-twenties. Nevertheless, numerous attempts to breed them in captivity failed, primarily due to their pugnacious habits exhibited whenever adult animals were paired. Since the Chinese hamster proved to be a most sensitive host for the various forms of Leishmanae, researchers in other countries, notably India and the Near East, were encouraged to import them from China for their own needs.

From mid-1925 to 1927, the British kala-azar team had extended their studies into Shantung Province. Although the British workers obtained Chinese hamsters initially from Peking, locally trapped animals were used as they travelled into the interior [HINDLE, 1944]. Animals brought to England by Dr. E. HINDLE and Dr. F. L. CHOW during the late nineteen-twenties failed to breed. Later, Dr. P. A. BURTON obtained one litter from a pair provided by Dr. CHOW but failed to continue the stock [SMITH, 1956]. PARKES [1931] studied the reproductive cycle in detail, but failed to observe copulation during the peak of estrus among captive animals. In China, CHANG and WU [1938] also noted irregularities in the estrous cycle of captured females, and were able to obtain 5 small litters from laboratory-born females over a 2-year period of trials.

In personal communications with Drs. H. E. Meleney, J. H. Korns, O. H. Robertson, C. TenBroeck and A. T. Hertig, SCHWENTKER [1957] reported these investigators as confirming earlier statements that they failed to witness successful breeding of captive hamsters in China. H. H. ANDERSON [1962] told this writer that while in Peking he kept Chinese hamsters individually caged 'because they were so ferocious'.

Interest in the Chinese hamster was renewed following the (erroneous) report by PONTECORVO [1943] describing the karyotype as consisting of 7 pairs of chromosomes. Since the writer first became aware of PONTECORVO's findings in early



1a

1b

Fig. 1a and b. Figures 1 and 3 in JÖCHLE [1963]. A Mandarin with his 'hamster circus' (Peking, 1930).

1949, the political scene in China prevented contacting individuals to assist in procuring animals. The values of a low-chromosome rodent need not be emphasized at this time. This feature impressed the writer sufficiently to think that anyone versed in animal domestication who happened to read PONTECORVO's report would have thought similarly to procure wild specimens. Therefore, the search was limited to inquiries addressed to animal breeders in the hope of locating such a far-sighted individual. The decision to seek the Chinese hamster in preference to other low-chromosome animals, such as marsupials, was based upon several fundamental factors which, ultimately, could reflect upon the extent of domestication one can attain with time. The small body size, polyestrous cycle, short gestation period, and related features were considerations favoring the Chinese hamster over marsupials. Also, the probability of developing genetically homozygous strains within the span of one's lifetime was far greater with a eutherian rodent than that expected from marsupials. By late 1951, the search led to V. SCHWENTKER, the one person who had the foresight to obtain Chinese hamsters prior to the lowering of the Bamboo Curtain. Following his successful breeding of the Chinese hamster in captivity, SCHWENTKER made them available for distribution. These animals exhibited the pugnacious habits of wild-type parents, a problem which could only be resolved by long-term selection for docility. In an effort to undertake this task, the writer's requests for details of SCHWENTKER's mating scheme were totally ignored, except for being informed that his method, submitted for publication, could very well be delayed for a number of years before appearing in print. Our success in breeding the Chinese hamster was a most timely event (February 27, 1952), for, in 1954, SCHWENTKER informed the writer that he had given up the Chinese hamster and was referring others requesting animals to the writer. Some 3 years later, the details of his random breeding scheme finally appeared in print [SCHWENTKER, 1957] – far too late to serve anyone, had we also failed to breed the Chinese hamster.

SCHWENTKER [1957] mentioned obtaining a shipment of Chinese hamsters consisting of 20 captured animals, 10 males and 10 females. Eventually, 4 females and 3 males produced offspring and gave rise to the present foundation stock retained at this Institution [YERGANIAN, 1958]. During 1961–1962, final inquiries were made to locate individuals, other than those contacted by SCHWENTKER [1957], who might be aware of early attempts to breed the Chinese hamster in captivity, particularly in the United States during the period from the mid-twenties to the mid-forties. Dr. H. MAZZONE, then a post-doctoral student in this laboratory, referred the writer to Dr. MARSHALL HERTIG as a likely source of information. Dr. HERTIG's personal experience, as we have seen above, clearly related Dr. ADLER's interest in seeking species of hamsters in the Near East, in addition to describing his unsuccessful attempts at breeding the Chinese hamster in Boston.

Perhaps the most enlightening information gathered during this period was obtained while attending a meeting in Puerto Rico where the writer happened to meet Dr. JOHN TOTTER, presently Chairman of the Division of Biology and Medicine, US Atomic Energy Commission. In the course of our conversation, it soon became apparent that Dr. TOTTER was relating items which were entirely new to the writer and linked together the many tidbits of information gathered over the years. Dr. TOTTER continued by stating that he knew the person who had transported the Chinese hamster out of China. The individual was Dr. ROBERT B. WATSON of the Rockefeller Foundation whom Dr. TOTTER had met in South America while both were assigned to regional offices of their respective institutions. Immediately upon returning to Boston I wrote to Dr. WATSON informing him of my interest and, in turn, I received the highly informative letters (see below), including detailed excerpts from his diary which he has maintained for many years.

The Rockefeller Foundation
Caixa Postal 49
Rio de Janeiro,
Brazil
January 30, 1962
Dear Dr. YERGANIAN,

Your letter of January 17, 1962, about my part in the introduction of the Chinese hamster, *Cricetulus griseus*, into the United States in 1948, reached me today when I returned from a visit of a week in São Paulo.

Fortunately, I have found here copies of my diaries and will extract from them the factual material you want . . .

Your reference to the matter brings to [mind] clearly the circumstances which attended the arrival of the animals in Nanking from Peking. In my transport of them I rode to Shanghai through communist lines; this was in December, 1948. I did not take them to the United States but sent them out on one of the last, if not the last, Pan American flights to San Francisco . . .

Sincerely yours,
ROBERT BRIGGS WATSON

Soon after Dr. WATSON's arrival in New York, the writer received a second letter relating the details which, admittedly, provided a climactic closure to the decade of searching for him.

The Rockefeller Foundation
New York, New York
February 15, 1962
Dear Dr. YERGANIAN,

By the first of December, 1948, Nationalist China was [going] to pieces and Nanking was hysterical. I had gotten my family out of Nanking to Shanghai and on to Hong Kong, en route Macau, on the 16th of November and had returned to Nanking on the 2nd of December to try to get staff and equipment evacuated to Taiwan (Formosa) by sea and air. There was nothing between the Communists and Nanking except the Yangtze River, and the general belief was that it would fall early in January at the latest.

On the afternoon of the 6th December while I was packing my optical equipment, a sergeant of the American Air Forces came into my laboratory followed by another non-commissioned officer who was carrying a crate on his shoulder. He had come down in the AAF courier plane from Peking and had been told to deliver the crate, containing ten male and ten female hamsters, to me personally. The only other passengers on the plane were two dachshund puppies. So I took delivery and wondered what I would do with them. I had forgotten that I had written some weeks – maybe months – before to Dr. H. C. Hu (his name escapes me, but can be had easily by inquiry of the China Medical Board in New York), pathologist at Peking Union Medical College, to ask him to get me a small collection of hamsters so that Dr. Schwentker could try to start a colony.

The hamsters were beautifully packed. Each was in an individual compartment in a single cage. Each compartment was filled with wood shavings and had a hardware cloth top through which the hamsters could be fed by putting black beans and kaoliang (millet) on the screen. A supply of food came down with them in a sack, enough for several days; and the instructions were to the effect that they should be fed only once daily, at night, and sparingly. I examined one and it was in beautiful condition with its buccal pouches full of food of some sort.

To complicate matters, I was ill with dysentery and with some sort of respiratory infection, and there was an almost incessant, cold rain. My diary of the 7th December notes that ‘I slept poorly from coughing and from the hamsters (which were in my bedroom) gnawing at their cages’. I had planned to get off for Shanghai by car, a station wagon, so as to haul more valuable items of personal property and laboratory equipment. Everything else was abandoned in Nanking, though some things were later recovered because the Communists didn’t arrive as expected.

On 9th December our Embassy, knowing that I planned to leave for Shanghai at dawn on the 10th, called to say that they would advise against the trip, because roving bands of Communists were across the Yangtze between Nanking and Wushi. They had already fought two minor engagements along the Shanghai-Naking railway that day. These men were thought to be irregular elements of Chen Yi’s forces that had crossed over to upset communications and the countryside generally. I told my informant (Fred Shultheiss) that I would chance the trip, and he replied that the next day would probably be the last chance I would have getting through by road, and he warned against driving at night.

