Studies on the biology of the polecat, Putorius Putorius (L)

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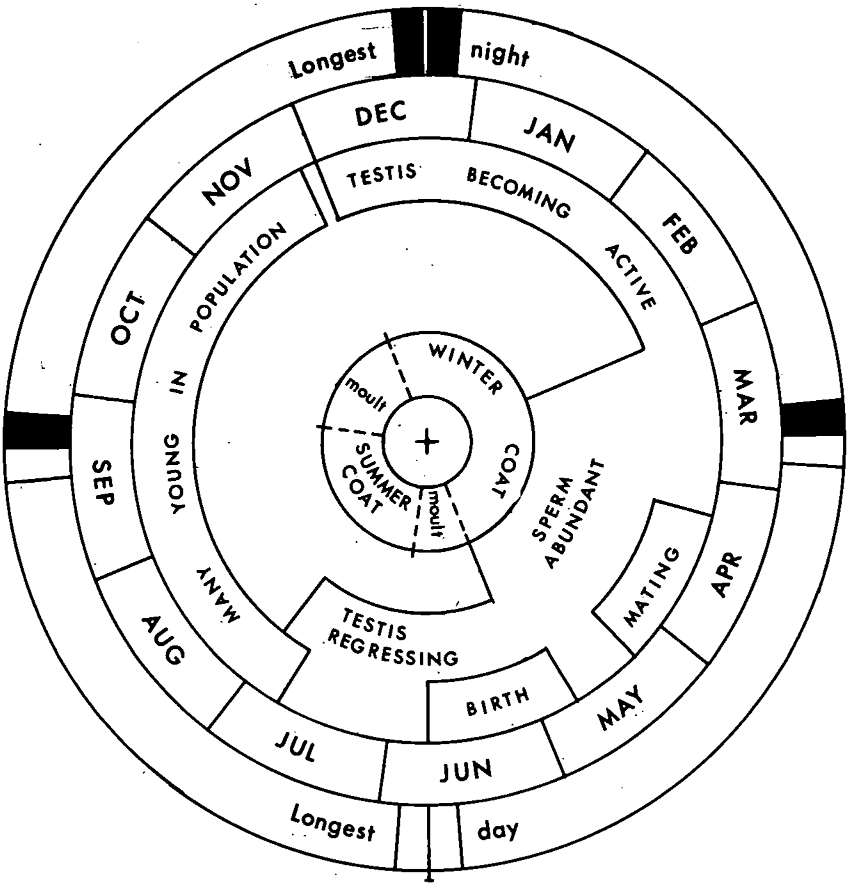
No part of the work described in this thesis has been previously submitted for a degree in the University of Durham or any other university. The whole of the work was performed by the candidate except where acknowledgment has been made in the text.

KCWalton

Frontispiece. Annual cycle of the polecat.



Longest night
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
Longest day
TESTIS BECOMING ACTIVE
SPERM ABUNDANT
MATING
BIRTH
TESTIS REGRESSING
MANY YOUNG IN POPULATION
WINTER COAT
moult
SUMMER COAT
moult

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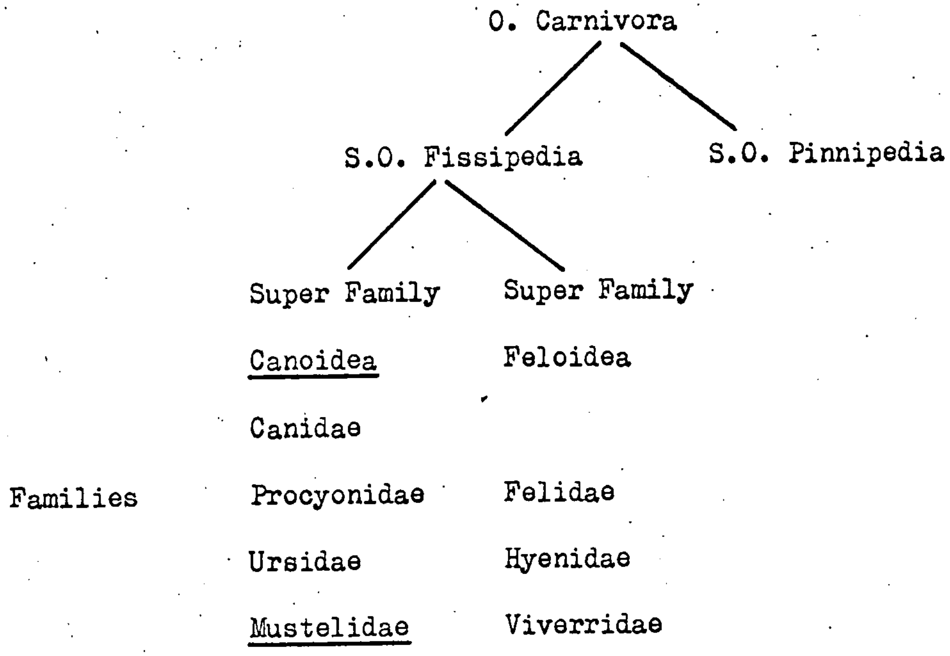
1.0 INTRODUCTION

1.1 Systematic position

Polecats belong to the Order Carnivora. Within this Order they are included in the Family Mustelidae whose position is shown below following the classification of Simpson (1945):-



The oldest known fossil remains of mustelids are from the Oligocene of Europe and North America. They were not, at this time, sharply differentiated from the Viverridae.

The Family Mustelidae is divided into five Sub-families:

Mustelinae	(stoats, weasels, martens, *polecats*)
Mellivorinae	(honey-badgers)
Melinae	(badgers)
Mephitinae	(skunks)
Lutrinae	(otters)

Many authors now use the combined generic name *Mustela (Putorius)* .... for polecats. For reasons of brevity only the name *Putorius* will be used in this work. Following Continental authors (van den Brink, 1958; Ognev, 1962; and Heptner, 1964) the species in this genus will be regarded as being the following:

Putorius putorius (L) - the European-, common-, or black-polecat.

Putorius eversmanni Lesson. - the Asiatic-, steppe-, or white-polecat.

Despite the uncertainty of its systematic position it will be convenient to add the ferret to this list:

Putorius furo L. - the ferret (including both albino and dark forms).

This work is chiefly concerned with the first of these species, namely the European polecat, *Putorius putorius* (L), although reference will be made to the other two species where this is relevant. The ferret is probably derived from one or other (or, possibly, both) of the polecats. Little credence can be given to the idea of a North African origin for the ferret as suggested by Cabrera (1932) on the basis of a single specimen of doubtful identity; nor to Tetley's (1945) hypothesis that the ferret in Britain originated in part from the Scottish polecat, a dubious sub-species based on four specimens of an animal now extinct. These matters will be discussed again.

1.2 World Distribution

The European polecat, P. putorius is found throughout almost the whole of Europe, reaching its western limits at the Atlantic coasts of Britain and Spain, and extending as far as the Mediterranean in the south but excluding southern Jugoslavia and the whole of Greece. In the north it reaches only southern Norway and Finland but extends eastwards to the Urals and the Crimea. Over part of this range its distribution overlaps with that of the steppe-polecat, but the two remain separated by ecological factors, although hybrids do sometimes occur. A map of this distribution was given by van den Brink (1958) but a version corrected for the Soviet Union is shown in Fig. 1.01 (from Heptner, 1964). Unfortunately van den Brink's map shows the polecat in Britain as being found only in Scotland and not in Wales, whilst the reverse is actually the case. Several later authors have perpetuated this error. Heptner's line enclosing Britain but excluding Ireland does not seem to be a satisfactory solution. The area of distribution has been re-drawn and North-Africa has also been omitted since Owen (1964) has shown fairly conclusively that there is no native polecat in Morocco; and there is no evidence of any elsewhere in the area.

1.3 History in Britain

The polecat was once widespread in Britain. It has always been regarded as vermin and occurred regularly amongst estate records. It was also trapped for its fur. From about the middle of the nineteenth century numbers began to decline and the area occupied by the animal was greatly reduced. Matthews (1952) regarded it as "nearly extinct" by the early years of the present century. Perhaps "localised" would be a better term, since it has apparently always been fairly common in mid-Wales at least. Its decline in Scotland has been graphically described by Ritchie (1920).

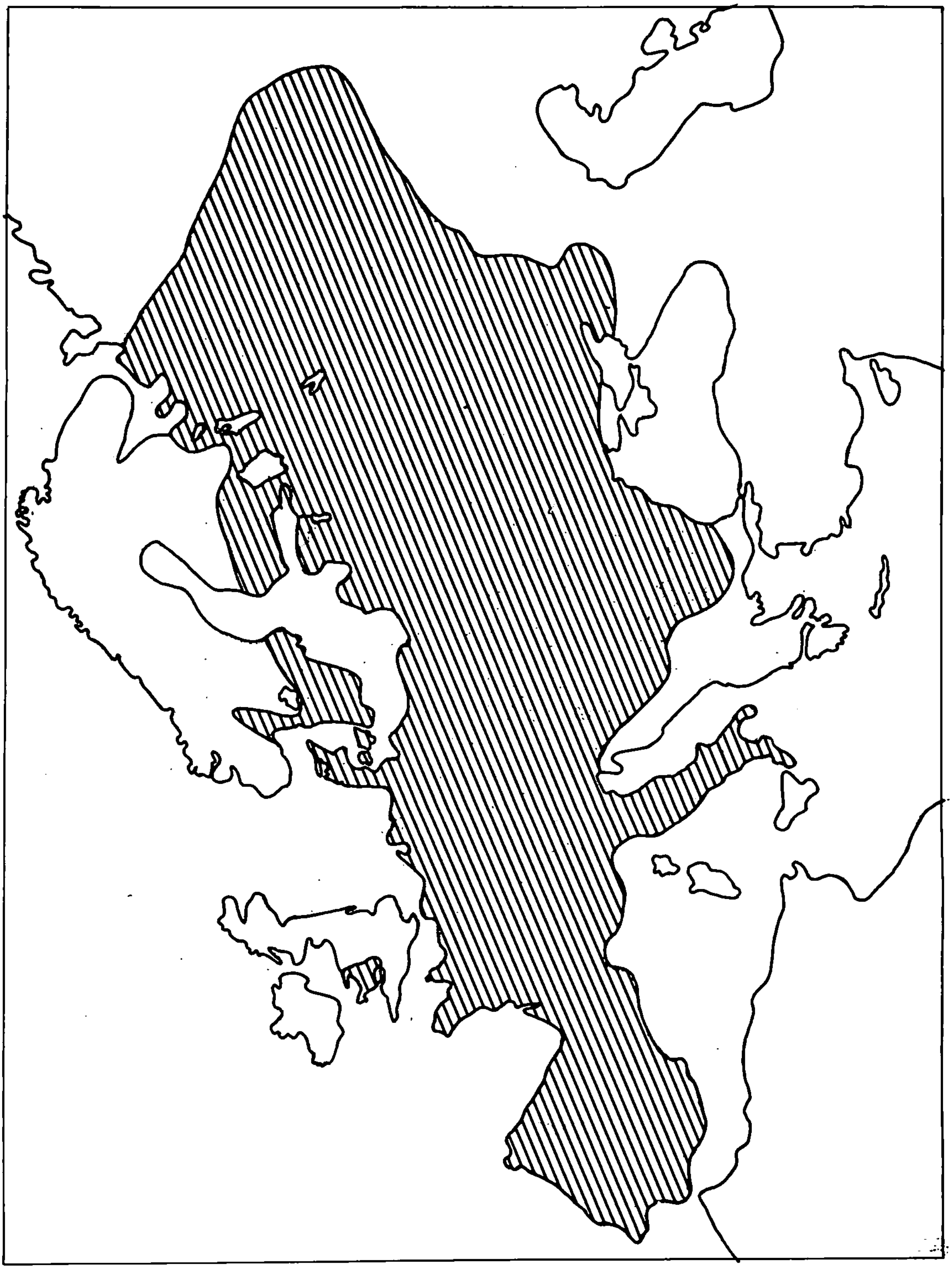
1.4 Aims of the present study

The polecat presents several interesting features. It is an animal which was once widely distributed in Britain but now has a restricted range. It is a close relative and possible ancestor of the domestic ferret. It is an unspecialised mustelid, similar in some ways to the stoat and weasel but much larger than either, and with no adaptations for climbing like the pine-marten, digging like the badger, or swimming like the otter. Lastly, it bears a superficial resemblance to the recently introduced North American mink _Mustela vison_ Schreber which is making destructive inroads into the riverine fauna at the present time.

