NEW LABORATORY ANIMALS FROM WILD SPECIES

BREEDING A LABORATORY STOCK OF HEDGEHOGS (*ERINACEUS EUROPAEUS* L.)

By R. M. RANSON

Bureau of Animal Population, Oxford University

(With 1 figure in the Text)

1. Introduction

For experimental work on foot-and-mouth disease and yellow fever a 'clean' and constant supply of hedgehogs is necessary. The only certain way of obtaining these is to breed them as domestic laboratory animals. Only two records of hedgehogs having been bred in captivity (Herter, 1932, 1933, 1938; Leutscher, 1938) have been found, although they have frequently been kept in laboratories and attempts have been made to breed them there. Herter was so interested in the physiology of the young which he bred that he unfortunately did not give details of the methods he used in breeding them. Leutscher records a family produced by a pair kept in an enclosure in his garden, but the young were killed by the female soon after they were born, as the result of being disturbed. Deansley (1934), in a comprehensive analysis of the whole of the reproductive cycle worked out by the dissection of monthly quotas of freshly caught animals, records a low fertility in wild hedgehogs: commonly several oestrous cycles were passed (identified by counting corpora lutea at post-mortem) before pregnancy was achieved, although once pregnant few ova were lost by not becoming implanted.

In the summer of 1938 a small colony of hedgehogs was obtained and brought into the laboratory. They were kept in laboratory cages $3 \times 2 \times 1$ ft. high. During the autumn and winter of 1938–9 they were kept in a constant-temperature room at summer temperatures of between 60 and 75° F. The lighting was supplied by an electric bulb of 40 W. intensity. No animal was farther than 6 ft. away from the light. For a time (about 2 months) the light was turned off during the night. Then it was left on all the time masked with a double thickness of blue paper giving roughly the intensity of moonlight. Two months later the light was turned out altogether and no illumination was given for a further 2 months. During this time two females were given subcutaneous injections of 1 c.c. of sterile human pregnant urine.

All these stimulants did not result in any breeding. So in February 1939, as the result of correspondence with Mr A. Leutscher, a pair were put out in a slightly heated nest box in an outside pen, and in early April most of the rest of the stock were put out in a similar pen with no heated nest box. The

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pair which were put out in February mated in April and the young were born in May. A second litter was produced by this pair in August. In all seven litters were produced in 1939 and 1940 with the birth of twenty-seven young. All these litters were conceived in open pens. Although throughout this time there were usually some pairs kept in laboratory cages, no litter was conceived in them.

It might be asked why the number of animals kept was so small, thirteen adults during 1938–9, seven adults during 1939–40 and nine adults at present. In breaking in a new laboratory animal there is no need for a large stock, as success can best be achieved by early intensive study of the requirements of a small colony. From the outbreak of war up to the present time, this work has had to be run in conjunction with other research, and the numbers have actually been reduced instead of expanded as was the intention.

2. Cages

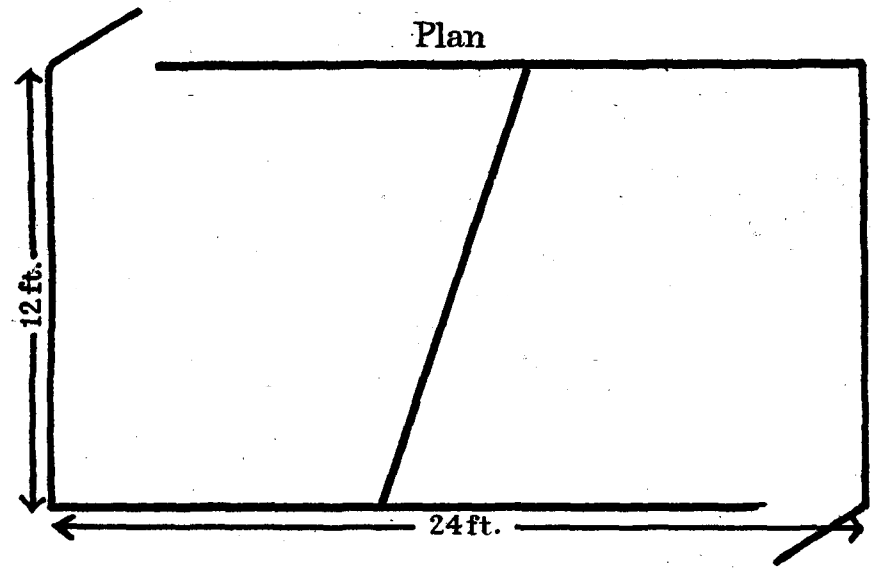
The breeding pens used were $12 \times 12 \times 5$ ft. high covered with 1 in. mesh wire netting (Fig. 1). The wire netting was buried 10 in. in the ground to guard against burrowing. The top of the pen was covered with the same kind of netting. These pens were originally designed for keeping partridges and are unnecessarily large. The greatest density at which breeding occurred was one animal to 24 sq. ft. Some smaller pens have been designed in collaboration with Mr J. Francis, and made by him at the Cattle Testing Station at Pirbright. These have so far proved very satisfactory for keeping hedgehogs, although no breeding has occurred there yet. They consist of a series of seven pens, two 9×10 ft. and five 9×5 ft. The sides, which are of $\frac{1}{4}$ in. mesh wire netting, are 2 ft. 6 in. high from the ground, and 1 ft. 6 in. is buried to prevent burrowing. A baffle board runs round the top of the netting projecting inwards 9 in. to prevent the hedgehogs from climbing over (they can climb over 6 ft. wire netting in a few seconds). The board covering the common side is 14 in. wide, allowing a projection of 7 in. into each cage. The tops of the cages are uncovered.