The station wagon was loaded last night (Dezember 9) and in fact was overloaded. I couldn’t decide what to offload and set out with my driver at 0545 with the hamsters riding on top of the load. At the last minute we picked up an extra passenger, a relative of one of the servants. I was running fever, and it was bitter cold, the rain having let up. It was still dark when we reached the east gate (Nanking was a completely walled town with four gates) which swung open prompty at 0600 (December 10) and we went through without stopping.

We reached Shanghai at 1800, just twelve hours later, a distance of about 500 kilometers, as I recall now. We had only one bit of trouble of moment. We had been held up at a checkpoint just at dusk and this delayed us thirty minutes, so that the last part of the journey was at night. Just outside of Shanghai three armed men tried to stop us, but I was driving at the time and drove through them, hitting one.

My diary for the 11th December says, 'The hamsters made the trip just fine and wakened me with their chattering. They are off to the States tomorrow so CGC (my office manager) and I changed their sawdust and examined each one to make sure each was well. Besides, I had to sign a health certificate required by Chinese customs for some reason not clear to me. Judging by the way they eat black beans and kaoliang and chatter all night, they are in fine health. They are cunning little animals, and Hank Lieberman (Henry Lieberman, New York Times correspondent) was so taken with them that he says he is going to write a story on them for the Times to take his mind off the war news, or lack of it.

The hamsters went off to San Francisco and New York on the next day, December 12th. Apart from the fact that the hamsters arrived in New York in good condition, I had never learned until your letter arrived anything about the success obtained in the attempt to breed them in captivity. Perhaps, someday, when I am in Boston, I may see some of the descendants of 'my' hamsters.

With all good wishes, I am
cordially yours,
ROBERT BRIGGS WATSON

The writer was aware of the role played by Dr. C. H. HU, having received a detailed letter earlier (July 1961) from Dr. SYLVIA PAN, University of Pittsburgh, following a visit to Boston, at which time she stated her information stemmed from Dr. HU's daughter whom she had met in Hong Kong. The following excerpts of Dr. PAN's letter supplement Dr. WATSON's account received some six months later.

University of Pittsburgh
Graduate School of Public Health
Pittsburgh 13, Pennsylvania
July 7, 1961

Dear Dr. YERGANIAN:

Thank you very much for your letter of July 3, 1961, inquiring about Dr. C. H. HU who introduced the Chinese hamster to this country. I am most certainly glad to give you my best knowledge of his whereabouts. But if you want to know more than what I could give you, here are the names of two people who associated with Dr. HU for 10–15 years at Peking Union Medical College: Dr. Harold H. Loucks, who can be reached easily through the Chinese Medical Board, Inc. (Rockefeller Foundation), New York City, where he is the ex-Director; the other is Dr. Pao-Chung Hao, through the Department of Pathology, University of Hong Kong, where he is the ex-Department Head.

Dr. C. H. HU is the head of the Department of Pathology at Peking Union Medical College. He received his medical degree from Peking Medical College in the late twenties and did his postgraduate work at Harvard Medical School and in Europe. He has contributed a lot of valuable experimental pathology; that is how he and his colleagues found that the Chinese hamster has unique value as a laboratory animal. They tried to breed the animal in different ways, [once in] a huge underground nest with everything controlled as closely as possible to its natural conditions. This work was interrupted by the Japanese invasion in 1937. The first shipment of Chinese hamsters to the United States was either during that period or after World War II; I am not sure which. After the Communists took over China, naturally Dr. HU was found guilty of supplying scientific material to the enemy country. He was therefore tried and brain-washed in 1955 or 1956. Because he is a well-known person in his field, he had to be put back to his original position instead of exiled to a labor camp after things quieted down.

Don't feel hesitant about getting in touch with the two references I gave you above, in case you would like to know more about Dr. C. H. HU. I think this will add more interest to your article. I surely would be grateful to receive a copy of this article after it is published.

Sincerely yours,
SYLVIA PAN, M. D.
Research Associate

A series of letters and contacts with other persons who may have also known the individuals mentioned in Dr. PAN's letter failed to reveal their whereabouts to confirm and add to this, the story of the Chinese hamster.

IV. Events Leading to Introduction of the Armenian Hamster (Cricetulus migratorius, Pallas)

Soon after the successful breeding of the Chinese hamster at the Brookhaven National Laboratory (February 27, 1952), interest in attempting the same with other species of *Cricetulus* was spurred on by MATTHEY's findings [1957] of Robertsonian relationships between the karyotypes of related species. The possibility of fostering F_1-species hybrids for detailed evaluations of karyotypic alterations and phylogenetic relationships, however, would have to await successful domestication before attempting hybrid matings. Dr. TATE [1952] of The American Museum of Natural History (New York) provided additional taxonomic information which helped to clarify the synonymous relationships of various specimens of the migratorius group *(C. phaeus* and *C. atticus)*, endemic to the Near East. In addition, arrangements to include *C. triton* from Korea were put into effect with the aid of Korean students studying in Boston, who served as liaisons on their return home. The Korean venture proved to be ineffective and efforts were then directed to the Near East. My files (of 1955) indicate a renewal of personal interest following a pause of several years, because of the need to resettle the Chinese hamster colony in Boston.

Dr. WILSON F. DODD of the American School in Talas, Turkey, was the first person to be contacted in the Near East. European taxonomists [PALLAS, 1778; DANFORD and ALSTON, 1880; NEHRING, 1902], trapping in the Near East, generally referred to *C. phaeus* as the 'house-haunting' hamster. This description can, perhaps, be more universally applied to many of the dwarf species of hamster, for they truly dominate as the local 'house mouse' throughout their respective endemic regions from the Near East to the Far East. Invariably, hamsters and mice, *Mus musculus,* occupy different homes. The difference in sites comes about because of the tendency for various hamster species to occupy clean newly constructed homes, while mice tend to occupy the poorly maintained abodes. This division of occupancy is much more evident today when trapping within city limits where new residential homes have been erected. The hamster is the 'house mouse' in such lacales and the ratio of hamsters to mice approximates 200:1.

The common name for the grey hamster of Turkey is 'kara-guz', and in Soviet Armenia 'mokhrakuyne-hamyak'. However, during the course of my correspondence with residents of Turkey, they continually referred to it as 'Gelinjik', which describes an individual who is overly active while gesturing or dancing. In addition, most correspondents referred to 'Gelinjik' as a commonly observed rodent seen in open fields during daylight hours. This description is contrary to the expected nocturnal habits of most, if not all, species of hamsters. The circumstances and confusion of several years were finally clarified, as illustrated by the following communications with residents of Central Anatolia during 1955–59.

At first, the information gathered from these individuals failed to verify taxonomic descriptions of the grey hamster, *C. phaeus* (syn. of *C. migratorius)* notably in the area of Kayseri (Gesaryah). Common names and descriptions received from local residents suggested the 'hamster' to be predominantly *Mesocricetus brandti,* even though DANFORD and ALSTON [1880] referred to *C. phaeus (Cricetus accedula)* as the 'house-haunting' hamster. For example, DODD [1955] of Talas, Kayseri, described his experiences as follows:

There is a small animal that runs around the fields here that is called a 'Gelinjik'; which could be the same as you call 'Galing-gee'. I have never seen them in houses, but they are common in open fields around us. One can see them any day driving past any field ...'

This description of 'Gelinjik', and inference to its larger size in order to be seen readly in an open field, was reaffirmed by others. Presence of the grey hamster first became evident when, a year later (1956), word was received from Dr. P. Çambel of Ankara that our 'joint expedition', financed by a modest sum contributed by the Damon Runyon Memorial Fund towards the purchase of traps and local travel, would soon be underway; and that, 'We have been gathering information about hamsters. Our University zoologists in Istanbul know practically nothing about them and they are not mentioned in their zoology books, but only in some zoology books for high schools. Talking with various people there seem to be grey hamsters as well as golden ones, sometimes in the same region ...'

A few months later, another letter from Çambel indicated still more progress: '... it seems [that] they will appear in increased numbers during the next months until July and August. Most of the descriptions we are getting sound like golden-colored hamsters, but, of course, this may be a different species from the Syrian hamster. They [the rural folk] also speak of grey hamsters ...' For some unknown reason, communications with P. Çambel ceased after April, 1956 and the 'expedition' was never heard from again. Perhaps it never departed from Ankara!

It is most surprising that Dodd, who has lived in Talas for many years, was unaware of the grey or 'house-haunting' hamster. Being nocturnal, this species has rightfully earned its title. Nevertheless, until 1959, the writer was uncertain as to the numbers of grey hamsters one might expect to trap in an arid region in contrast to *M. brandti*. Yet, the taxonomic literature and folklore of both the Far East and Near East associate dwarf hamsters, in general, as the local 'house mouse'. Perhaps this confusion regarding the status of *C. phaeus* in and around Kayseri can be explained by the rather extreme geographical conditions which tend to favor the sighting of *M. brandti* during daylight hours, in contrast to the totally nocturnal habits of *C. phaeus*.