Because of the polecat's restricted range, its reduced numbers owing to trapping, and its retiring habits, little research has been carried out in Britain on any aspect of its biology.

The present work was undertaken with a view to remedying this situation by discovering the facts of its life-history. It was thereby hoped that a more satisfactory evaluation might be made of its position among the British fauna; and that some basis might be provided for an understanding, through future studies, of the success of the mink in this country.

Fig. 1·01 Distribution of P. putorius in Europe, (shaded). After van den Brink 1958, and Heptner 1964.



2.0 SURVEY OF THE LITERATURE

Scattered references to the polecat and ferret can be found in historical works; the ferret was mentioned by Strabo in the first century B.C. and the polecat figured prominently in records of bounties paid for vermin in the nineteenth century.

A general account of the polecat was given in Matthews (1952) whilst Herter (1959), brought together much of the published information on polecats and provided a good bibliography, mostly of Continental authors.

Millais (1905) provided a description and Miller (1912) catalogued the polecats in the British Museum collection. Pocock (1936) using this same collection with some additions, chiefly from Wales, provided a useful description of skins and skulls. Tetley (1939, 1945) described polecats from Scotland and also compared some of the physical features of polecats with those of ferrets. A recent statistical study by Ashton and Thomson (1955) was based once more on the British Museum material, and took into account _P. eversmanni_ which has been suggested as a possible ancestor of the ferret. Their results showed that the divergence of the ferret from _P. eversmanni_ is five times greater than from _P. putorius._ Ashton (1955) also re-examined the four specimens of polecat from Scotland and concluded that the skulls were similar to that of the ferret. Rempe (1965) has examined the relationship between the common polecat, steppe polecat and ferret by the technique of multivariate analysis, carried out on a large number of skull measurements. He showed that the three forms could be separated by this method and that artificial hybrids between steppe-polecat and ferret were intermediate in character between the parent forms. Rempe (1962) investigated and described the effects of domestication on the physical features of ferrets as compared with wild polecats. He concluded that the ferret possesses many features not found in the wild, because these features are not disadvantageous to a captive animal. McCann (1956) described museum specimens and captive live animals in New Zealand where polecats or, more probably, ferrets were introduced during the nineteenth century.

Distribution of the polecat in Britain has been described by Taylor (1952), Condry (1954), Matheson (1963) and Walton (1964). Matheson's paper dealt solely with the erythristic or 'red' variety of the polecat.

Mazák (1965) gave a full account of the history and distribution of the steppe polecat in Czechoslovakia, which included a useful bibliography of work covering eastern Europe and the Soviet Union. The spread of P. putorius into Finland has been fully described and analysed by Kalela (1940, 1948, 1952). He related the spread to climatic factors, especially the extent of snow cover in the winter. Heptner (1964) gave an excellent account of the differences in morphology and geographical distribution between P. putorius and P. eversmanni. Distribution and ecology of the introduced animals in New Zealand was described by Wodzicki (1950) and Marshall (1961).

Because of the close relationship between the polecat and the ferret, it seems relevant here to consider work on the ferret. For many years this animal, because of the ease with which it can be bred and reared in captivity, has been the subject of many investigations into reproductive physiology. Marshall (1904) established that the female ferret ovulates as a result of coitus. Robinson (1918) in a study of the development and fate of ovarian follicles, held that proper insemination is necessary for ovulation to take place. Hammond & Marshall (1930) showed that this was not so, since coitus with vasectomized males can cause ovulation. Other workers who have dealt with various aspects of this subject include Murr (1931, 1932, 1933) who investigated reproduction and birth in the ferret; Farris (1950) who determined the duration of coitus in the ferret; McPhail (1933a) who showed that ovulation still occurred even after the interruption of coitus; McKeown and Zuckerman (1937) who found that failure of penetration did not prevent ovulation; and Hammond and Walton (1934 a & b) who determined the time of ovulation, the survival time of sperm in the female tract, and associated phenomena. They also investigated pregnancy and pseudo-pregnancy outside the normal breeding season. Early stages in the development of the egg have been described by Hamilton (1934). Marshall (1933) demonstrated cyclical changes in the vagina and vulva.

The part played by the pituitary in causing ovulation has been studied by Hill & Parkes (1932, 1934) and McPhail (1933b). Deanesley & Parkes (1933) showed that removal of the uterus during anoestrus does not affect the cycle of ovarian changes associated with oestrus and pseudopregnancy. Parturition has been described by Murr (1932), and, more recently, as an adjunct to a film of parturition, by Naaktgeboren (1961).

The reproductive cycle in the male ferret was investigated by Allanson (1931, 1932) who studied the gross and histological changes in the reproductive organs. She showed that there was an annual increase and regression of activity in these organs, with significant changes in the state of the interstitial tissue. The effect of light on the breeding cycle has been studied by Bissonnette (1932, 1935), Hart (1951), and Hammond (1951, 1952) and in Australia by Harvey and Macfarlane (1958).

Breeding and other behaviour has been investigated in captive polecats by Eibl-Eibesfeldt (1955, 1956) Herter and Herter (1953), Herter (1953), Goethe (1940), Murr (1931, 1932, 1933) and Rempe (1957). Aggressive play was studied by Poole (1966).

Some work on the diet of polecats in the Soviet Union was reported in Ognev (1962) whilst Kratochvil (1952) gave an account of the diet of both species in Czechoslovakia.

Popov (1943), in a paper on age estimation in mustelids, stated that the weight of the baculum could be used to distinguish juvenile and adult males in several species including P. putorius.

Mathey (1958), in a survey of chromosome numbers in mammals, assigned to the ferret the value $2n = 40$.

3.0 MATERIAL AND METHODS

Little systematic work has been carried out on the polecat in Britain but it is common enough in Wales for sufficient material to be available for study.

The work described below was carried out between summer 1965 and autumn 1967. The samples from the two twelve-month periods have been combined and treated together as though from a single period. Some additional material has been considered from outside this period.

Observations and material were collected with the help of the field staff of the Ministry of Agriculture, Fisheries and Food and private individuals (rather than by trapping which would have been insufficiently productive in the time available for study). Records were kept of both live and dead animals seen. Polecats were killed by various means, the majority being killed by road traffic or trapped. Occasional individuals were found dead from no apparent cause - poison or disease may have been responsible. Whenever possible, dead animals were collected and examined according to the standard procedure given in Appendix 3.01.

4.0 DISTRIBUTION IN BRITAIN

There has been a marked increase in the area of distribution of the polecat Putorius putorius (L.) since information was last summarised (Walton 1964). In addition to animals examined in the laboratory more than 80 individuals have contributed records of dead and live animals seen. Additional records have been extracted from "Nature in Wales". Criteria for records are given in the earlier paper.

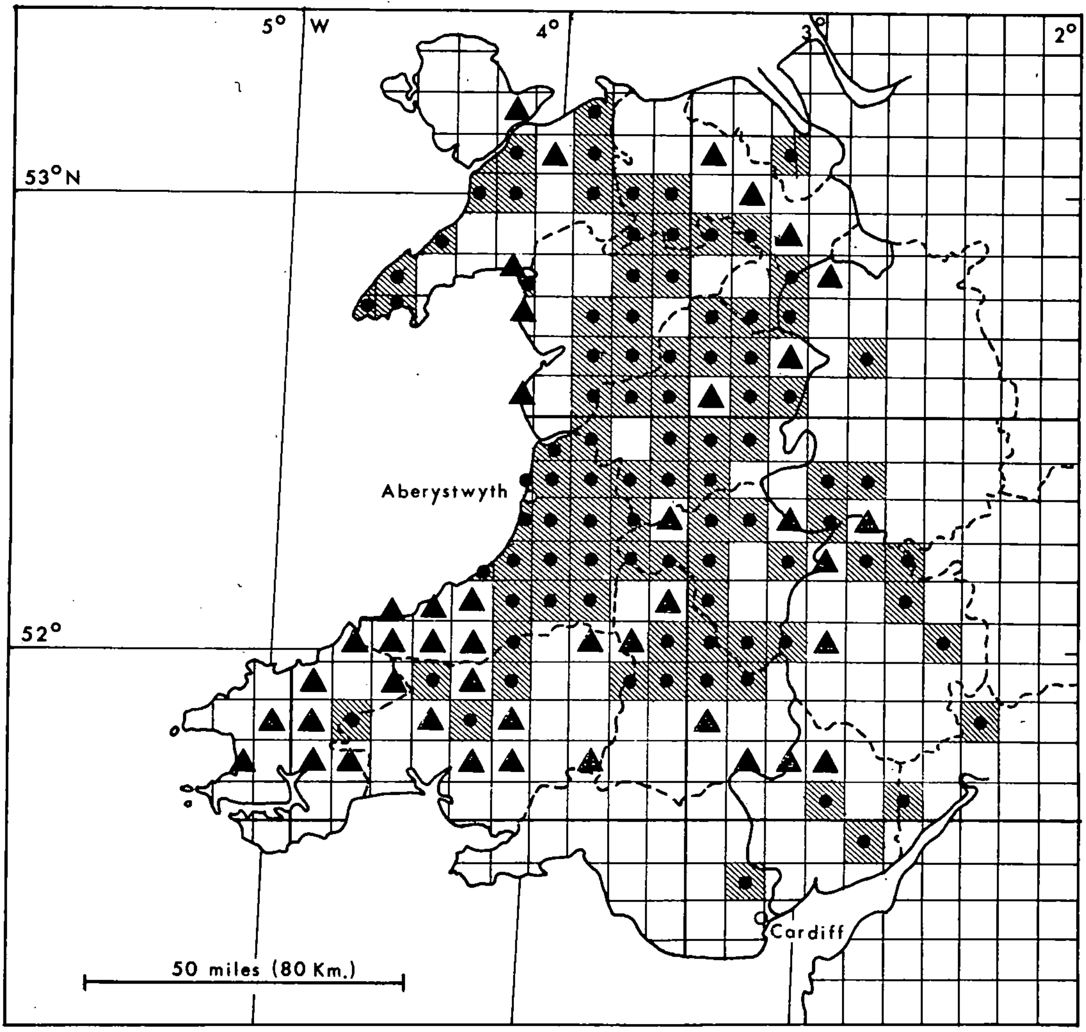
Almost 200 records have been collected since the previous survey period. This figure includes those animals sent for examination. The combined records for 1959-67 are shown in Figure 4.01.

Most of the records from 1962 onwards only confirm the distribution shown by the earlier ones, although one or two squares have been filled in within the main area of distribution. Some records, however, show a considerable extension of range of the polecat. This extension is most marked in south-west Wales where polecats have now been recorded well into Pembrokeshire and Carmarthenshire. New records have also come from the Usk valley, the borders of Monmouthshire and Brecknockshire, and north-east Denbighshire. Altogether the number of 10 Km. squares from which records have been obtained is now about one third greater than in 1962.

Fig. 4.01 Distribution of *P. putorius* in Wales and the Border Counties plotted by 10 Km. squares.

▨ Present from 1959 onwards

△ Present from 1963 onwards


5°
W
4°
3°
2°
53°N
52°
Aberystwyth
Cardiff
50 miles (80 Km.)

One of the most noteworthy records is from Anglesey. This county is represented by a single sighting, but this one is from a most reliable observer. This is the first record from the island since Forrest, writing in 1907 about the polecat in Wales said "almost extinct in the East and Anglesey".

Further records have been added to the known distribution in England.

Two animals from the Preston area of Lancashire were found to be escaped ferrets. Two more which had been seen swimming in the Usk and mistaken for feral mink were found to be feral albino ferrets. These findings underline once more the real likelihood of ferrets being wrongly identified and also the importance of physically checking the identity of animals whenever possible. This is especially so when they are found outside the known area of distribution.