A small shelter or a nest box is provided in each pen and this is stuffed full with hay or straw. The large pens can accommodate a harem of four, while the small ones are large enough for a pair.

When the females are pregnant they can be put into much smaller cages, $3 \times 2 \times 1$ ft. high. These can be either metal or wooden bins with floors and with wire netting or wooden framework lids, or wire netting on a wooden frame with a netting floor and a 1×1 ft. nest box attached to one end. These framework cages are kept out of doors on grass and moved when the ground under them becomes foul.

If the pregnant females are brought into an animal house and kept in bins, the floors of the bins should be covered with sawdust or granulated peat moss. A heap of dry hay or straw at least ten times the volume of the animal should

be put at one end as nesting material. Two jars should be provided for each cage, one to contain food and the other water.



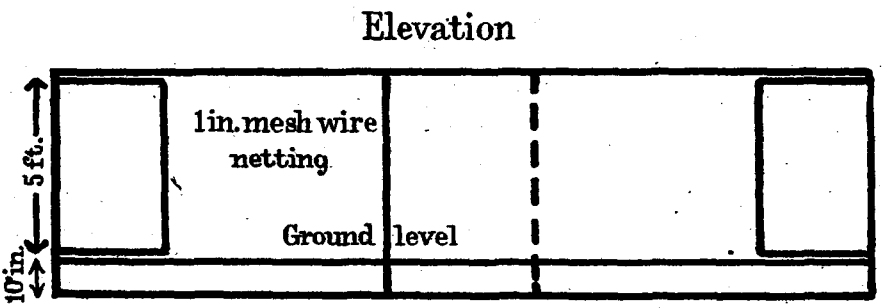


Fig. 1. Partridge breeding pens used for hedgehog breeding at Oxford.

3. FOOD

Bread, milk and cooked cat's meat are given, prepared as follows. The meat is cut into strips, boiled for at least ½ hr. and minced through a coarse mincer. 50 g. of this meat and 50 g. of minced bread mixed with 150 c.c. of milk is sufficient for a day's food for a single pair; about the same amount is given to a pregnant female or one with young. Mincing is an important factor in the preparation of the food. A marked improvement was noticed in the condition of the animals after mincing replaced the previous method of cutting

the food into cubes with a knife. The meat should be as lean as possible, as these animals dislike fat. They much prefer cooked to raw meat. Stale bread is used, most of which is household scrap. Boards are placed round the edge of the breeding cages inside and outside the wire to act as slug and worm traps. A rank growth of vegetation is encouraged for shelter and to attract insect and small animal life. Occasionally an animal will refuse to feed for no apparent reason and even starve itself to death. No explanation can be offered for this peculiarity, which occurs more frequently in laboratory caged animals than in those kept in pens outside, and no cure has been found. Herter records very erratic fluctuations in the growth curves of some individuals.