Danford and Alston [1880] described some specimens of *C. phaeus* trapped in Kayseri as having dry pigeon droppings in their cheek pouches. The fact that laboratory hamsters consume rather startling amounts of fecal waste as a nutritive supplement may explain this practice among wild specimens. However, in this instance, this rather unique utilization of another animal's wastes may actually be a basic compensatory practice of many rodent species endemic to extremely arid environs such as Keyseri with its hot, dry summers and lack of palatable surface water reservoirs and streams. Prior to Danford and Alston's trapping *C. phaeus* in Keyseri (and, perhaps to this day) drinking water was piped in from distant sources because of the high saline content of local well water, which was used solely for laundry and general washing purposes. Drinking water was piped to central locations throughout the city and delivered to each home by the 'water man' and stored in covered vats and containers. On occasion, the main pipe lines were cleansed with sawdust to remove rust and debris. Only on such occasions would the water be turned on to flow freely until the pipes were clean. Thereafter, conservation measures were again put into practice. Consequently, field rodents had no immediate source of palatable water, even though adapted physiologically to exist in the desert clime.

It is also quite reasonable to consider that the droppings found in cheek pouches were not derived entirely from pigeons, since they were not abundant in the area and only small numbers were confined to lofts by fanciers [Mezian, 1970]. However, the area was described as having countless numbers of 'sparrows'. Collectively, the lack of palatable surface water, abundance of sparrows, and general limitations of an arid environment, when related to one another, provide a plausible explanation for the droppings found in the cheek pouches.

Unlike *M. brandti, C. phaeus* can survive for only about 1 week without access to water or moist foods. Therefore, to survive, it must remain close to human activities, such as in the house and barnyard where its nocturnal activities are rarely disturbed. *M. brandti* requires less water to survive and, hence, tends to burrow in the fields. Its daytime activities in the open fields must be related to seeking fresh bird droppings, in the absence of palatable water. What other form of activity can explain why an otherwise nocturnal species is seen wandering in arid fields during daylight hours? To what extent fresh bird droppings may also serve nutritionally could be the basis for an interesting experiment, particularly when conducted under field conditions.

The proximity of the grey hamster, *C. phaeus*, to man could also explain its absence during daylight hours. It can burrow in and around areas of spilt and waste water, as well as have access to drippings from feed and water pans during the evening hours. Thus, the degree of dependence to water may be responsible for the tendency of dwarf hamsters to reside closer to man, whereas the more adaptable species of *Mesocricetus* tend to remain isolated in the field, their survival capacity ultimately being determined by the availability of bird droppings in the more arid zones.

Perhaps the most helpful information indicating the abundance of grey hamsters in central Turkey was eventually provided by my maternal aunt. She recalled the following incident which, in turn, led us to seriously consider proceeding with plans to obtain live specimens of *C. migratorius*. The particular incident referred to by my aunt took place at the summer home ('ayki') where my grandfather, a miller ('dermenji'), was having a late evening conversation with his assistant who was standing guard over the bushels of grain delivered earlier by local farmers for milling. When asked how things were going that particular evening, the guard replied that all was well, including the mice and hamsters. My grandfather was apparently intrigued by his reference to several rodents, since one could hardly distinguish a mouse from a dwarf hamster gathered under the carts. His assistant replied by stating that he could judge between the two rodents in the relative darkness by their prowling habits. It seems that mice remain relatively poised while eating the spilled grain, whereas hamsters race to and fro, hastily gathering the grain in their cheek pouches and running off to deposit each load in their nearby nests.

In certain areas of northeastern China, large numbers of animals have been recorded and their pestilence has, at times, seriously impaired the productivity of the land. Interesting accounts of the hoarding nature of one particular species, *Cricetulus (Tscherkia) triton*, the giant or rat-headed hamster, are given by SOWERBY [1914] and ALLEN [1932]. For example, burrows have been located on the south side of graves which descend for many feet to stores of grain amounting to a bushel or more. When extremely numerous, particularly during periods of famine, peasants have survived by digging for the buried grain. Several common names have been assigned to the various species of hamsters in China, such as 'granary rat', 'land grabber', 'landlord', and 'grain storer'. *Tscherkia triton* is perhaps the most injurious rodent to the agriculture of Manchuria and Korea [LOUKASHKIN, 1944]. It seems that during and after construction of the Chinese Eastern Railway in 1898, farmers came to settle the virgin lands of eastern Manchuria. Once the forests were cleared and cultivation began, this hamster emigrated to the opened area, thus following the footsteps of the Chinese peasants. It is a fierce and cannibalistic rodent, killing other species in its immediate surroundings. For example, the striped hamster (*Cricetulus barabensis fumatus* Thomas) (syn. of *C. griseus*) was readily seen until 1933, at which time the giant rat-headed hamster came to occupy the territory. Its burrows are multichambered, with ample storage capacity. Examined seeds (soy bean, pea, and other plants) were of high quality, none having been spoiled or injured by insects. For those interested in utilizing the cheek pouch for their experimentation, it should be mentioned that this species possesses an extremely large one, since its head comprises one-third of its body. As many as 43 soy beans have been removed from cheek pouches of captured animals. In some instances, as much as 5 kg of stored seeds were excavated from a single burrow.

Reinforced with folklore and several negative attempts at collaboration with interested local residents, it was decided that personal participation in the field was imperative and steps were taken to submit details of such a proposal as part of a USPHS grant renewal. Following acceptance of the grant, contacts with various organizations and, particularly, the Academy of Sciences, USSR, proved to be negative at first, while requests for assistance from various countries, through their embassies (Iranian, Pakistani, Turkish and Greek) in Washington, D. C., were most fruitful. In fact, the Greek consular agents recommended the name of Prof. J. C. ONDRIAS, Curator of the Zoological Laboratory and Museum of the University of Athens, as a potential source for *C. atticus*. Once again, as on an earlier occasion, traps and auxiliary equipment were sent to Athens and final arrangements were made to receive and quarantine trapped animals in Boston.

Dr. ONDRIAS was indeed successful in trapping animals – dead ones! Surprisingly enough, he was unable to obtain live specimens even though his bait, peanut butter, worked so well for the killing traps. This bit of cunningness on the part of *C. atticus* was discouraging at first but, as stated above, having been armed with sufficient folklore and knowing that specimens of the migratorius group do abound in the Near East, I felt that ONDRIAS' experience signified the behavioral agility and caution practiced by scarcer members of a species for survival along, and penetration beyond, their geographic boundaries. This contrasts sharply with the ease with which live trappings can be conducted among the teeming numbers of animals that comprise a central or endemic population (as witnessed while trapping in Yerevan, Armenia, SSR) where losses fail to affect the survival of the species. Nevertheless, ONDRIAS' experience further endorsed plans to settle this matter, once and for all, by personal participation in the field.

Although several (synonomous) species of *Cricetulus* are to be found in any of several countries whose embassies had graciously extended an invitation, the final choice of country was delayed until word was received from the USSR. With all due respect to the generous offers of cooperation made by the consular agents of the other countries, circumstances were such that, on this one and only occasion available to us, trappings had to encompass as wide a territory as possible in order to fulfill long-range programs. An opportunity to include Siberia in our travels could lead to specimens of *C. griseus* once again. However, this time they would be employed to determine the eastward distribution of the genotype for diabetes mellitus. This syndrome was observed in all partly inbred animal lines which stemmed from nonsymptomatic, random-bred stock received initially from SCHWENTKER [MEIER and YERGANIAN, 1959]. The role and significance of the multifactorial diabetic genotype maintained in the heterozygous state of wild-type populations could very well provide some insight toward the future trends of this mutation in man [YERGANIAN, 1965]. Aside from this important spin-off from earlier efforts to inbreed, the availability of several species of *Cricetulus* could also serve as a nucleus for obtaining F_1-species hybrids which, if even partly successful, would provide an excellent series of biologicals pertinent to mammalian somatic cell genetics. Thus, the need for a variety of species could be fostered only by conducting the field work in Russia and Siberia.

In addition, experiments conducted with the Chinese hamster, notably those pertaining to *in vivo* and *in vitro* carcinogenesis, employing hydrocarbons and oncogenic DNA viruses, suggested that inbreeding was highly imperative if this species was to be effectively employed in such investigations [YERGANIAN, 1966; YERGANIAN *et al.*, 1966, 1968]. The rigid histocompatibility relationships had to be satisfied by means of advanced brother-sister matings before skin and tumor transplantations could be genetically related. Judging from the rate of inbreeding the Chinese hamster, duplication of this task with another species would again require considerable time and effort. Contrastingly, the ease with which skin and tumor transplantations are conducted with random-bred Syrian hamsters tends to shift the Chinese hamster into the category of murine-like animals, such as the mouse and rat.