Discussion

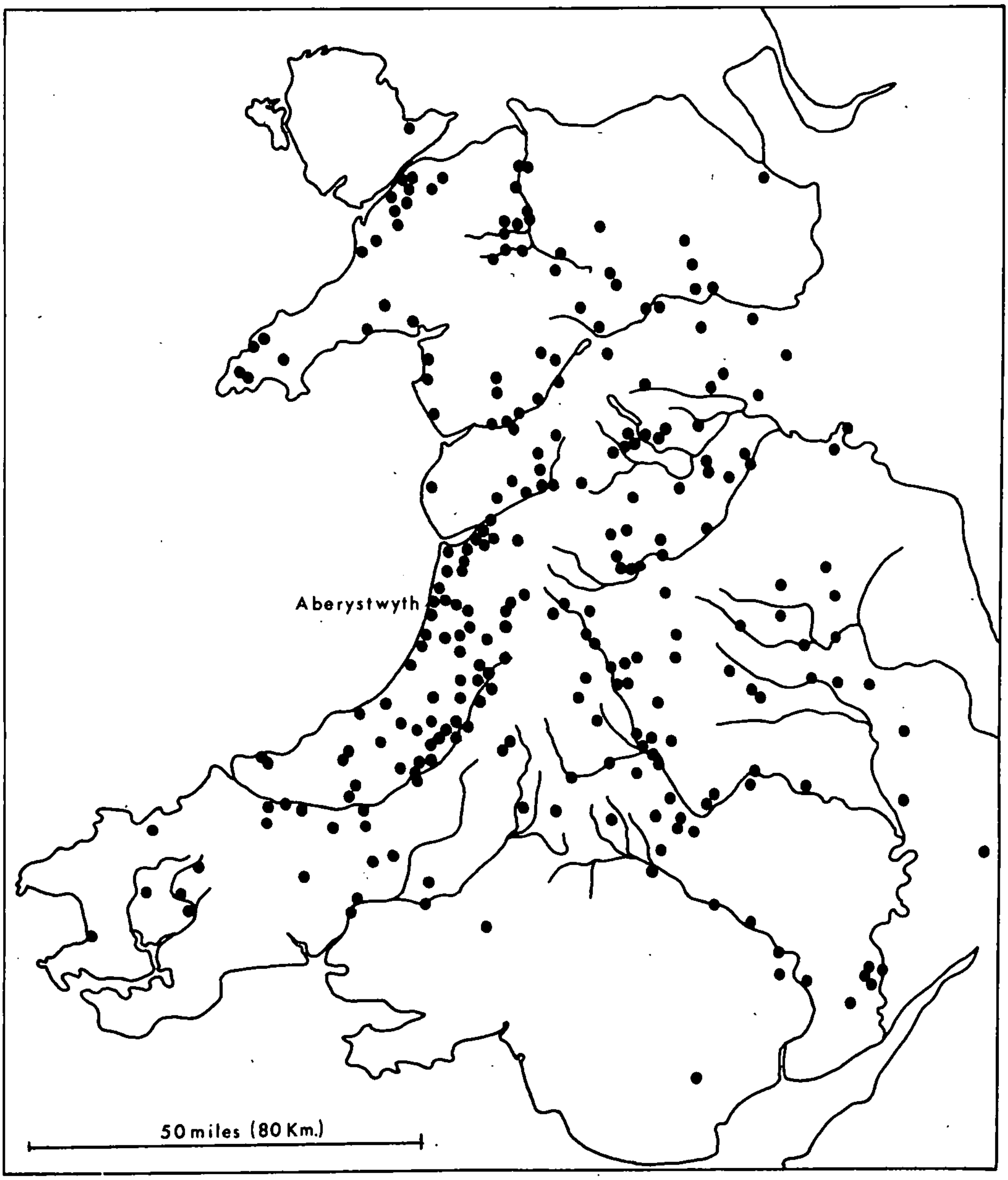
Plotting the distribution of any animal by means of squares of uniform area as in Fig. 4.01 may obscure interesting facts. Unless a species is uniformly spread the use of this method tends to equate one record with many but it does show the general shape of the area occupied. On the other hand, plotting records as points tends to show up the distribution of observers and main roads. This drawback can be overcome to some extent by having a sufficiently large number of observers, for example, trappers and foresters, whose work does not restrict them to roads. This has been possible in this study.

When records are plotted in this way, as in Fig. 4.02, a more detailed picture emerges. There is undoubtedly a considerable cluster of points around Aberystwyth where many of the observers live. Nevertheless this does reflect on how very common the polecat is in this area.

Many records tend to follow river valleys such as those of the Wye, Teifi, Towy, Dovey, Conway and, running into England, Severn and Teme. This pattern could be of some significance since several authors have said that polecats of both species have extended their range in Europe by way of the river valleys. For example, Mazák (1965) ascribes the presence of the steppe-polecat in the Tatra to its spread by way of the river valleys from south-eastern Slovakia; whilst Heptner (1964) says the same thing of the spread of the European polecat into the south Russian steppe from the north. It is of interest that Schäff (1911) states that (translated from the German) "for choice, the polecat lives in the vicinity of brooks, ponds, canals and similar waters without, however, venturing directly onto the water."

Fig. 4.02 Distribution of P. putorius in Wales and the Border Counties in relation to the major rivers.

○ One or more records from 1959 to 1967.


Aberystwyth
50 miles (80 Km.)

Unfortunately, in a country as mountainous as Wales, the roads also follow the river valleys and since a high proportion of records are of road casualties the connection with rivers could be a spurious one. The relative absence of roads on high ground could well explain why few records have been received from, for example, the Brecon Beacons and Snowdonia.

From what has been learned by discussion with farmers, former rabbit-trappers and foresters it seems that the polecat is now present in many areas of Wales where it has never been within living memory. In central Wales, it is now very common, particularly when compared with 10-15 years ago, but has not yet regained the degree of commonness which it enjoyed 20-30 years ago.

5.0 PHYSICAL FEATURES

5.1 Coat

Herter (1959) described the coat of very young polecats: at birth they have a sparse covering of white hair; this coat grows denser after birth and is replaced at about 20 days old by a dark coat; by the age of 50 days the young have a typical polecat appearance with the characteristic white facial markings.

5.11 General appearance

The coat in the polecat 50 days or more old consists of two types of hair:-

(i) the under-fur or "wool". This is the fine, dense, insulating part of the coat.

(ii) the contour or guard hairs. These are the long, coarse, shining hairs which project beyond the wool and act as a water-shedding layer.

Both these elements varied between juveniles and adults and winter and summer. The juvenile and summer adult coats were found to be very similar. In both, the density of wool and guard hairs was reduced. The wool was a buff colour over most of the body but was greyish over the shoulders and fore-limbs, rump and hind-limbs, and on the tail: also sometimes on the head and neck. This made the extremities appear very dark. The guard hairs in the juvenile and summer coat were pigmented black almost to the base. The combination of colouring gave the animal a very dark appearance in the summer and juvenile coat (Fig. 5.11).

The winter coat differed from the above description. The wool was much whiter, longer, and denser except over the areas mentioned above as being greyish. The guard hairs were much longer and were pigmented black for only the distal half of each hair. The denseness of the wool caused them to stand out from the body at a greater angle. When viewed from a distance the winter coat appeared much lighter, especially in the live animal. (Figs. 5.12 and 5.13). This was due to a combination of wool colour, foreshortening of the guard-hairs, and the pale bases of the latter.

Some winter coats which had persisted into the early part of the summer were found to have the wool stained yellow by sebaceous secretions from the skin. This coloration is not to be confused with a similar sort of colour noted in a few skins. In these there was a band of diluted pigment where the black tip of each guard hair faded into the white base. This band had a yellowish appearance and, since it occurred at about the level of the wool, gave the impression that the wool itself was coloured.

5.12 Face pattern and moulting

The white facial markings are one of the most characteristic features of the polecat. All the animals examined had white ear tips, a white chin patch which extended onto the muzzle, and white cheek patches (Fig. 5.14) In the juvenile and summer adult coat these were the only white facial markings.

Fig. 5.11 Pelts of common polecat in summer coat

A. Dorsal view

B. Ventral view


♂
EUROPEAN POLECAT.
♀
SUMMER. DORSAL.

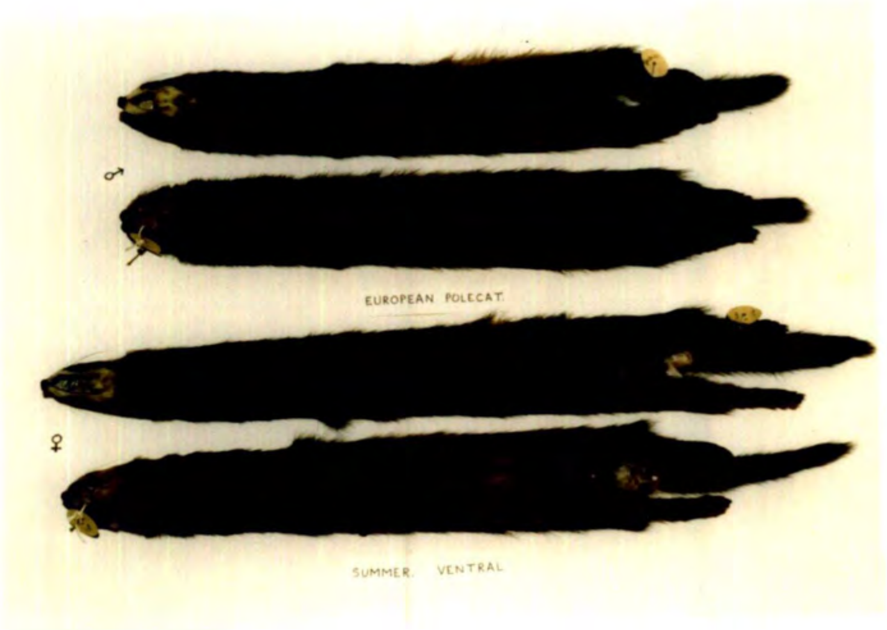

♂
EUROPEAN POLECAT.
♀
SUMMER. VENTRAL.

Fig. 5.12 Pelts of common polecat in winter coat

A. Dorsal view

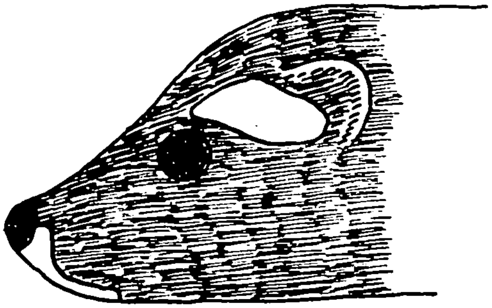
B. Ventral view


EUROPEAN POLECAT
♂
WINTER DORSAL

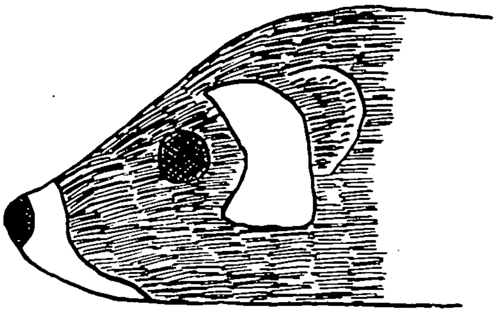

EUROPEAN POLECAT
♂
WINTER VENTRAL

Fig. 5.13. Common polecat in winter coat (female)

Fig. 5.14 Variation in the face pattern of the polecat (for explanation see text).



1



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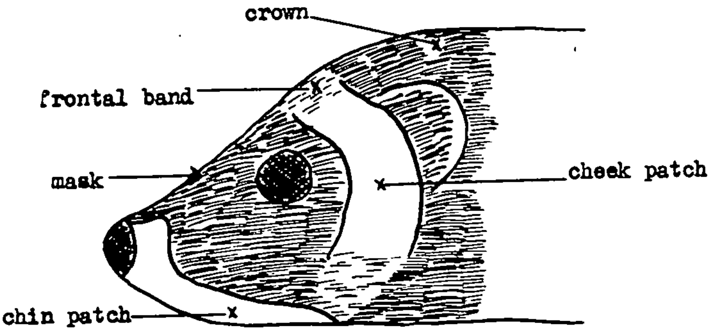

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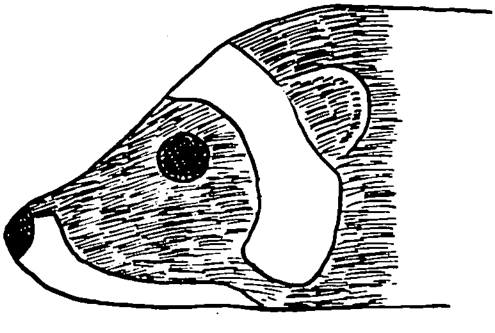

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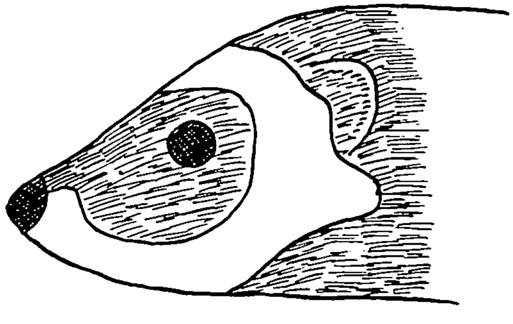


5

During the winter, however, there were found to be varying degrees of development of the "frontal band" which joins the cheek patches across the forehead and cuts off the dark "mask". The development varied from Pattern 3 to Pattern 5. The collection pelts could be classified as follows:-

Pattern	No. of pelts
1 or 2	13
3 or 4	21
5	6

The slightest development was the situation where the cheek patches were separated from the chin patch by a band of brown hairs and the frontal band had a mixture of brown and white hairs (Pattern 3). A further advance on this was the situation where the frontal band was more or less completely white but the cheek and chin patches were still separated (Pattern 4). The most advanced development was where chin and cheek patches and frontal band were all confluent giving a complete band of white round the face (Pattern 5). In all cases these patterns could be easily distinguished from the condition of the juvenile or summer coat where the area of the frontal band was completely black (Pattern 1 and 2).