4. Breeding

It is not yet known whether it is the addition of natural food to the diet or whether it is the population density, increased exercise, or light and temperature extremes which causes hedgehogs to breed in outdoor pens but not in the laboratory. When a breeding stock born in captivity has been built up, experiments, which have been planned, will be carried out to ascertain the factors influencing breeding.

Many authors have guessed the gestation period to be from 4 to 7 weeks. In three litters described by Herter the gestation period was calculated to be 34–49, 34–46 and 35–42 days. Leutscher records an interval of about 30 days between observed copulation and the birth of the young, but was not certain of the exact date on which the young were born and, moreover, the parents had been mated before the observed copulation took place. I have not yet ascertained the minimum time, but one litter was born on 16 August 1939 to a female (No. 12) which was mated on 7 July, so that the gestation period cannot be more than 40 days. Another female (No. 4) was mated on 28 May and five young were born on 4 July, 37 days later, but as this female had been with another male for some time before 28 May she may have been pregnant before this date. Probably the minimum is very close to Herter's suggestion of 35 days.

While maintaining a breeding colony of voles for 10 years, certain skill in counting and estimating the age of embryos by palpating the female was developed by the author. In two cases where the embryos of pregnant hedgehogs were palpated the age was estimated from their size by assuming that the rate of development of the embryos and the gestation period was the same as that of the vole, i.e. 21 days. This figure was then increased in proportion to Herter's minimum figure of 35 days by multiplying it by 21/35. In one case the result was that the young were born on the forecast day and in the other they were born a day earlier.

If pregnancy is diagnosed by palpation the bladder must not be confused with an embryo. The bladder is nearly always full during the day and feels very much like an embryo in the later stages of development. However, when several definitely non-pregnant females have been palpated it will be found

that it is easy to move the bladder to one side with the thumb of the left hand and feel the uterus and kidneys lying below.

When the hedgehogs are first obtained they should be placed in the outdoor breeding pens as soon as the sexes have been determined. If necessary they can be cleared of ectoparasites by anaesthetizing them with anaesthetic ether and shaking them over a large sheet of paper. The ticks and fleas must be burnt or drowned, as they revive after ether almost as quickly as the hedgehogs. If cage space is not available to arrange them in pairs, harems may be set up, but there is a slight risk of loss from fighting or bullying. Two or more males should not be put in the same cage with females, but males will live together if there are no females near.

Table 1. *Showing the results of breeding experiments*

Female No.	Date Mated	Date Young born	No. of young born	No. of young weaned	Age at weaning	Sex ratio of young
12	To male No. 11 all winter (after short hibernation)	26 May 1939	4	4	43–45 days	2 males : 2 females
1	To male No. 2, male No. 3 and male No. 5, 1 April 1939 (after no hibernation)	25 June 1939	4	Died soon after birth as the result of disturbance		
12	To male No. 7, 7 July 1939	16 Aug. 1939	3	3	42 days	2 males : 1 female
1	To male No. 11, 26 March 1940 (after no hibernation)	12 June 1940	5	5	38 days	4 males : 1 female
16	To male No. 17, 10 May 1940 (after no hibernation)	22 June 1940	3	Died soon after birth as the result of disturbance.		
4	To male No. 17, 28 May 1940 (after hibernation)	4 July 1940	5	5	40 days	3 males : 2 females
18	To male No. 17, 3 May 1940 (after no hibernation)	6 July 1940	3	3	40 days	2 males : 1 female
		Total	27	20	—	13 males : 7 females
		Average	3·86	4·00	—	2·6 males : 1·4 females

Mating can be expected in April–May, and the first litter should be born in May–June. The second mating occurs in July–August, and the second litter should be born in August–September (Table 1). No post-partem oestrous cycle occurs in the hedgehog (Deansley, 1934), so that there is no advantage in leaving the male with the female after she becomes pregnant, in fact, there is a definite disadvantage in leaving the pair together, as the male may destroy the young or so disturb the female that she neglects them. The pregnant females can either be put into the small outdoor movable cages or into bins in the animal house. When the young are expected the nest can be examined during the evening when the female is out feeding; but this must be done very carefully and the nest must be covered over again when the count is complete.

If the female is removed from the nest during the day and the young counted she will kill or desert them. This has happened on two occasions when the nests of females 1 and 16 were intentionally disturbed during the day time. Both litters, which were alive and well, were killed by the parent.