It was reasoned that the comparatively weak immunological mechanism of the Syrian hamster may, in part, be a reflection of peculiar selective (environmental) mechanisms to which the species had been exposed during the course of its evolution. Therefore, it was reasonable to assume that other rodents endemic to this region may have also experienced parallel genetic trends while responding to nearly identical selective pressures. If this proved to be correct, the Armenian hamster would exhibit physiological properties characteristic of the Syrian hamster, while retaining cytogenetic properties of its taxonomic relative, the Chinese hamster. Such a combination of appropriate physiological and cytological features in one animal would indeed be useful in the laboratory. (This *a priori* consideration has now been borne out, following a variety of experiments to evaluate the Armenian hamster since its introduction in 1963–1964.)

During the ensuing 3 years (1960–1963), efforts to obtain new species of dwarf hamsters and additional Chinese hamsters finally bore fruit. Dr. MURRAY J. SHEAR of the National Cancer Institute, Bethesda, suggested that our proposal be submitted for consideration as part of the USA-USSR Cultural Exchange Program. In essence, the proposal was based upon a joint effort with members of the Laboratory of Experimental Oncology and Chemotherapy at the Roentgen Institute in Yerevan, Armenia, SSR, whose Directors, Dr. B. FARNARDJIAN and Dr. S. POPOYAN, had visited Boston as earlier participants of the Exchange Program. Final arrangements were made through the auspices of the Director's Office, National Cancer Institute (Dr. M. Sloan) and the Office of International Health, HEW (Miss Francis Cutter), in association with the Ministry of Health and Medical Academy of Sciences, USSR. Furthermore, arrangements to ship some 500 pounds of laboratory and field equipment were also finalized.

Our itinerary included a visitation with taxonomists in Leningrad to review distribution patterns of dwarf hamsters and to seek the collaboration of their colleagues throughout Siberia. With Yerevan as the center of our activity, live trappings from Siberia could be received and quarantined most effectively. These plans, although accepted and encouraged as being quite feasible, rapidly disintegrated following our arrival in Yerevan (September, 1963). Restrictions and delays ultimately reflected the preplanned activities of the one person who, on behalf of the Ministry of Health, was responsible for our stay in the Soviet Union. For example, Dr. V. D. MAKAROV of the Ministry of Health in Moscow proposed that we resubmit our itinerary upon arriving in Yerevan. A single page (typed, double-space), abstracting our itinerary already on file at the Ministry, was sent to him. However, before considering the schedule, the itinerary had to be translated into Russian, even though Dr. MAKAROV spoke and read English extremely well. The resulting delay of 18 days was sufficient grounds to cancel our plans for the Siberian collection of animals. In the interim, our cargo was being delayed in Moscow. Repeated efforts by telephone, cable, and personal visits resulted in reducing the delay to 35 days. Meanwhile, animals were effectively being procured by the repeated use of a single trap. Caging and watering of animals, however, were ineffectively being attempted using available facilities and by feeding bread soaked in milk and water. Consequently, the trappings were limited to only 1 species – *Cricetulus migratorius,* the grey hamster of Armenia (fig. 2).

While the above events were being experienced, plans were put into effect to obtain the appropriate documents (Certificate of Health and Release of Animals) necessary for the exportation of animals. Months later, after our equipment had

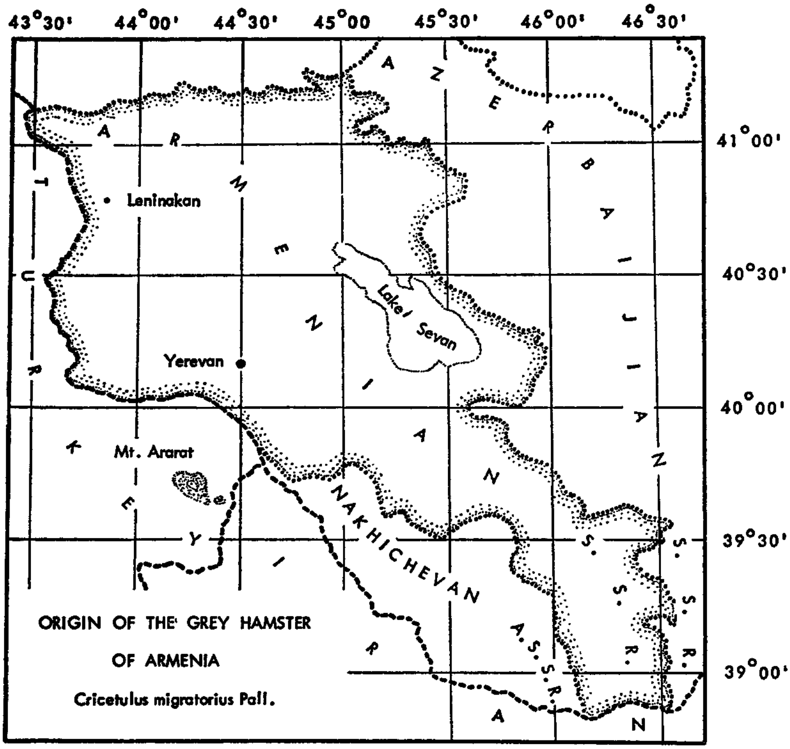


Fig. 2. Example of desired form of geographic mapping denoting exact site(s) of trappings leading to domesticated specimens. In this instance, trappings were conducted in and around Yerevan (lat., 40° 10′; long., 44°, 30′).

finally arrived and some 200 animals had been quarantined and surveyed for ecto- and endoparasites, the local health minister refused to grant permission for preparation of the required documents. This blatant decision was still another reflection of the difficulties encouraged and, possibly, promulgated by MAKAROV in Moscow to disorient and negate our progress. By December 1963, the time had come to leave Yerevan, with or without the animals. As a final measure to counteract the negativity of administrative officials, several moments of embarrassment were conceived. In the first place, the local minister of health, who had refused to grant permission to process the documents because of 'the presence of hoof-and-mouth disease in the vicinity', was informed that the hamsters were, indeed, healthy; so healthy, in fact, that he might consider substitution of hamsters as a meat source when the livestock, which was being butchered because of the lack of feed grain, became exhausted. And to facilitate such a decision on his part, I would sign a Certificate of Health covering the entire endemic population of hamsters! Furthermore, to reinforce our response, cables were sent to various agencies in the USA informing them of our predicament and also stating that the field equipment was to be repacked and shipped to Ankara, Turkey via Moscow as excess baggage. Although there would be a delay in our progress for one more year, the grey hamster would be trapped on the other side of Mt. Ararat and, in turn, named the 'Turkish hamster'. With these final details out of the way, the necessary equipment was packed and addressed to Dr. P. ÇAMBEL, Ankara, Turkey.

Several days later when the time had come to depart, the necessary documents appeared on the scene several hours before flight time. After some minutes of deliberation, some 70 animals were selected randomly and placed in the shipping crates packed earlier for delivery to Ankara. Upon arriving in Moscow, additional delays (up to 3 days) were imposed upon the shipment by the veterinarian at the airport. Once again, the lack of suitable documents issued, this time from Moscow agencies and laboratories, was the cause of delay. Fortunately, I was given a telephone number just prior to leaving Yerevan, and told to refer to it in the event of any further delays en route. The persistent efforts of Mr. ANDRIAN of the Sabina Airlines minimized the delay in making this important telephone contact, and he was able to place the animals aboard his flight to Brussels after holding its departure for 45 min. If the particular telephone number had not been on hand, the Armenian hamsters would have had to be sacrificed in the airport incinerator.

Upon arrival of the shipment in Boston, only 1 animal had succumbed en route. Following another 30-day quarantine period, test matings were conducted and an initial series of pregnancies was obtained during late December 1963. By mid-January, 1964, a slight adjustment in caging design resulted in a mass regulation of estrous cycles, and pregnancies were obtained routinely thereafter.

V. Status of Other Hamster Species as Laboratory Specimens

A. The Rumanian Hamster (*Mesocricetus newtoni,* Nehring)

Distribution of the Rumanian hamster appears to be limited to several laboratories in and around Bucharest. The colonies stem from specimens initially trapped and described by HAMAR and SCHUTOWA [1965], as referred to by RAIÇU and BRATOSIN [1966] in their description of the karyotype consisting of 38 chromosomes. Care and management of this species is, no doubt, quite similar to that of *M. auratus*. Provisions to compensate for its pugnacious tendencies and possible decline in fecundity and vigor during the early phases of inbreeding will, no doubt, be described and evaluated elsewhere by present users.