If Patterns 3, 4 and 5 are all considered together as varying stages of development of the frontal band, and Patterns 1 and 2 are regarded as showing no development of the frontal band, the distribution of the two situations can be arranged as in Table 5.11. It will be seen that Patterns 3-5 were found during the period December-June whilst Patterns 1 and 2 occurred during July-September. In June, October and November both types occurred together: it can be assumed that at these times of the year the types are in the process of changing over.

5.13 Moulting The term "moult" has often been used to describe new hair growth and/or old hair shedding. The terms "growth" and "shedding" will be used here for clarity. Growth of new hair was found in 27 of the 40 collection skins. Growth was determined by carefully examining the skin at the base of the wool where the emerging tips of the contour hairs could be seen as short, dark bristles. These were found in every month of the year except April but over half occurred in the period October-January (The samples for each month are, however, not of equal sizes). Hair shedding was found only in May and June but was difficult to detect since many animals showed "hair slip" (loosening of the hair as the animal begins to decompose) which could be confused with shedding.

Greatest growth of guard hairs was observed from about October and continued into the following year. This corresponded with an increase in the density and length of the wool and the change in the face pattern. Coat shedding and re-growth oocurred in May-June. One skin was shedding hair in June and had new contour hairs visible on the neck. It was also shedding the white frontal band. There seems little doubt that there are two periods of shedding and growth annually in the polecat.

5.14 Variations

The chief impression given by the pelts is one of uniformity. Only two pelts showed a backward extension of the chin patch onto the throat, associated with "grizzling" (a scattering of white guard-hairs amongst the black ones, often noticeable on the thighs and tail). This type of pattern is common in fitch ferrets and may have been caused by recent crossing with escaped animals. (Fig. 5.15)

Only one of the animals examined was erythristic. This was received late in 1967 but has been included because it was exceptionally interesting. The pattern was that of a typical polecat but all the hair which is normally black was a light reddish-brown.

Fig. 5.15 Pelts of the fitch ferret - ventral view

Discussion

McCann (1956) said that in captive "New Zealand fitch" there was only one moult which was prolonged. Other authors have assumed that there are two moults in a year.

Harvey and Macfarlane (1958) stated that there were two moults annually in the ferrets which they used for their experiments. They said that the moult proceeded backwards from the head in a wave-like manner. It was not possible to determine the sequence of hair shedding and new hair growth in this present study.

The face pattern in the polecat is of interest since it was used by Pocock (1936) as a basis for separating the British and Continental polecats. According to his classification the British form Putorius putorius anglius never develops a full white frontal band in the winter whereas the Continental form Putorius putorius putorius does. The differences are illustrated in Figs. A and B at the end of this paper. Poole (1964) has already pointed out that the face pattern is not reliable as a guide. His view is confirmed by the present observations, since 6 out of 21 winter pelts showed pattern 5 (Fig. B of Pocock 1936) which, according to Pocock is that of the Continental P.p.putorius.

5.2 Linear Measurements

The numbers and sexes available for length measurements are shown in Table 5.21. All differences between males and females were highly significant. The least difference was in the length of the hind foot (females 95% of males) and the greatest was in body weight (females 63% of males).

Discussion

There is a marked sexual difference in the dimensions of many mustelids. Ondrias (1960) measured the sexual variation in the skeleton of several European mustelids and found it to be greatest in *Mustela erminea* and least in *Meles meles*. In a further paper, (Ondrias 1961) on the structure of the fore limbs in mustelids and its correlation with their mode of life, he quoted values for the humerus length in the polecat, which are compared below with the values found in this study.

	MALE			FEMALE		
	No.	Mean (m.m.)	S.E.	No.	Mean (m.m.)	S.E.
Ondrias (1961)	15	49.5	-	10	42.5	-
Walton	32	47.1	0.3	6	40.5	0.3

The mean values appear to differ but no statistical comparison was possible as he quoted only maximum and minimum lengths.

Kratochvil (1952) published data for some skull and body measurements of polecats from Czechoslovakia. A comparison with the values found in the present study is shown in Table 5.22. A statistical comparison was not possible as only the range of measurements was given. The skull measurements appear to differ only slightly, but the body measurements show considerable mean differences. In all respects the body measurements are greater in the Czechoslovak sample than in the British, with the exception of the hind-foot length in the female where the reverse is true.

If this finding is considered together with the data on long bone lengths given above, it seems to indicate that the polecat of Continental Europe is of slightly greater body dimensions than that found in Britain. There appears to be little or no difference between the skulls of polecats from these two areas.

5.3 Weight changes

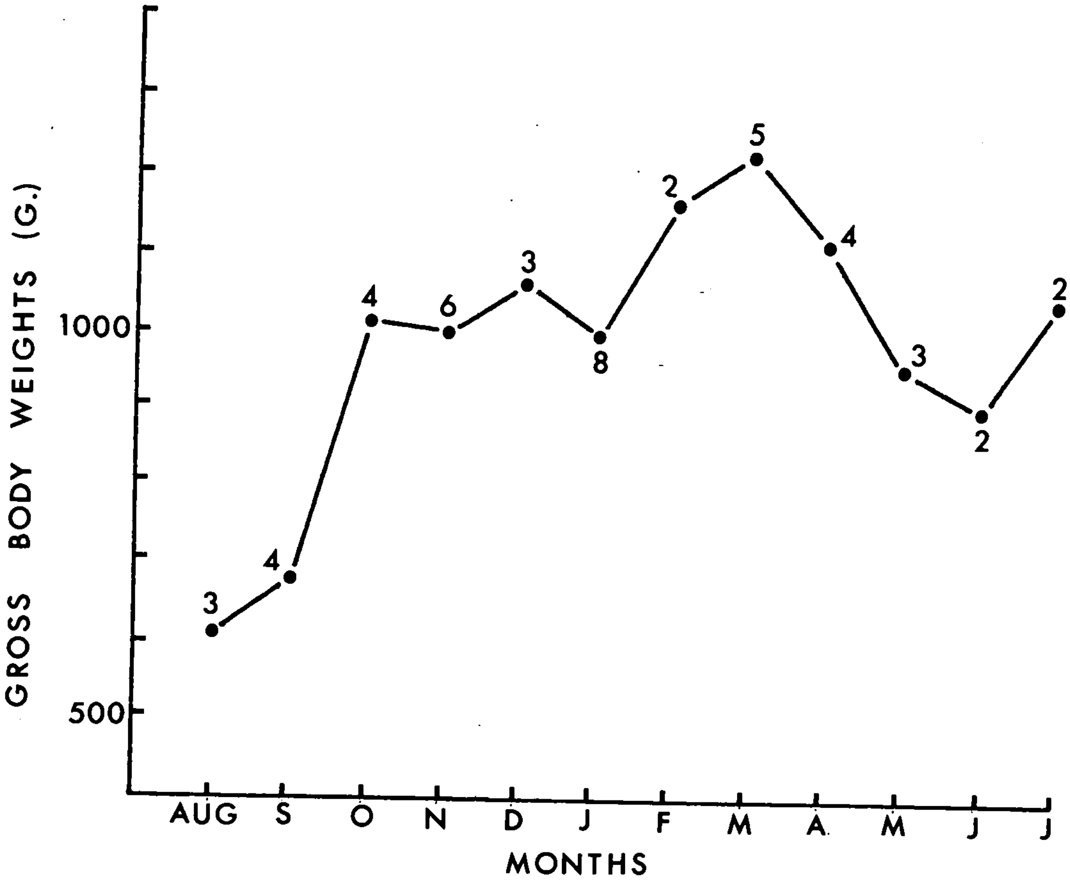
For males 45 gross weights were obtained. Their monthly variation is shown in Figure 5.31. There was a fairly obvious increase in weight from August onwards as juvenile animals became adult. Analysis of variance for body weights from October (when the juveniles approximated to adult weight) to July, confirmed that there was a considerable amount of change in weight over this period. There was not sufficient material available for the weight curve to be calculated, since the variance within each month was fairly high. However, there seemed to be a general increase in weight to a maximum in March followed by a loss in weight. It is assumed that this gain and loss in weight was due to the accumulation and dispersal of fat in the body. Observations on body fat made during skinning and cleaning support this view.

Only 9 female gross body weights were recorded. Mean body weights for both sexes are shown in Table 5.21.

Discussion

The weight curve obtained by plotting weights of a sample of animals from the field is unsatisfactory unless the sample is very large. Apart from differences between individuals there were also, in this study, varying proportions of adults and juveniles in the sample for each month. Despite these handicaps there did appear

Fig. 5.31 Monthly variation in gross body weight in the male polecat. The numbers indicate the size of each monthly sample. (From the data of Table 5.31).


GROSS BODY WEIGHTS (G.)
1000
500
AUG
S
O
N
D
J
F
M
A
M
J
J
MONTHS
3
4
4
6
3
8
2
5
4
3
2
2

to be a considerable increase in weight during the autumn and winter which reached a maximum in March. A similar curve was obtained by Harvey and Macfarlane (1958) for captive ferrets based on periodic weighings of a group of 5 live animals. In their experimental group, maintained in the equivalent of Northern Hemisphere lighting, maximum weight was reached in February and minimum weight in June. The curve obtained in this study follows their published curve well, despite the small sample size used here.

Cyclical changes in weight have been recorded in other mammals. Flux (1967) for the European hare in New Zealand found that males reached their maximum weight just prior to the breeding season in mid-winter (July).

It has often been assumed that the accumulation of body fat is a means of preventing heat loss, serving a similar function to that of the winter coat. For example Hammond (1954) said "The deposition of fat, mainly subcutaneously, in the autumn months clearly serves the double purpose of providing extra thermal insulation and extra energy reserves for the winter". This may not be the whole explanation, however, since the maximum weight (and probably the maximum accumulation of fat) in this study was achieved in March, i.e. at the end of the winter. It seems probable that this increase may be correlated with breeding. This suggestion is supported by the observations of Schmidt (1943), who noted in captive pine-marten that maximum weight occurred in June, and Markley and Bassett (1942) who recorded that oestrus in the female of this species is in July and August; hence maximum weight occurs just before breeding. Neal (1964) stated that in the badger also, maximum weight occurs in December or January and that breeding takes place from February to May.

No distinction has been made in this study between brown and white adipose tissue which have been shown by Hull and Segall (1966) to have different functions.

5.4 The shape and dimensions of the skull

The shape of the skull has often been used to distinguish the European polecat, steppe-polecat and ferret from one another (Miller 1912, 1933: Ellerman and Morrison-Scott 1951, Pocock 1936, and Rempe, 1965). The polecat and ferret were compared in this study in an attempt to throw further light on the relationship of the two animals.

5.41 Skulls of the polecat and ferret: differences in appearance

The shape of the skull in the European polecat and ferret is shown in Figs. 5.41A and 5.42A. The most obvious difference between the two forms is the shape of the braincase between the zygomatic arches. This is almost parallel-sided in the adult polecat but pinched in to produce a post-orbital constriction in the adult ferret. This constriction is not so well developed in the juvenile ferret. (5.42B) In profile the ferret is seen to have a shorter nasal region than the polecat (Fig. 5.43).

Juvenile skulls of both forms, in addition to having open sutures, were found to have a bone surface which was dull in appearance and felt gritty to the touch. The sagittal crest had not formed and in very young skulls it was present only as two bands of raised bone one on either side of the dorsal mid-line. The occipital crests were also poorly developed.

Fig. 5.41 Skulls of polecat - dorsal view

A. Adult. Left - female. Right - male.

B. Juvenile. Left - female. Right - male.


100 MILLIMETRES
10 CENTIM


PR48
100 MILLIMETRES
10 CENTI

Fig. 5.42 Skulls of ferret - dorsal view

A. Adult. Left - female. Right - male.

B. Juvenile. Left - female. Right - male.


10
20
30
40
50
60
70
80
90
100
100 MILLIMETRES
1
2
3
4
5
10 CENTIMET

Fig. 5.43 Skulls of polecat and ferret in lateral view.
Upper - ferret. Lower - polecat.