5. Rearing

Herter records that the last time he observed a female give milk was when the young were 42 days old; and he observed one young of 21 days old eating solid food. Litters have been weaned at from 38 to 44 days old with complete success (Table 1). There is some evidence that 40 days is the best time, as after this the female is not giving food but is competing unfairly with the young for the food provided. The young have been examined during the day time without the female objecting, when they were 5 days old, but it is probably safer to wait until they are at least a week old before they are examined during daylight hours. All the twenty young which were not killed at birth were weaned, the sex ratio being thirteen males to seven females. In four litters of *E. europaeus* bred by Herter twenty young were produced, an average of five per litter, there being twelve males and eight females. It therefore appears as though the sex ratio were biased in favour of males. Herter has described minutely the growth and development of the young illustrated with some charming pictures, so it is not necessary to redescribe this part of the cycle. All that need be said here is that no matter how fast the young grow they are incapable of breeding in the season in which they are born (unless they can eventually be made to breed in the winter).

6. Handling

When freshly caught, hedgehogs are the most disconcerting of all laboratory animals. Their wall of spines cannot be breached even by patience or guile. If they are anaesthetized to remove ectoparasites, advantage can be taken to make a thorough examination of them. After a few weeks in captivity, if they are handled gently when they come out to feed, they will become fairly tame and remain uncurled when picked up. The females are always more obstinate than the males, and it takes much longer to win their confidence. The technique for handling adult hedgehogs is as follows: the animal is placed on a flat surface and the spines over the rump are tickled with the left hand. This makes the animal lift up its head, and the scruff of the neck can be gently grasped with the right hand by placing the first finger and thumb in the ears. It can now be gently lifted up so that it is standing on its hind legs. If it starts to curl up again the back and the rump should be tickled once more without releasing the grip with the right hand.

When the hedgehog is standing up slide the left hand gently under the belly and the animal can be lifted up, held by the neck with the right hand and resting on the left hand. Sexing or palpation of embryos is now easy, as the animal will almost certainly remain extended.

If a large number of hedgehogs is being dealt with and there is no time to study the idiosyncrasies of individuals, then force will have to take the place of guile. For this an apparatus, like a trousers' press, made of two wooden frames covered with wire netting, is used. These frames are hinged at one side in such a way as to leave a space of about 2 in. between the upper and the lower frame when the apparatus is completely closed; the frames are held together when closed by an adjustable catch. The press is opened wide and the hedgehog is encouraged to sit on one of the frames and uncurl as far as it will by tickling. The other frame is then pulled over and pressed down firmly on to the back of the animal and the catch secured. The hedgehog is now in a large compressorium, and by turning the press over the underside is accessible through the netting for examination, inoculation, or for taking vaginal smears. If the press is used gently but firmly the hedgehog cannot hurt itself nor can it close up, as its claws and spines anchor it quite effectively. Of course it is impossible to palpate embryos in a hedgehog which is in a press, but if a mated female is very obstinate it can either be weighed regularly together with its mate and a sudden increase in the weight of the female used as an indication of pregnancy, or it can be anaesthetized periodically. This latter method is, however, not recommended owing to the uncertainty of the part played by the disturbance factor in preventing animals from breeding.

7. HIBERNATION

It makes no difference to the breeding of hedgehogs whether they hibernate or whether they spend the winter in a warm animal house in a fully active condition (Table 1). For economy of food it is probably better to let them hibernate, for as yet no litters have been produced in the winter.

The young should be brought into the laboratory as soon as the cold weather starts and kept there at least until the New Year, i.e. until they have grown to adult size of 500–600 g. Then they should be put outside for a short hibernation. Without this additional growing time it is possible that the young would take 2 years to reach sexual maturity, for those left outside until January are very puny little things of about 350 g. If, on the other hand, they are kept in the laboratory all the winter in a fully active condition, they may begin to lose weight after January. This may be due to a diet deficiency or to an unnaturally lengthy growing period.

During very cold weather no food need be put into the pens containing hibernating hedgehogs, but during mild weather it is important to keep a small food supply always available as they will sometimes break hibernation and eat ravenously. It need not be wasted if uneaten as it can be used for hedgehogs in the laboratory and a fresh supply put outside.

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8. Summary

It has not yet been possible to breed hedgehogs in laboratory cages, but they have been bred and reared successfully in pens in the open, twenty-seven young being produced by five females in seven litters. The methods adopted in breeding and maintaining this stock are described.

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