B. The Transcaucasian or Kurdistan Hamster (*Mesocricetus brandti,* Nehring)

The writer is aware of only 2 laboratories presently maintaining this species. Animals reared by Dr. C. LYMAN of Harvard Medical School, Boston, were obtained from BILLINGHAM, who in turn received the original specimens from Dr. BAHMANYAR of the Institute Pasteur in Teheran, Iran. The original shipment to BILLINGHAM in 1962 consisted of 2 adult males and a female with 10 young trapped in the vicinity of Pirbadan in Kurdistan [PALM *et al.*, 1967].

Specimens of this species were periodically trapped during the nineteen-sixties by Dr. V. N. ZILFIAN, Institute of Roentgenology and Oncology, in Yerevan, SSR. Prior to 1963, ZILFIAN had not bred them in captivity but soon thereafter he did succeed, and has reported the animals to be very fertile and easy to rear in captivity [ZILFIAN and FITCHIJIAN, 1968]. These authors confirm LEHMAN and MACPHERSON's description [1967] of the diploid chromosome number of 42.

C. The Djzungarian Hamster (*Phodopus songorus,* Thomas)

The colony of Djzungarian hamsters, maintained by POGOSIANZ and SOKOVA [1967], stems from 2 breeding pairs provided by Dr. M. N. Meier of the Zoological Institute, Academy of Sciences of the USSR, Leningrad. The breeders were third-generation progeny from animals trapped in Tuva (Siberia). The present colony was derived from 1 female bred to 2 males. These animals yielded 744 newborn during the course of 5 generations of matings.

The Djzungarian hamster is, without a doupt, the most timid of the species of hamsters yet encountered. This feature is well documented in taxonomic literature describing both *Ph. songorus* and *Ph. roborovskii.* ALLEN [1922] states that M. P. ANDERSON and SOWERBY were 'unable to find the burrows of these animals and it seems probable that the shifting sand closes their entrance as soon as the animal has passed through'. In addition, these dwarf hamsters tend to occupy the burrows of *Meriones*, instead of digging their own. SOWERBY [1914] stated that he and ANDERSON found them to make 'charming pets, being very easy to keep and naturally tame . . . have amusing habits . . . and are scrupulously clean'.

The karyotype, $2n = 28$ [MATTHEY, 1957, 1960] was confirmed by POGOSIANZ and BRUYAKO [1967], in addition to proposing the use of this species for cytogenetic studies.

VI. Cytotaxonomy of Hamsters

The Old World (Palaeartic) hamsters are classified in the subfamily *Cricetinae* (Cricetidae) with some 70-odd taxonomic forms (species and subspecies) distributed among 5 major genera: (a) the genus *Cricetus*, which is found in Central Europe, westward into Belgium and France and eastward to Kazakstan; (b) the genus *Mesocricetus*, which ranges from eastern Europe, Asia Minor, Transcaucasia, and Iran; (c) the genus of small or dwarf hamsters, *Cricetulus* and its several subspecies, spans an extensive area from Greece and Asia Minor, eastward through Russia, Tibet, China, Mongolia, and Korea; (d) the genus *Phodopus (Cricetsicus)* which occupies the arid regions of China, Tibet, Mongolia, and Siberia; and (e) the genus *Cansumys*, limited to a single species found in China and Mongolia. Several extensive compilations on taxonomy and distribution of the various hamster species have been prepared by ALLEN [1932], ARGYROPULO [1933], ELLERMAN [1941], TATE [1947] and ELLERMAN and MORRISON-SCOTT [1951].

Chromosome numbers of karyotypes and taxonomic relationships of representative specimens of *Cricetinae* have been evaluated primarily by MATTHEY (table I) and subsequently confirmed by others. At present, the greatest degree of chromosomal polymorphism (number and form) is confined to the genus *Cricetulus* and its subgenera, *Allocricetus* and *Tscherkia*. Their chromosome numbers range from $2n = 20$ to $2n = 30$, indicating that members of *Cricetulus* have undergone extensive chromosome alterations during the course of isolation and speciation over a wide and varied geographical range.

Collectively, there are some 70-odd races cited for the 5–10 genera of hamsters [ALLEN, 1932; ARGYROPOULO, 1941; TATE, 1947; ELLERMAN and MORRISON-SCOTT, 1951]. However, cytological studies have thus far been limited to some 12 species and subspecies [MATTHEY, 1958, 1960]. The latter type of information is highly essential, for it substantiates the presence (or absence) of chromosome polymorphism among the different forms of a species, particularly those having a wide geographic range. The need for further cytological studies is warranted because of discrepancies in classifications based upon details obtained from a few specimens which may reflect morphological variations due to seasonal and ontogenic fea-

Table I. Cytotaxonomy of Old World hamsters, subfamily *Cricetinae*[1]

Genera (sub-genera) and species	Common name(s)	Chromosome Nos.
Genus *Cansumys*, Allen		
C. canus Allen	grey long-tailed hamster	?
Genus *Cricetulus*, Milne-Edwards		
C. barabensis Pallas		20
C. griseus Milne-Edwards	striped-back or Chinese hamster	22
C. lama Bonhote		?
C. alticola Thomas		?
C. longicaudatus Milne-Edwards		?
C. migratorius Pallas	grey or Armenian hamster	22
Sub-genus *Allocricetulus*, Argyropulo		
A. curtatus Allen	stumpy-tailed hamster	20
A. eversmanni Brandt		26
Sub-genus *Tscherkia*, Ognev		
T. triton DeWinton and Styan	giant or rat-headed hamster	30
Genus *Cricetus*, Leske		
C. cricetus Linnaeus	European hamster	22
Genus *Mesocricetus*, Nehring		
M. auratus Waterhouse	golden or Syrian hamster	44
M. brandti Nehring	Transcaucasian or Kurdistan hamster	42
M. newtoni Nehring	Rumanian hamster	38
Genus *Phodopus*, Miller (*Cricetiscus*, Thomas)		
P. songorus Thomas	Djzungarian or striped hairy-footed hamster	28
P. roborovskii Satunin (syn. *P. bedfordiae* Thomas)	Duchess of Bedford's desert hamster	28

1 Modified to include cytological relationships outlined by MATTHEY [1958, 1960] with taxonomic features presented by ALLEN [1932] and ELLERMAN [1941]. For details, see text.

tures, rather than comparable patterns that become fixed due to subspeciation. A case in point involves *C. migratorius atticus* and *C. migratorius phaeus*. Specimens of *C. migratorius* trapped in and around Yerevan during the fall and early winter of 1963 [YERGANIAN and PAPOYAN, 1965] had been previously described by others as *C. m. pulcher* Ognev (Furova-Morozova and Shidloski); *C. m. vernu-*

la Thomas (Pidoplichka); *C. m. cinerascens* Wagner (Neuhauzer), *C. m. phaeus* (Ellerman) and *C. m. isabellious* De Filippo [Ellerman, 1941]. The coat colors of these live specimens ranged from the characteristic smoky-grey of younger animals to the roan-like hue among certain obese females which weighed over 85 g. In the event trappings were sporadic and intermediate forms were lacking, these animals would have had to be placed temporarily into 2 racial categories, prior to conducting cytological studies and breeding in captivity. Pelts of *C. m. atticus* obtained in Greece by J. C. Ondrias were identical to those of the younger *C. m. phaeus* trapped in Yerevan. Both groups matched well with pelts of their respective races checked at the Smithsonian Institute, Washington, D.C., and Museum of Comparative Zoology at Harvard University [Yerganian, 1963].

In attempting to relate the live specimens trapped in Yerevan to descriptions assembled by Ellerman [1941], the animals currently breeding in Boston have the smoky-grey dorsal hair and stark white ventral hair pattern and, based upon taxonomic codes, they are intermediate between *C. m. vernula* and *C. m. cinerascens.* The entire breeding colony in Boston (and Yerevan) displays a difference in the relative sizes of chromosome pair No. 8 [Yerganian and Papoyan, 1965]. This distinction between members of a somatic autosomal pair is termed 'autosomal heteromorphism', i.e., 8a8b. To what extent such features may actually be involved in reflecting the different geographic populations of *C. migratorius* as an indication of early signs of subspeciations, i.e., 8a8a or 8b8b, remains to be seen. The final answer can only stem from reciprocal matings of animals procured from extreme geographic points, such as Greece and Turkey, Armenia and Syria, Russia, Siberia and Afghanistan.