PR86
100 MILLIMETRES
10 CENT

As skulls became adult the suture lines became obliterated, the crests became distinct and raised and the bone surface developed a smooth, polished look and feel. The braincase became wrinkled in appearance. Old skulls developed concretions of bone especially on the post-orbital process and as ridges below the mandible.

Many adult polecat skulls had broken teeth especially the canines. Such damage was sometimes very recent, as when an animal had presumably been biting a trap, but some was much older and had often been repaired by bone growth over the surviving tooth stump. Many polecats appeared to have decayed teeth; these were often canines which had been damaged.

An extra tooth was present in 3 out of 48 polecats and 5 out of 40 ferrets. Two more ferrets had incipient doubling of a tooth with the root single and the biting edge split for some distance towards the jaw. In all cases the tooth involved was one of the upper incisors, usually the first on either the right or left. In some skulls the entire lower incisor row had been displaced to one side to accommodate the altered pattern of the upper row. The dental formula in both polecat and ferret is

$$\frac{3.\ 1.\ 3.\ 1.}{3.\ 1.\ 3.\ 2.}$$

5.42 Skulls of the polecat and ferret: dimensions

A series of measurements was made on each skull (Appendix 5.4) Only simple skull dimensions were measured and no account was taken of the many other individual features which Ashton and Thomson (1954) investigated.

(a) Comparison of adult polecat and adult ferret (Tables 5.14A and 5.14B).

Skulls of males and females were compared separately and only those differences are presented which occurred in both sexes. The following dimensions were found to be significantly greater in the polecat than in the ferret ($P < 0.02$):-

Maximum bizygomatic breadth
Minimum frontal breadth
Minimum distance between bullae
Width of palate at third premolar
Minimum distance between orbits
Volume of braincase.

With the exception of the last item these are all horizontal measurements of the skull at right angles to its long axis and they suggest that the skull of the polecat is broader than that of the ferret. This agrees with the empirical statement of Pitt (1921) who said of the polecat "Its head is decidedly blunter in both sexes". It is probable that many of these measurements are highly correlated.

The distance from the orale to the posterior palatine foramen was found to be greater in the polecat at a less significant level ($P < 0.05$). The reduction of this distance in the ferret may reflect its shorter nasal region as compared with the polecat and mentioned above.

No comparison of means was made between juveniles of polecat and ferret since there may have been large individual differences in age, even though all were classed as juveniles.

(b) Comparison of adult and juvenile polecats (Table 5.14C)

This comparison was made only on males because the sample of juvenile females was too small. The adults were found to have a greater byzygomatic width ($P < 0.05$) whilst the juveniles had a greater minimum frontal breadth and volume of braincase ($P < 0.02$ and $P < 0.05$ respectively).

(c) Comparison of adult and juvenile ferrets (Tables 5.14D and 5.14E).

Both sexes were compared. The only difference found in both sexes was that the juveniles exceeded the adults in minimum frontal breadth and volume of braincase ($P < 0.02$).

(d) The normality of the distribution of skull length in the adult male polecat.

Rempe (1962) showed that the ferret sample which he examined differed from normality with regard to condylo-basal length. He plotted condylo-basal length of 80 male and 50 female ferrets against frequency on a logarithmic scale and obtained multiple peaks. He also showed that the value of the statistic g_2 differed from that characteristic for a normal population. In the present study the distance from the prosthion to the occipital condyles for 44 male polecat skulls was examined and found to conform to a normal distribution (Appendix 5.41) This was not done for ferret skulls as the size of the sample was inadequate for this procedure. It is considered that this finding is due to the greater homogeneity of the wild population resulting from random mating, as opposed to selective mating in the captive ferret.

Discussion

The differences in skull width presented in comparison (a) do not make any obvious visual impression with the exception of the minimum frontal breadth. This measurement is probably the one responsible for braincase volume, since the two occur together in comparisons (b) and (c).

Both juvenile polecats and ferrets have a pear-shaped skull (Figs. 5.41B and 5.42B). This feature is so marked that Kostron (1949) mistakenly described a juvenile of P. putorius as a new form piriformis. In both polecat and ferret the juvenile has a greater frontal breadth and braincase volume than in the corresponding adult.

As the animals become adult the reduction in frontal breadth (and braincase volume) is greater in the ferret than in the polecat giving rise to the post orbital constriction in the former; whilst the increase in zygomatic breadth is greater in the polecat than in the ferret. These relationships are summarised in Fig. 5.44.

$$\begin{tikzcd}
\text{AD. POLECAT} \arrow[r, "-\ 11.5\%"] & \text{AD. FERRET} \\
\text{JUV. POLECAT} \arrow[u, "-\ 4.6\%"'] & \text{JUV. FERRET} \arrow[u, "-\ 9.3\%"']
\end{tikzcd}$$

Minimum frontal breadth

$$\begin{tikzcd}
\text{AD. POLECAT} \arrow[r, "-\ 20.6\%"] & \text{AD. FERRET} \\
\text{JUV. POLECAT} \arrow[u, "-\ 6.7\%"'] & \text{JUV. FERRET} \arrow[u, "-\ 16.3\%"']
\end{tikzcd}$$

Braincase volume

$$\begin{tikzcd}
\text{AD. POLECAT} & \text{AD. FERRET} \arrow[l, "+\ 4.3\%"'] \\
\text{JUV. POLECAT} \arrow[u, "+\ 4.5\%"'] & \text{JUV. FERRET} \arrow[u, "+\ 2.9\%\text{(not significant)}"']
\end{tikzcd}$$

Maximum bizygomatic breadth

Fig. 5.44 Relationship of certain skull dimensions in adult and juvenile polecats and ferrets.

The combined effect of these changes could be interpreted as providing an increase in the space available for the jaw muscles; in the case of the polecat by a slight narrowing of the braincase and a widening of the zygomatic arch; and in the case of the ferret by a greater narrowing of the braincase and slighter widening of the zygomatic arch. Why the two skulls should develop differently in this way is not clear. It is possible that there may be differences in the rate of development of the braincase. If, for example, in the polecat the sutures of the braincase close at an earlier date and the bone becomes thicker then the structure may be less susceptible to compression from the contraction of the jaw muscles. The adult skull would then be little changed in this area compared with the juvenile. The reverse would be true for the ferret.

A change in the relative dimensions of juvenile skulls of the polecat and ferret with increasing age in relation to increasing use of the jaw muscles is supported by the observations of Moore (1967) on the effects of jaw musculature on the developing rat skull. He compared the effects of total removal of the masseter, in one group, and removal of the temporal muscle in another with a third control group. Removal of the whole masseter produced gross changes in many dimensions of the skull. Of more interest in the present context was the increase in the width of the braincase which was observed in the group in which the temporal muscles were removed. This operation would presumably reduce the force of compression from the jaw muscles, producing a similar situation to that observed in the polecat and ferret skull before the jaw muscles are in full use i.e. in the juvenile.

It has been suggested by Pocock (1936) that the reduced frontal breadth in the adult ferret is due to being reared in captivity. Although it is not clear how this cause is supposed to operate there should be, if it is true, two corollaries: firstly that the skulls of polecats reared in captivity should be constricted; and secondly that the skulls of feral ferrets born and raised in the wild should not be constricted. None of the evidence available in the present study supports these ideas. The skulls of polecats raised in captivity were in no way different from those of wild animals; nor were the skulls of feral ferrets different from captive ferrets.

It has been suggested, in general terms by Zeuner (1963) and in the case of the ferret by Rempe (pers. comm.) that there is commonly a reduction in brain size in domesticated animals. Rempe suggested that the reduction in brain size in the ferret is the cause of the reduction in frontal breadth i.e. that the skull develops in relationship to the brain. Whilst it seems certain that the pressure inside the skull must play a large part in determining the final shape of the braincase, it seems equally certain that this effect must be modified by the pressure of the jaw muscles as they contract. If this is not so, then it is extremely difficult to explain the much greater constriction in the braincase of the closely related wild form P. eversmanni. It seems highly unlikely that this species also has a brain even more reduced than the ferret, if the former relationship were correct. If reduced frontal breadth (and reduced braincase volume) are considered as being due to reduced brain size, can it also be assumed that the greater size of these dimensions in juveniles indicates greater brain size also? This too seems highly unlikely.

Darlington (1957) showed that the endocranial pattern of the skull in the ferret was determined by the pattern of convolutions of the brain. This pattern is not exerted directly, however, but by the arachnoid trabeculae and the pressure of the cerebro-spinal fluid. When the trabeculae were damaged by experimental interference with the brain, the overlying part of the skull in suckling animals bulged outwards since it was no longer anchored by the trabeculae. Whether a mechanism such as this could determine the overall size and shape of the adult skull in the polecat and ferret is open to question.

It is difficult to account for the greater volume of the braincase in juvenile animals unless these have a greater space for the cerebro-spinal fluid with a brain similar in size to that of the adult. The linear increase would need to be only slight since, for a sphere with a radius of about 8 mm., an increase of 12½% to 9 mm. produces a corresponding volume change of 70%. This problem could be resolved by examination of this feature in juveniles and adults.

It seems probable that the shape of the skull in both polecat and ferret is genetically determined and results from a number of proximate causes acting together. These might include different rates of development of the skull bones, intracranial pressure, and times at which various muscles, especially those closing the jaw, come into use. Investigation of these factors would, doubtless resolve this problem further.

5.5 Internal appearance

5.51 Internal organs. Compared with most other mammals the only relatively unusual feature of the internal organs was the simple nature of the gut which was not markedly differentiated into a rectum at the hind-end. This is a common feature in carnivores. There were a pair of stink-glands, one on either side of the tail root, secreting a thin, milky fluid offensive to human nostrils. These glands opened onto the perineum. Their use in "setting scent" has been described by Goethe (1938, 1940). The specific odour doubtless impregnates the faeces as well, so that the latter would be well suited to act as territorial markers. (cf. Wynne-Edwards 1962 pp. 102-108.)

5.52 The humerus and closure of the epiphysis

The time of closure of the proximal epiphysis of the humerus was found to be of some use for age determination. Epiphyseal closure has been used for this purpose in rabbits by Thomsen and Mortensen (1946), and Hale (1949) but relied upon comparison with material of known age. Such material was not available in this study so that the technique has been limited to confirming the juvenile/adult status of bacula in the male during the latter half of the year. Epiphyses were found to be open up to October and just closed by November. Almost all specimens were closed by December and juveniles could no longer be distinguished from adults by the appearance of the humerus.

6.0 REPRODUCTION IN THE MALE

The majority of the animals obtained throughout the study period were males. This made possible an examination of the male reproductive cycle for a reasonably good sample in each month of the year. Organs were available from 54 animals. Most of the testes were in complete pairs from each animal but in some cases one was missing or damaged, so that a few animals were represented by one testis only.

The methods used for dealing with the testes are given in Appendix 6.01. In what follows, the weight of the testis refers to the mean weight of a pair of testes and their associated epididymides, with the few exceptions mentioned above. When a value is given for the tubule diameter, this value is the mean of 50 measurements of tubules taken over an entire section of one testis. Where the testes of more than one animal have been used for such measurements in a given month the means have been averaged.

6.1 Changes in testis weight, tubule diameters, and sperm production

The testes could be detected by palpation from about December onwards and by January were in evidence by the bulging of the skin which covers them.

Fig. 6.01 shows that there was a well defined breeding season in the male if testis weight is accepted as a suitable criterion of breeding condition. Its suitability was confirmed by the appearance and disappearance of sperm, which is shown on the same figure, and also by the associated changes in the diameters of the seminiferous tubules shown in Fig. 6.02.

The sequence of events in the testis was as follows. When young animals first appeared in July-August the testes were very small and weighed about 0.14g. each with tubule diameters of about 50 μ. During September and October there was a slight increase in weight. Tubule diameters increased slightly in October - one testis measured in this month had tubules averaging 80 μ.

In November there was a decrease in testis weight almost back to that found in August. The tubules of the testis measured in this month were smaller than in October.

In December there began the marked increase in testis weight observed during the breeding season. Both testis weights and tubule diameters now increased steeply to reach a maximum in March which was maintained until May at a fairly constant level. The testes weighed 2.00 to 2.03g. during this period with tubule diameters between 150 and 197 μ.