A. Cytogenetic Mechanisms Implicated in Speciation

Matthey [1957, 1959, 1960, 1961] has applied the Robertsonian Rule to graphically illustrate the structural relationships among karyotypes of certain related species of hamsters. The Robertsonian Rule is one that implicates centromeric fusions and breaks as historic cytological mechanisms leading to speciation through the formation of new chromosome types as seen in related species. For example, the fusion of 2 rod-shaped (acrocentric) chromosomes at their centromeres results in the formation of a single V-shaped (metacentric) chromosome. Conversely, a V-shaped chromosome may misdivide transversely at its centromere to produce 2 functional rod-shaped chromosomes from each arm. In this manner, simple changes in chromosome number and form can take place during the course of speciation, while the number of chromosome arms (and genomic content) remains relatively constant. Since many rod-shaped chromosomes tend to have a small amount of chromatin representing the 'short' arm adjacent to the centromere, it is reasonable to assume that such chromatin (satellite DNA) is lost in the course of fusions to form metacentrics. The late-replicating nature of this kind of chromatin suggests its DNA to be genetically inactive and its loss need not be detrimental. Also, such events reflect the degree of genetic redundancy that resides within the mammalian genome.

B. Cytotaxonomy of the Genus *Mesocricetus*

The 3 species comprising this genus, *M. auratus, 2n = 44* [MATTHEY, 1957; LEHMAN *et al.*, 1963], *M. brandti, 2n = 42* [LEHMAN and MACPHERSON, 1967; ZILFIAN and FITCHIJIAN, 1968], and *M. newtoni*, $2n = 38$ [MATTHEY, 1959; RAIÇU and BRATOSIN, 1966; RAIÇU *et al.*, 1968] are considered, taxonomically and cytologically, to be good species. The status of *M. raddei* must still be resolved. Although it is considered presently as a race or biotype of *M. brandti,* karyotype analysis and breeding trials with *M. brandti* are expected to substantiate this relationship.

Each of the 3 species of *Mesocricetus* possesses karyotypes which, because of their size, number, and form, cannot be accurately applied to determine the degree of Robertsonian involvement or the direction of speciation, cytologically speaking. One cannot judge whether the trend in speciation followed numerical increase, i.e., 38→42→44, or numerical decrease, i.e., 44→42→38 in the number of chromosomes. Of the 3 species, the Syrian hamster appears to have the narrowest geographic distribution.

Successful hybridization among members of the genus *Mesocricetus* has been limited thus far to reciprocal crosses involving the $c^d c^d$ mutant of *M. auratus* × *M. newtoni* [RAIÇU and BRATOSIN, 1968]. It is surprising that attempts to hybridize the 2 species employing the agouti *M. auratus* were repeatedly negative. The hybrid is described as being temperamentally closer to the Syrian hamster. Hybrids of both sexes are completely sterile, with only a few male spermatocytes reaching metaphase I.

C. Cytotaxonomy of the Genus *Cricetulus*

As stated above, this genus has the widest range in chromosome numbers, i.e., from $2n = 20$ to $2n = 30$, and several species and subspecies display Robertsonian relationships quite clearly. For example, in the barabensis group, *C. b. barabensis* ($2n = 20$) and *C. b. griseus* ($2n = 22$) differ by only 2 chromosomes. Karyotypic analysis by MATTHEY [1960] indicated the 2 smaller submetacentrics of the *C. b. griseus* karyotype to have fused to form 1 V-shaped autosome in *C. b. barabensis.* Although morphological and geographical considerations indicate that the 2 species are quite distinct, breeding trials and large field collections would provide the final answer as to their true status as subspecies or good species.

A more extensive series of Robertsonian relationships is noted for the subspecies of *Allocricetus, A. curtatus* ($2n = 20$) and *A. eversmanni* ($2n = 26$) [MATTHEY, 1960, 1961]. The karyotype of *A. curtatus* contains 3 metacentrics which are represented in *A. eversmanni* as 6 telocentric chromosomes. The remaining chromosome types appear to be identical in both species. Thus, by either fusion of 6 telocentric chromosomes or misdivision of the centromeres of 3 metacentric chromosomes, the karyotypes of these 2 species can be interrelated as having a common or prototype origin. In both the above-mentioned instances (*C. barabensis – C. griseus* and *A. curtatus – A. eversmanni),* sex chromosomes are not implicated in any of the structural realignments.

Phodopus songorus, $2n = 28$ [MATTHEY, 1957, 1960; POGOSIANZ and BRUYAKO, 1967] and *Phodopus roborovskii,* $2n = 28$ [MATTHEY, 1957, 1960] have virtually identical karyotypes. Although both species display differences, morphologically and ecologically, they may be expected to hybridize successfully, as in the case of *M. brandti* × *M. raddei.*

Tscherkia triton, $2n = 30$, possesses primarily acrocentric chromosomes, a feature that is unique among the various hamsters [MAKINO, 1951].

Although *C. m. migratorius,* $2n = 22$, has the same chromosome number as *C. b. griseus* [MATTHEY, 1960], Robertsonian relationships have been totally masked by numerous translocations and other rearrangements. The only plausible chromosome type which might have remained intact in the course of divergent speciation from an ancestral prototype is chromosome No. 4 of both species [YERGANIAN and PAPOYAN, 1965]. The observance of heteromorphism of an autosomal pair, 8a8b, in *C. migratorius* suggests that segments of this rather widely scattered group of dwarf hamsters may be experiencing some subspeciation at the present time. This possibility can only be checked by extensive field trappings at extreme ends of its wide geographic range, followed by cytological and breeding studies to determine the degree of association, if any, of minor chromosomal polymorphism with subspeciation.

The latest review on the findings of other authors regarding structural features of the sex chromosomes of various species of hamsters are presented by LAVAPPA and YERGANIAN [1970].

VII. Discussion

Chronologically, domestication of hamsters is judged to have taken place as follows: *Mesocricetus auratus,* 1930–31; *Cricetulus griseus,* 1949–52; *Mesocricetus brandti,* 1962–63; *Cricetulus migratorius,* 1963–64; *Phodopus songorus,* 1965; and *Mesocricetus newtoni,* 1966. Failure of ADLER's group to succeed with *C. m. phaeus* was indeed unfortunate. Aside from contributing *M. auratus,* the availability of *C. m. phaeus* as another of their hamsters would have added appreciably toward generating renewed interest in mammalian cytogenetics as we know it today. Active cytologists, such as KOLLER and MATTHEY, were in excellent positions during that period to include domesticated species in their general surveys of the meiotic chromosome of mammals. Once revealed, the low chromosome number and large sex bivalent would have made an early and profound impact upon the designation of suitable rodents for experimental cytogenetics. Had they succeeded, the Chinese hamster might never have been considered for domestication. The combination of excellent cytological features, desirable physiological traits, including susceptibilities equivalent to *M. auratus,* would have hastened the ever-expanding role of the Armenian hamster.

Throughout this documentation, reference has been limited to successful reports of domestication and breeding in captivity. Yet, there were several instances when hamsters bred by themselves while displayed as wild specimens. The first occasion took place at the London Gardens during April–September, 1920, when 3 litters of *C. migratorius* were born [ZUCKERMAN, 1952–53]. The second occasion at this same locale involved the birth of 4 litters of *C. triton* during April, 1928, to June, 1929. It is also of passing interest to note that AHARONI managed to sustain the litter of 10 Syrian hamsters, which he dug from their mother's burrow (2.5 m deep), on a meat diet for several months while in the field, prior to returning to Jerusalem by the end of July 1930.

Within days, the remaining litter-mates bred successfully [ADLER and THEODOR, 1931].

These earlier trends, when coupled with personal experience in handling wild-type *C. migratorius*, emphasize the need to exercise patience by simply delaying mating trials for at least 3–4 months when newly captured animals fail to breed immediately. The most recent application of this procedural delay involved a Venezualian species of *Akodon*. After repeated failures to breed them in Caracas, Dr. O. REICH shipped newly captured animals to our laboratory during the winter of 1967. After some months of negative results, the neglected animals suddenly bred spontaneously while housed in caging designed for hamsters[3]. To reiterate, had ADLER's group been a bit more patient, their contribution would have been magnified considerably by the successful propagation of *C. migratorius*.

Sufficient knowledge has been accrued during the past 20 years to qualify the statement that virtually all species of wild hamsters may be readily bred in captivity by simply applying the experiences gained to date. Consequently, the history of hamsters will, hereafter, be confined to and advanced within the laboratory. Efforts must be concentrated upon inbreeding and development of inbred strains. This emphasis upon inbreeding is, perhaps, the greatest task (and risk) an investigator can assume, for it requires considerable time and losses can be quite extensive. However, once the task has been accomplished, the vastness of available avenues of exploration due to genetic homozygosity is far too profound to list in detail at this time.

Hereafter, individuals interested in domesticating a new rodent species must also consider assuming the burden of inbreeding, if they truly wish to qualify their efforts toward the development of effective laboratory specimens. To what extent these goals can be satisfactorily met with current specimens remains to be seen.

Acknowledgements

The author wishes to express his sincerest gratitude to the individuals whose personal experiences have made this documentation possible. Fulfillment of many personal goals with dwarf hamsters has stemmed from the years of encouragement and interest by Dr. SIDNEY FARBER. The unselfish efforts and devotion of

3 SONNENSCHEIN and YERGANIAN, unpublished data.

Mr. HENRY J. GAGNON, leading to advanced inbred strains of dwarf species of hamsters, deserve more than these few words of acknowledgment.

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Addendum

Excerpt from Memoirs of a Hebrew Zoologist (1942)

ISRAEL AHARONI

Translated from the original Hebrew by Marshall Devor, Department of Psychology, Massachusetts Institute of Technology, Cambridge, Mass. Permission to use this translation here has been granted by the publisher of the entire book, Am Oved Limited, 22 Maza Street, Tel Aviv, Israel.
(Chapter on 'The Golden Hamster', pp. 132–145)

Today, thousands of details on the golden hamster have been disseminated in America and in the British Empire. And what is the source of this beautiful hamster, whose only natural habitat in the whole world is the region of Aram-Zova[1]? Jerusalem! But does a single one of the many doctor-researchers in those countries know who provided him with the source of this dear rodent now in his laboratories? This singular rodent that makes possible several medical tests and assays that would have been impossible without it, before this hamster came into his hands? This rodent that is so useful for no mean number of medical tests? Though the following words are merely historical, their memory will probably fill many lines in books on the history of medicine. Students of medical history will justly be interested in the primary sources in which are described the experiences upon which they base their work. Among the many species of mice[2], the hamsters are the most susceptible to the Leishmania germ[3], as one example, the germ that threatens the lives of patients with the evil disease of the same name. For experiments, assorted hamsters were used; but they couldn't be raised in captivity, in lab cages. One couldn't raise them because the female would kill the male as soon as she was able. It was always necessary to collect thousands of new hamsters yearly, in the wild. What great investments this necessitated! Aside from that, the finding of hamsters in the wild was more a matter of chance than a dependable, orderly venture; this fact caused the abortion of many experiments, and was a great impediment to the progress of research. Nonetheless, medical researchers in the field had no choice but to follow the well worn path of searching for new hamsters in the wild. This situation was eased when Mr. and Mrs. Aharoni brought 10 golden hamsters to the Land of Israel.

The following is the story of the golden hamster, an animal that will doubt-

1 Translator's note: Aram-Zova is the Hebrew name for Aleppo, a large city in northwestern Syria.

2 Translator's note: Hebrew word used was 'achbar', meaning mouse.

3 Leishmaniasis is a common disease in the Mediteranean area found primarily in children under 6 years. The cause of the disease – a microscopic flagellate. Its carrier is the flea and other blood sucking organisms.

less serve, perhaps shortly, as an experimental subject in new medical tests that will result in saving thousands of patients from death, or at least from extended suffering. Upon our return from the sea of Antiochia[4], where we had spent two months studying its fauna, my wife and I stopped for 8 days in the area of Aleppo.

Georgeus, my Syrian guide (his native languages were Arabic and Syrian; spoke and wrote in the language of the biblical commentator Unkelus [an Aramaic dialect similar to Hebrew]) went according to my instructions to a certain farm, about 30 km from Aleppo. When he arrived there, he explained his mission to the local sheik (sheik El-Beled). He said to him, 'My lord surely is familiar with the disease that is found primarily in Aleppo, the city near this farm. I mean, "Hub-Halebi", the evil disease that gouges deep wounds on the faces of those who suffer from it – the sickness that leaves skin blemishes, that makes good looking girls and handsome young men ugly by leaving pock marks on the forehead, face, cheeks, chin, and palms. And there are cases where this disease kills its host. A certain Jew, a resident of Jerusalem, told me that the carrier of this scourge to man is a kind of very small flying insect, and doesn't warn of its approach by humming like the mosquito does; it is the one that bites at night, whose young grow in still water, in sewers and ditches, and so forth. But before one can cure these patients, one must develop a medication. Such a drug can only be prepared by many tests involving the infection of the variety of hamster that lives in your farm.'

When the sheik heard this he said, 'Before we try to trap this hamster, we must know in whose fields he is to be found. I shall call a meeting at which I will present your plan, advising in favor of it, and we will hear what the others have to say.'

And thus he did. At the meeting, it was decided to hunt out this creature in one of the best fields, a field that the hamster had chosen to colonize. The sheik hired a few laborers and they dug in many places destroying a good part of the wheat field. After several hours of hard work, they succeeded in raising from a depth of $2^1/_2$ meters, a complete nest, nicely upholstered, with a mother and 11 young! They had all been brought into a large burrow-fortress whose diameter was about 35 cm. Thinking that the mother would care for her young, raise her infants and feed them, Georgeus put the whole family into a colony box. But his hopes were not fulfilled. Chateaubriand, the famous French author, in his moving story 'Les Natchez', tells of how Adario who, upon seeing that his daughter has been stripped and displayed for public sale as a slave girl, and that her infant (his grandson) whom she held and squeezed close to her heart would be separated from her forever, to be a slave to some rich man who would afflict the small child with grueling labor when he grew up, turned to his daughter and pleaded that she pass him her dear child so that he might kiss it one more time before they were separated in eternal slavery. When the daughter extended him the baby, he hugged it to his chest with such force that the infant was smothered to death in the arms of its grandfather. The

4 Translator's note: a small lake near the town of Antioch on the Mediterranean coast of Syria.

poor old man, who himself was to be sold, then gave the body of his dead grandson to its mother, his daughter, and cried aloud, 'I have won! It is better that my grandson not live at all than that he live a life of eternal slavery!'

Darwin always described 'savages' as highly evolved animals, like anthropoid apes. This thought came to me as I saw the mother hamster (a creature whose evolutionary level is not high) harden her heart and sever with ugly cruelty the head of the pup that approached her most closely (each of the young measured at the time just under $2^1/_2$ cm). Natural mother-love led her to kill her dear child: 'It is better that my infant die than that it be the object of an experiment performed on it by a member of the accursed human race.'

When Georgeus saw this act of savagery, he quickly removed the murdering mother hamster (for she would surely kill them all!) and put her in a bottle of cyanide to kill her.

I now had to attend to 'the ten sons of Haman', who would soon have been killed in a most vicious manner, in accordance with that explicit injunction of Moses (may he rest in peace), *When you raid a nest, chase away the mother before taking the young* (essence of Deut. 22: 6, 7). The eyes of the infants were still entirely closed; they could neither walk nor move around. The inn room was colder than 0 °C, and when the lantern flickered, the poor creatures were in danger of freezing to death. It didn't even help that they were huddled together and piled one on top of the other. I wrapped the whole outside of the cage in cotton and they pulled pieces of it bit by bit inside and built themselves a round nest to sleep in. Their 'menu' included several items – green wheat stalks and grains, barley still moist and also corn stalks (it was a good year), all sorts of breads; they particularly liked dough mixed with oil or both egg yolk and oil, and then baked in an oven, sweet cakes made of flour, beans or cucumbers (which served to quench their thirst as well, because the water would dampen their bedding material), cooked hedgehog meat, and fat. All of this seemed not to do them any harm, in my opinion. My luck held out and they didn't shun any of these things. And what a beautiful performance it was to see them hold one strand of wheat or a piece of meat between their paws and pass it into their narrow mouths to quickly devour it, with their lips barely moving and their eyes squinting like those of an old scholar praying with great fervor.

'Thank God!', I said to my wife who was accompanying me. 'All is well. They are eating heartily, and this shows that they are healthy and full of life.'

I held my parcel in my hand all the way back to Israel for fear that the heaving of the vehicle might upset and scare them or knock their soft skulls against the wire of the cage. I kept a constant eye on them and brought them hale and healthy to Jerusalem!

On our trips to Rehovot we always took them with us, and when we returned to the capital, we brought them too. With their cute looks they delighted the police at the Bet-Dagon station which we passed on our way to and fro. By the end of the month I moved them to a cubic cage, 35 cm on a side, with a straw floor. To their menu I added many plants, as well as nuts and almonds – so that they might gnaw on the hard shells; this is to prevent overgrowth of their front teeth.

After $2\,^1/_2$ months, I began to think about their future. They had already grown noticeably and their night time needs and calls I attributed to their close quarters. The possibility that they were crying out of pain hadn't occurred to me. I had never handled or bred this variety of rodent before and I considered my 'orphans' to be so young that they hadn't yet reached puberty and were still, so to speak 'free from sin . . .'