Fig. 6.01 Monthly variation in the mean weight of the polecat testis. The numbers indicate the size of each monthly sample. The values for adults from August to December have been transposed to follow the value for July. (From the data of Table 6.01).

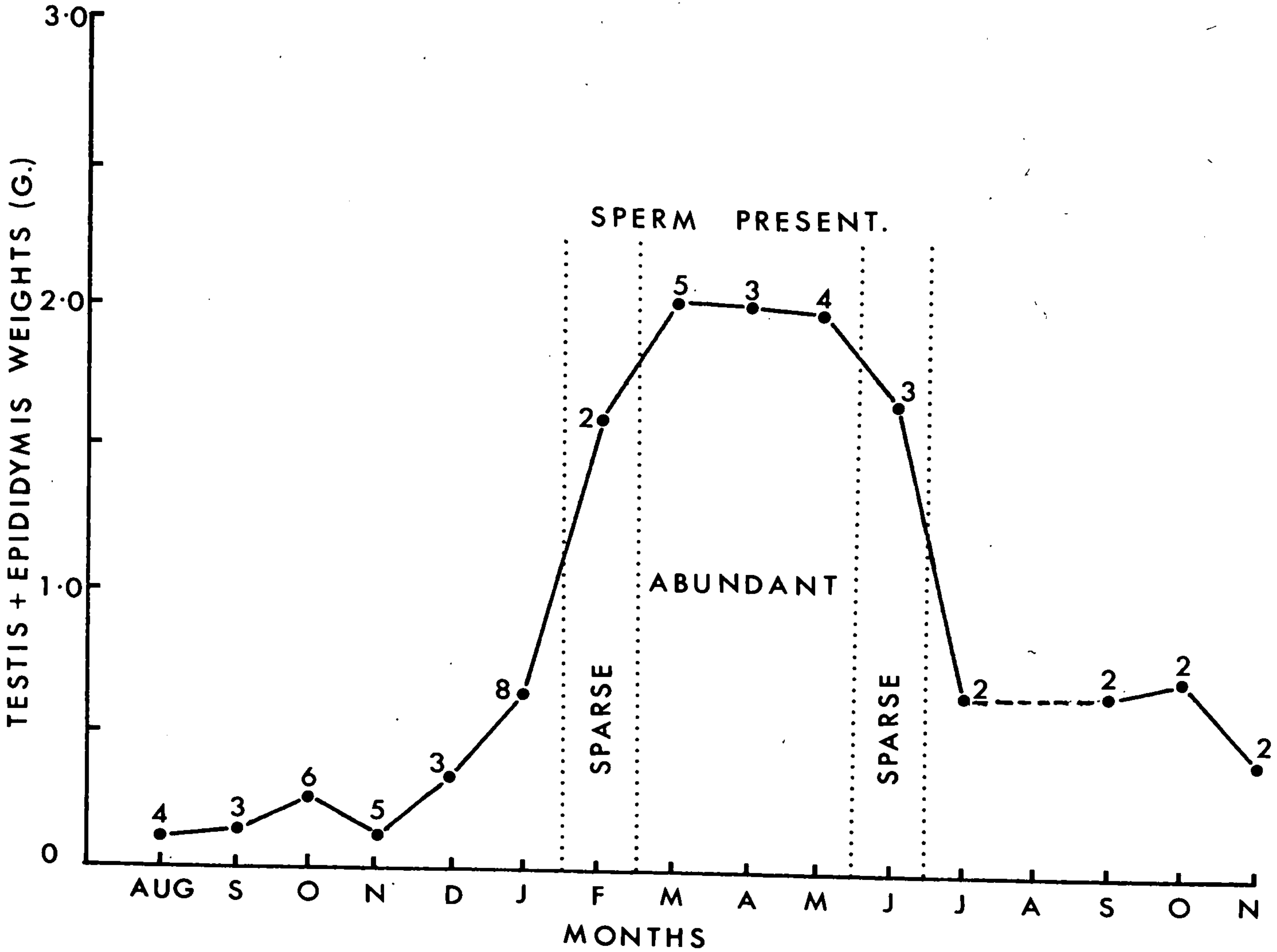
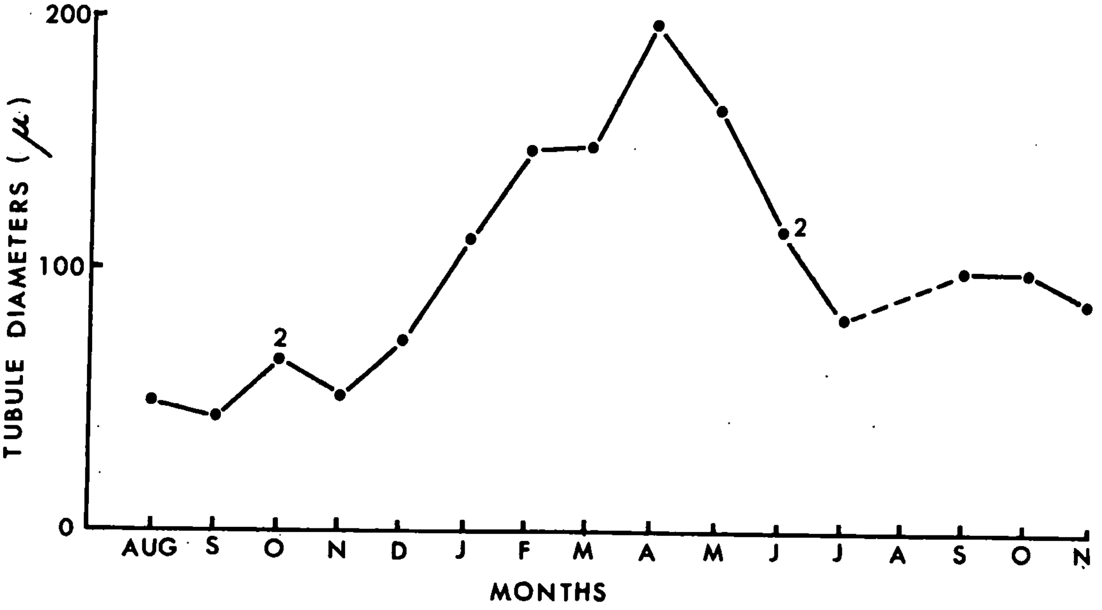

SPERM PRESENT.
SPARSE
ABUNDANT
SPARSE
TESTIS + EPIDIDYMIS WEIGHTS (G.)
3·0
2·0
1·0
0
AUG
S
O
N
D
J
F
M
A
M
J
J
A
S
O
N
MONTHS
4
3
6
5
3
8
2
5
3
4
3
2
2
2
2

Fig. 6.02 Monthly variation in the mean testis tubule diameter in the polecat. Each value is the mean of 50 measurements taken across a single testis section except where indicated. The adult values for September - November have been transposed to follow the value for July. (From the data of Table 6.02).


200
100
0
TUBULE DIAMETERS (µ)
2
2
AUG
S
O
N
D
J
F
M
A
M
J
J
A
S
O
N
MONTHS

In June-July there was a sharp decline in both weights and tubule diameter.

The testes continued to decrease in weight to August-September but were never as light as those of the new generation of juveniles from the current year. As with the juveniles there was a slight rise in testis weight during October followed by a fall to their lowest weight in November. The adult testes weighed approximately three times the weight of juvenile testes until the latter began to increase in weight in December.

Sperm first appeared in February, but in only small numbers. They were abundant from March to May (i.e. during the period of maximum testis weight), decreased in numbers in June and were absent in July.

6.2 <u>Histological changes in the testis</u>. From August to November the seminiferous tubules of juvenile polecats showed little activity. They were lined by a single layer of Sertoli cells of which the cytoplasm extended across the lumen. Spermatogonia could also be seen. There was some production of primary spermatocytes during October (Fig. 6.03) but these were no longer to be seen in the organs examined during November.

In December the picture changed completely. (Fig. 6.04) The tubules were lined with actively dividing spermatogonia and spermatocytes were being produced once more. The Sertoli cells were displaced to the tubule sheath. By February all stages to spermatids were present and a few spermatozoa were present, both in the tubules and the epididymis. (Fig. 6.05) Maximum development occurred from March to May (Fig. 6.06A).

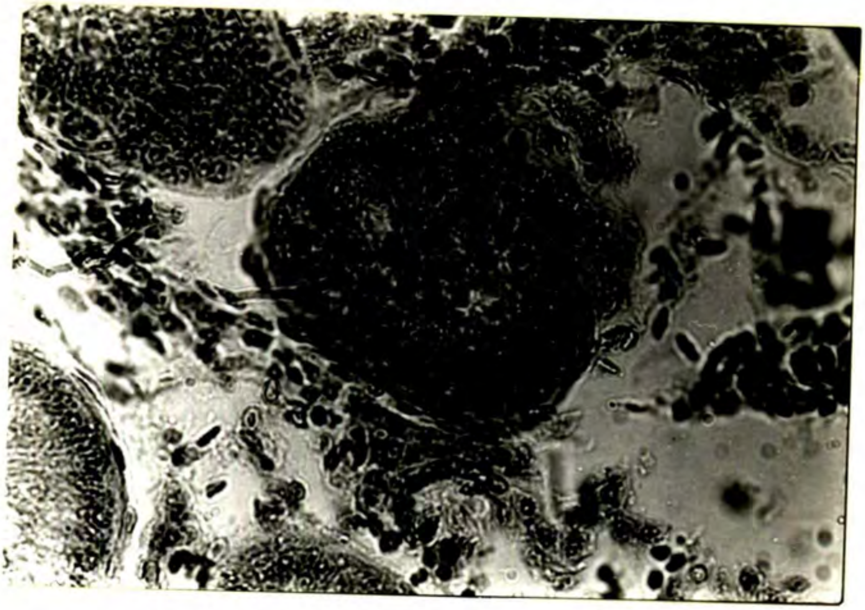
Regression began in June, but sperm could still be seen in the epididymis for some time afterwards. Primary and secondary spermatocytes continued to be produced in the adult testis until September (Fig. 6.07A).

6.3 Histological changes in the epididymis

A series of changes occurred in the epididymis which were associated with the breeding season. The diameter of the lumen increased during the breeding season and decreased towards its end. During the period of maximum enlargement there was considerable development of the cilia lining the lumen. (Compare Figs. 6.06B and 6.07B). These cilia were stated by Benoit (1926) to be non-vibratile but to be concerned with secretion by the epithelial cells, during which process droplets pass along them to the lumen.

Fig. 6.03 Transverse section of polecat testis - juvenile - October. x 350.

Fig. 6.04 Transverse section of polecat testis - juvenile - December. x 350.



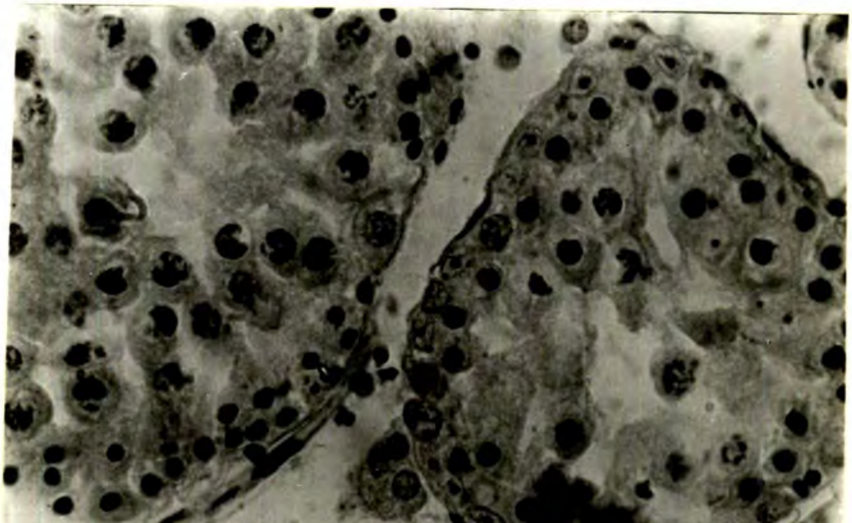


Fig. 6.05 Transverse section of polecat testis - February.
x 350.

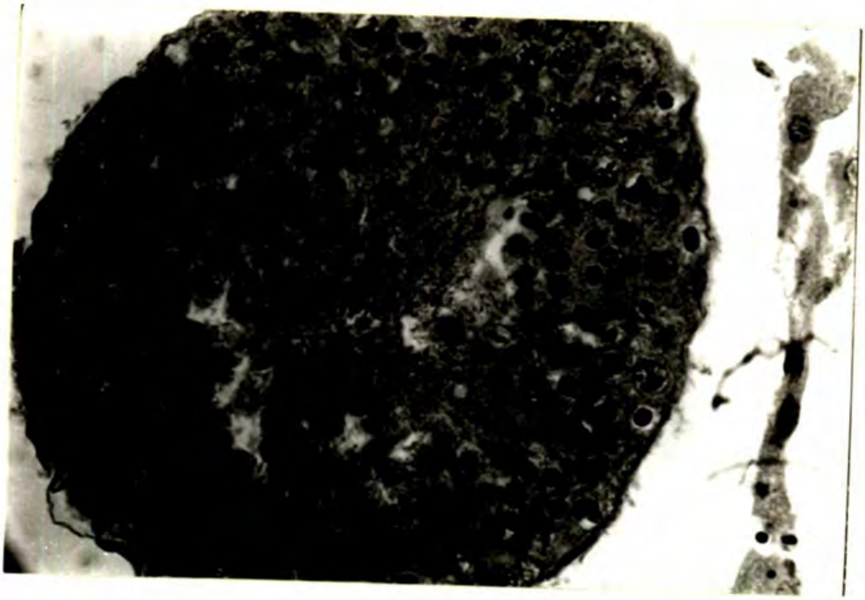
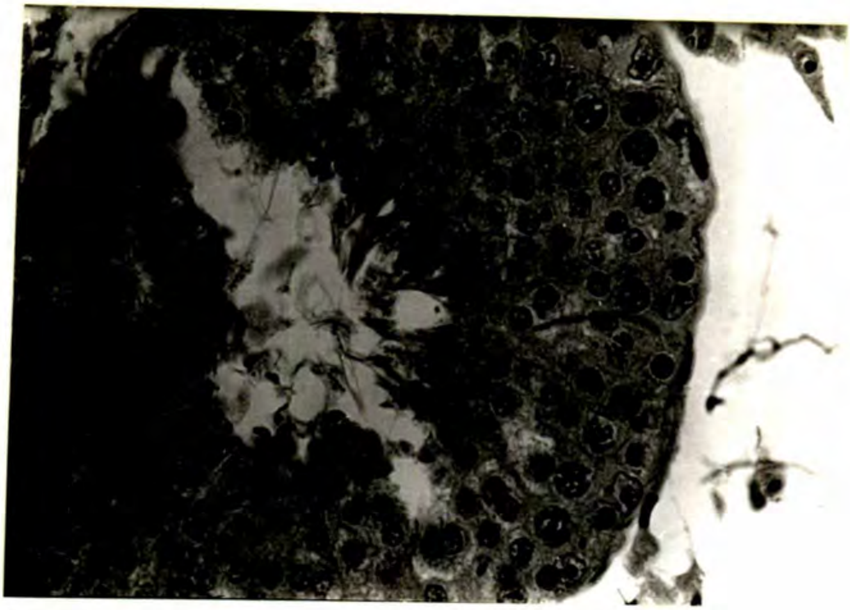


Fig. 6.06A Transverse section of polecat testis - April. x 350.

Fig. 6.06B Transverse section of polecat epididymis - April. x 350.



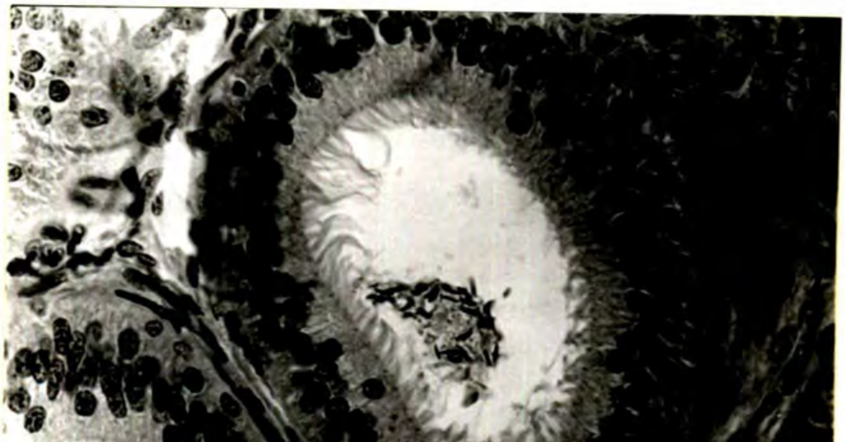
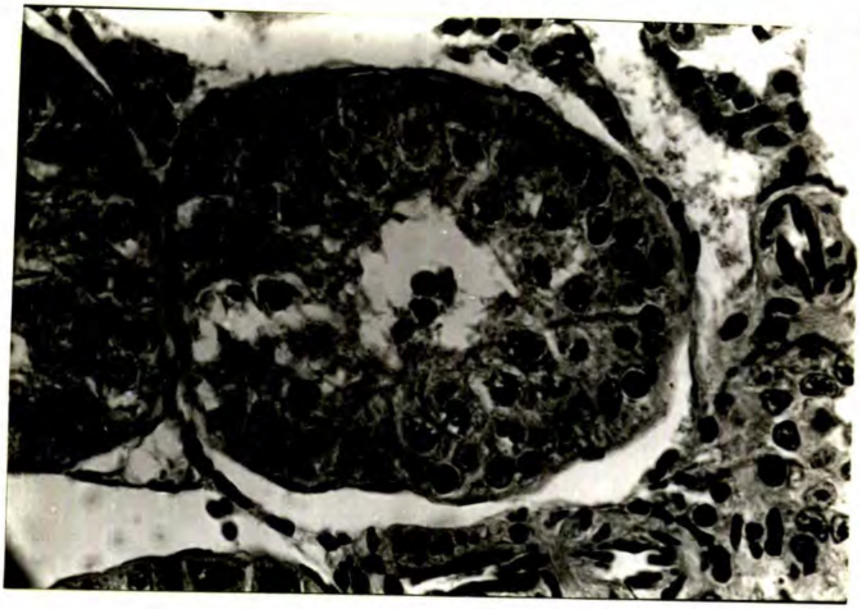
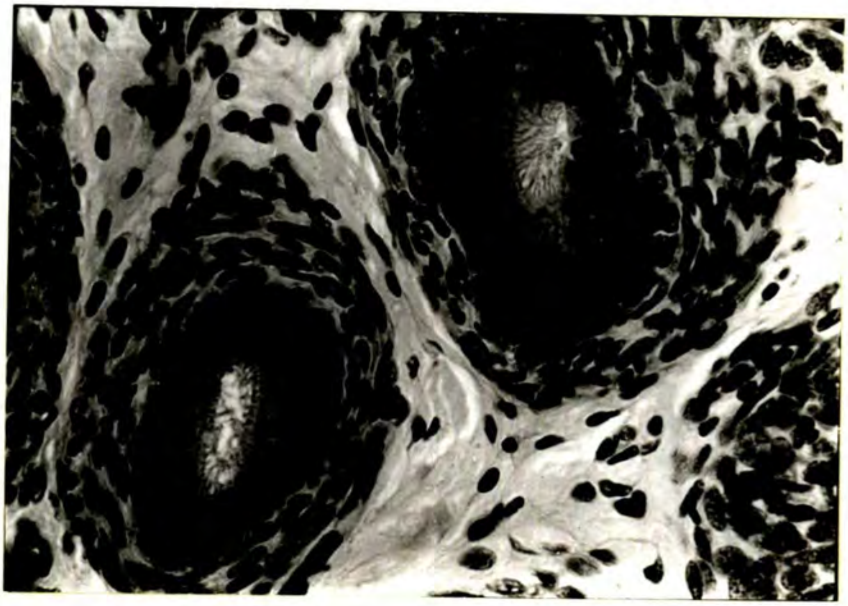


Fig. 6.07A Transverse section of polecat testis - adult - September. x 350.

Fig. 6.07B Transverse section of polecat epididymis - adult - September. x 350.





Discussion

Reproduction in male mustelids has been described for the ferret by Allanson (1931), for the stoat by Deanesly (1935, 1943) and for the weasel by Hill (1939).

Allanson (1931) used 16 adult and 3 juvenile ferrets for her studies and gave a detailed account of the various changes observed. Unfortunately she had no data for three months of the year and most of the remaining months were represented by data from a single animal for each month. She also chose to present her observed testis weights as percentages of the associated body weights. It has already been shown that body weight, in the polecat at least, varied in a cyclical manner throughout the year. (Section 5.3). Thus her percentages for the breeding season appear to be too low and vice versa.

For this study actual testis weights were used following Creed (1960), for the fox.

It is of interest that Allanson (1931) noted that November was the month in which the lowest percentage weights of the testis occurred. She attributed this to the fact that the young animals had increased in body weight without any appreciable increase in testis weight. Thus the testes appeared to have lost weight.

In fact the lowest actual testis weights occurred in November in the present study, correlated with a decrease in tubule diameter and cessation of the activity observed during October. Although the sample sizes for testis weights in each month were not adequate for statistical analysis it is suggested that the increase in weight in October and decrease in November, which seemed to be present in adults as well, could be accounted for by a burst of premature tubule activity in October. The changes in tubule diameter and the production of spermatocytes in October would seem to support this view.

Marshall and Coombs (1957) stated that there is an autumnal sexual season in rooks. They found that there were not only changes in the appearance of the testis but that there were also correlated behaviour changes of a type normally seen before the main breeding season in the spring. Various stages of spermatogenesis were seen in September and October, including mature sperm. Only 13.6% of the birds examined, however, showed spermatogenesis. The authors considered that the similarity in day length between Autumn and Spring could be factors in these changes but that the changes did not persist because day length is decreasing in Autumn

Development of breeding condition is often connected with the regime of light and darkness to which an animal is subjected. Bissonnette (1932) caused male ferrets to have enlarged testes by supplementing daylight with artificial light from October onwards. The response was obtained over 59 days. They did not produce sperm, however, even after 71 days of this treatment. Harvey and Macfarlane (1958) used the ferret as an experimental animal in an investigation of coat shedding, but made other observations on weight and reproductive changes at the same time. The experiments were done in Australia. Since this is in the Southern Hemisphere the normal reproductive cycle is reversed under normal lighting conditions. By completely reversing the natural sequence of day lengths for Australia with artificial lighting, they succeeded in reversing the breeding season of male ferrets to what is normal for the Northern Hemisphere. Their assessment of breeding condition was based on external examination alone so that they stated that testis development began about a month after the change over from decreasing to increasing day length. This would appear to be incorrect as has been shown here for the polecat and by Allanson (1931) for the ferret. Development of the testis in both these animals began <u>before</u> the light regime changed, but this was only detectable by the histological appearance of the tubules.

Changes in the testis may be associated with changes in the light regime but the relationship is not a simple one since Creed (1960) has shown that development of the testis in the fox begins in September and reaches a maximum in January. Marshall (1961) discussed some of the other factors which may be involved in birds, such as temperature, rainfall, breeding area, territory, nests, food and behavioural interactions. There is a great need for work on wild populations since captive experimental animals are often subject to a variety of unknown factors which could affect breeding. One such factor affecting wild animals has been recently demonstrated by Lockie (1966). He showed that some male weasels which were not territory holders at the appropriate time of the year failed to come into breeding condition. They did so, however, on acquiring a territory.

Thus, although it seems that light may be an important variable with which reproductive activity is associated, there could be several other climatic, social, and nutritional factors acting on the wild animal.

Furthermore, the response to light in mammals appears to differ from that in birds, as Bissonnette (1932) pointed out. Male starlings with which he experimented were more responsive to light than male ferrets. There are also differences between species e.g. the fox which begins development of the testis in September and the polecat in December. The response is not even identical for the different sexes of the same species since, in the ferret, whilst the male begins development in December, the female reaches oestrus only some months later.

Donovan (1967) in a series of experiments obtained some puzzling results for ferrets. Females subjected to "long day" lighting (16 hours light, 8 hours darkness) at the end of July were completely inhibited from reaching oestrus. If not corrected this anoestrus lasted for a long time, up to 49 months in one case. It could, however, be ended by treatment for eight weeks of exposure to "short day" lighting (8 hours darkness, 16 hours light). Females subjected to "long day" treatment in August-September either behaved like the July animals or reached oestrus rapidly with a latent period of two weeks. Females given "long day" treatment in October responded more normally with oestrus in six weeks. Females on "short days" from birth still came into oestrus in the Spring following birth. His conclusions were that the ferret has an inherent tendency to come into breeding condition in the Spring but that this tendency can be blocked, under certain conditions, by prolonged illumination which inhibits gonadotrophin formation. If "has an inherent tendency" can be read as "has evolved genetically" then this explanation would seem reasonable, although it leaves unresolved the problem of how the mechanism works.