At one point something happened which just about shook the foundations of our house and collapsed its walls. My wife, my partner in all my trials and tribulations, took it upon herself (for the sake of Jewish science and human medicine) to tend the hamsters at Rehovot. She filled her difficult role energetically, with exemplary dedication. Night and day she concerned herself with their welfare; and there were nights when she didn't sleep at all. She was always late for social events. Whenever someone would come to visit me at our house for the evening, he knew that Mrs. Aharoni would be busy tending the hamsters from sunset till nightfall. Late one night the screams of the hamsters frightened her and she got up to listen to them as was her habit. Quickly she opened the cage door, looked inside, and was shocked... oh no! Because she had been exhausted, she hadn't locked the cage with care, and all the hamsters had gotten out into the room.

Soon after this a noise had begun that was entirely different from the sounds the hamsters made on other nights, and even an hour beforehand. It was a noise that filled the whole room. The space under the wooden floor shook 'like the distruction of Sodom and Gemorah.' By the light of the lantern which she lit, she checked the cage – finding it wide open without a single hamster inside. Her heart skipped a beat... she moved decisively; deftly she scooped up in her palm the four that had not yet managed to find a hiding place beneath the floorboards, and put them back in the cage, before they had any chance of recovering from their fear. The suddenness of this maneuver made them forget their teeth, that they could bite, and they didn't. The remaining six had gnawed rapidly through the thin plaster strip between the floor moulding and the walls – several holes had been gnawed into it, and disappeared through them beneath the room. If they were left there, they would scratch and dig at the wall, in order to open a way outside. It was easy to see what terrible havoc they would wreak on the house with their healthy powerful chewing muscles and their teeth – steel chisels are nothing in comparison! The following day she called a carpenter to lift the floor in order to catch the naughty bunch.

That same day my travels brought me to Rehovot and I saw the damage with my own eyes... among the suggestions and theories that were voiced was the fear that the hamsters might have already found a passage from room to room and that pulling apart the floor in one room might not be enough. For this reason we delayed raising the floorboards for a few days. Since, in the space between the boards and the ground, the hamsters couldn't find the necessities of life, a food supply, they were forced to enter the room for a short moment to hoard for their hideouts the bread or cucumber that we left as bait; after grabbing the morsels, they popped back out of sight. And so we conceived this scheme: we left sheets of paper around the edges of the floor and on the papers we put various goodies. I lay in the bed beside the wall. 'These treats', I figured, 'would bring even the most cautious from its hiding place, would induce even the most fervent ascetic to indulge himself'. All that night I stayed wide awake and listened for each creak or slight movement. When a hamster came out of hiding, the sheets of paper rustled. At that moment I jumped over my bed quick as if a snake had bitten me, and like lightning plugged with cotton the holes in the wall through which the hamsters escaped (for this purpose a big sack of cotton was prepared beforehand).

The second night we repeated the strategy, but we moved the goodies closer to the center of the room in order to track the hamsters to their hideouts. I was the ambusher, and my wife, who had not had a good night's sleep for a while, took it upon herself not to fall asleep, but just to drowse, nap but not doze off, like that author of Jewish lore, about whom it is written in the Talmud (chapter Brahot, page 3) 'thus spoke King David: I never once saw midnight pass without being awake. Rabbi Zera commented: until midnight David dozed restlessly like a horse; from then on he gained the courage of a lion.' Rashi added: like those horses that rest fitfully and never really fall asleep. According to a detailed plan which we agreed upon beforehand, my wife, a courageous warrior, would grab the biting rodent and put it, in a blink of the eye, into the cage. For my part, I tried with all my strength to ward off sleep thinking about the great salvation that these hamsters would bestow upon humanity by sacrificing their bodies for the sake of stricken patients. Thus we worked wide awake with pooled idealism for the cause of our science and for the good of mankind. It took three or four consecutive nights before my wife was able to catch five more hamsters. But in all our nights of watching we did not manage to trap the tenth hamster who remains to this day under the floor. Eventually we gave up hope that he would ever come out. And unless he died, he is most likely still living under there now.

This episode taught us one thing: leaving the hamsters in our house at Rehovot simply would not do; we would have to transfer them to an institute where many animals are sacrificed for science and at which they might be of service to all mankind.

I handed our 'step-children' over to the supervisor of the animal facilities at our university[5] with the hope that their martyrdom would bear fruit, that the medical experiments that would be performed on them would succeed and that those who received injections of the hamster vaccine would recover. The supervisor was delighted to accept the important guests under his aegis, and put them in a very large and roomy cage befitting such dignitaries. The cage walls were made of steel screening; only the floor was made of wood. Animal caretakers of the institute were not yet fully familiar with the behavior of this hamster, they had not yet realized how sharp and strong its teeth were. The supervisor had not figured that the powerful jaw muscles, the edge of the incisors and the bite of the interior teeth of this strong rodent would enable it to gnaw through a thick plank. Believe it or not, though, that is what happened. At dawn of the following day, the supervisor was brought down to the animal room. When he found out about the great catastrophe (the escape of five of the hamsters who chewed their way through the bottom of the cage and got out), he was aghast. Anyone who did not see the shock on that man's face has never really seen a man smitten, shaken to the depths ... I pitied him. His

5 Translator's note: Sieff Institute, now called the Weizman & Sieff Institute.

dismay increased as I described how difficult it was to get the creatures out of the depths of the earth, the great value of the discovery of this beautiful animal, that in the whole wide world, the only suitable habitat it could find was a lone region between Aleppo and Homs; of all the bundles of dried grass, all the hay, all the sheaves of wheat... All the agonizing searching we went through turned up nothing; only one single hamster, and it was dead. It drowned in one of the pipes thinking that it was a passage through the wall. This lead us to find that all the others had done similarly and wound up drowned in the pool outside, irrevocably dead...

It was decided to keep a tight surveillance on the four survivors who were nice enough not to escape along with their fellows, rebels against that lofty human ideal: to culture in their bodies a cure for humans suffering from Leishmaniasis and other related diseases. Luckily for the animal colony supervisor, supposedly an expert in his field, and happily for the honor of the Jewish people, it turned out that there survived among the four remaining hamsters one female! I was overjoyed, drunk with glee! And in my ecstasy I turned to God and said, 'Dear Lord, Father of forgiveness, mercy and goodness! Let it be your will that from this one hamster, from this sole surviving daughter of its species, will arise a generation, and that on the strength of experiments performed on its offspring, its relatives and grandchildren, evidence will accumulate that the common flea (species Phlebotomus) is the true carrier of the infection that develops in the skin, that awful disease called Leishmania.'

In actual fact, I was skeptical about the realization of my hope; for I knew very well from reviewing the literature and from hearsay that despite all the efforts of professionals in the field, not a single one had succeeded in breeding any variety of female hamsters in captivity; they do not become pregnant and they do not give birth. But then again, every rule has an exception.

Out of love for science and for the broadening of mankind, the Allpowerful nudged a single wheel of the uncountable wheels of nature – and a miracle happened! The female was put together with one of the males in a spacious cage (with a steel floor) and when we figured that the female had been impregnated, the male was removed. And then, what a surprise! After about eight or ten days[6] the female gave birth to eight[7] healthy pups. (Its mother, who according to an examination of her teeth was two years old[8], bore eleven young as was mentioned before.)

Only someone who has tasted true happiness, heavenly joy, can appreciate our

6 Translator's note: The normal gestation period of the caged golden hamster is just under 16 days.

7 Eight is also the average number of young found in the body of the wild Philistine groundhog throughout the month of March. This number does vary with age and with the seasons. We raised this species for several years, to study the number of times per year the female gives birth; we found out that the situation in the field is different from that in captivity.

8 Translator's note: It should be pointed out that in captivity, the golden hamster female rarely remains fertile beyond 9–12 months of age. It is not known exactly how Dr. Aharoni came to the conclusion that this specimen was two years of age at the time of its discovery.

elation over the fact that our great effort did not prove to be in vain. Our goal was achieved. From now on there will be a species of hamster that will be fruitful and multiply even in captivity, and will be convenient for endless laboratory experimentation! Perhaps one day, this hamster may turn over a new leaf in medical treatment of a dreaded disease for which there is as yet no cure.

The supervisor of the animal colony devoted himself to raising the infants with love and admirable selflessness. Instead of the water she had received as a pup, the mother fed the infants milk, known since ancient times to be more beneficial than water. The sons sired and the daughters gave birth to 'countless' new sons and daughters. And with the aid of God (not just by luck) the hamster that was brought from Aleppo proved to be incredibly prolific, and all from one mother!

How marvelous are thy works, O Lord!

Note: The preceding translation of Aharoni's Memoirs was brought to my attention by Michael R. Murphy, of the Department of Psychology, Massachusetts Institute of Technology, soon after these Proceedings were held. Many, if not all, of the deductions that I've made concerning events pertaining to the acquisition of the Syrian hamster are substantiated by Aharoni's experiences prior to, and following, the presentation of the littermates to Adler's group.

George Yerganian
August 26, 1971