Hammond (1952) explored the effect of a variety of light regimes on the reproductive state of female ferrets. He attempted to interpret his results in terms of stimulators and inhibitors, although admitting that these did not explain all the findings. Both he and other authors mentioned the possibility of increased light acting by way of increased activity of the ferret. Whilst this may be true for the domestic ferret it is almost certainly not so for the wild polecat. The latter is mainly nocturnal and thus would be more active during periods of longer darkness.

7.0 REPRODUCTION IN THE FEMALE

6 juvenile and 6 adult reproductive tracts were obtained. No pregnant females were found throughout the entire study period.

Some measurements were made on reproductive tracts and these are shown in Table 7.01. Of more interest was the number of nipples found in some of the females, especially those which had been recently suckling young. Details are given in Table 7.02. If the number of nipples in recent use can be taken as indicating the number of young, then this number varied from 6-9.

Despite the lack of precise information it seems reasonable to form some conclusions about the breeding season. Records of young animals are set out below.

July	20th	6 young with milk teeth; trapped
	23rd	"a litter seen"
	23rd	3 young seen
	25th	"a litter"
August	18th	1 examined which had milk teeth

By comparison with ferrets and polecat-ferret hybrids of known age, the young with milk teeth were judged to be 60 days old. Their approximate birth and conception dates would have been as follows:-

EXAMINED	BIRTH	CONCEPTION
July 20th	last week in May	mid-April
August 18th	mid-June	early May

This assumes that the gestation period is about 42 days, a figure widely quoted (Herter 1959).

<u>Discussion.</u> It seems probable that most of the young were born in late May and June. The question has often been raised in the past as to whether the polecat normally has one or two litters. Assuming that conception were to occur immediately after the birth of the first litter, a second litter would be born about mid-August at the earliest. These young would be independent about October although still carrying some milk teeth. No young in this condition were found during this study. It is concluded that only one litter is normally produced.

Captive polecats and ferrets are known to lose a first litter occasionally and in such a situation a second litter may be conceived. These would, however, only constitute a small proportion of a wild population and would rarely be represented in a limited sample.

8.0 THE BACULUM AND AGE DETERMINATION IN THE MALE

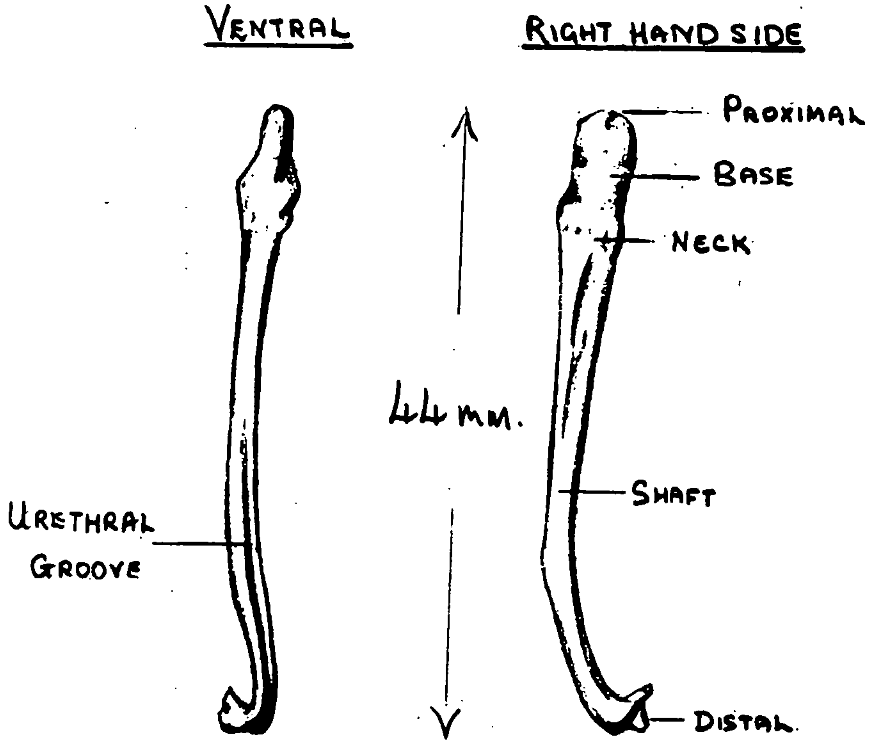
46 polecat bacula were examined. These were prepared as described in Appendix 3.01, air dried and weighed to the nearest 1.0 mg. The maximum length was measured to the nearest 0.1 mm.

8.1 Appearance of the baculum

The adult baculum, or os penis, in P.putorius is similar to that in other mustelids (see Fig. 8.01). It consists of an expanded knobbly base, a tapering shaft and a hooked tip. The base, forming the proximal end, is the point of attachment to the corpus cavernosum penis; the shaft bears the urethral groove running ventrally along the distal half; and the hook at the tip points dorsally. Viewed from the ventral side the bone is seen to be asymmetrical, curving slightly to the left near the tip. There is some individual variation in the extent of the development of the petal-like processes at the tip. There are no spiky processes encircling the basal end of the shaft as occur in the mink.

In the juvenile animal the shape and size of the baculum differ considerably from the foregoing description. The base is hardly distinct from the shaft and has a porous appearance; whilst the shaft itself is of an almost uniform thickness for the whole of its length. This distinction persists until the animal is approximately 6-8 months old. Differing stages in the baculum are shown in Fig. 8.02.

Fig. 8.01 *P. putorius* - baculum. x 2. (approx. age 26 months).



P. putorius - baculum × 2
(approx. age 26 months)

Haine M. Gorman

Fig. 8.02 Polecat baculum - changes of length and shape with age. Youngest bacula on the left, oldest on the right.


PR79
PR78
PR82
PR71
PR72
10 20 30 40 50 60 70 80 90 100
100 MILLIMETRES
1 2 3 4 5
10 CENTIMET

As indicated above, animals up to the age of about 6-8 months can be readily distinguished from adults collected at the same time of year (and, therefore, at least one or more years old) by the appearance of the baculum.

8.2 Changes in weight and length

Fig. 8.03 shows a progressive increase in the weight of the juvenile baculum. Analysis of variance for the period August-January (juveniles only Appendix 8.03) showed that weight increased with time. The increase appeared to be roughly linear but was not considered to be worth further analysis in view of the large range of sample sizes. Above about 300 mg. the juvenile baculum becomes indistinguishable from the adult baculum in terms of its appearance, and its weight evidently now approximates to that of the adult baculum.

Fig. 8.04A shows the growth curve of the baculum with regard to weight and length. In the juveniles, there was a period of growth where the rate of increase in length exceeded that in weight. This was followed by a phase when the rates of increase approached equality. In the older animals growth in length practically stopped but the bone continued to increase in weight, mainly by the addition of knobs on the base. These knobs give the baculum of the adult its characteristic appearance.

Fig 8.03 Monthly variation in the weight of the polecat baculum. Juvenile weights are shown joined, up to the beginning of January. Beyond this point no distinction is made and the points represent mixed samples. The numbers indicate the size of each monthly sample. (From the data of Table 8.03).

o - single bacula classified as "adult".

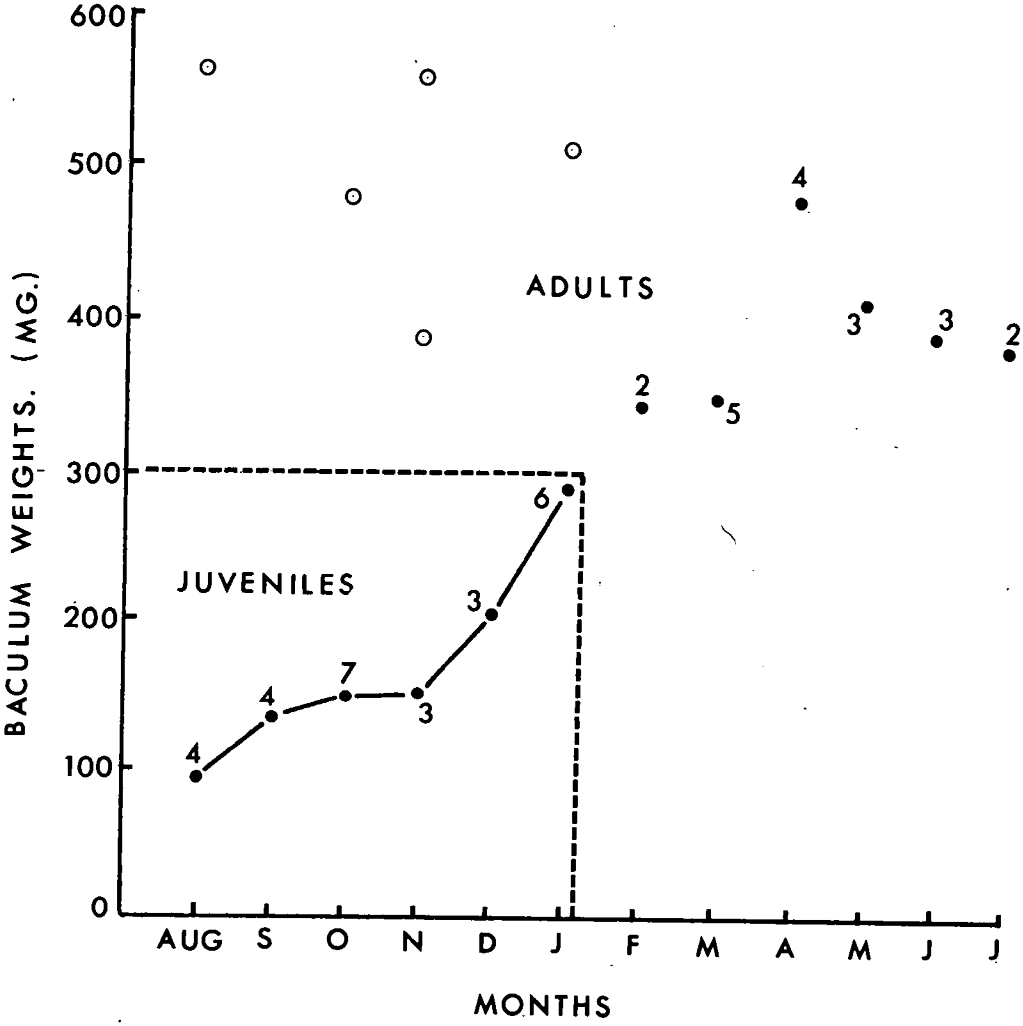
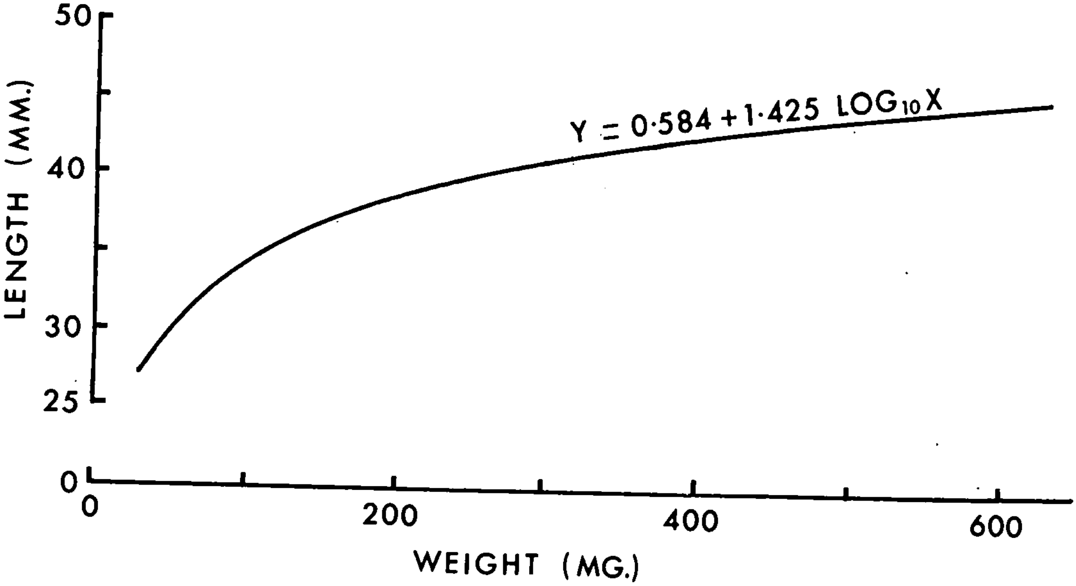
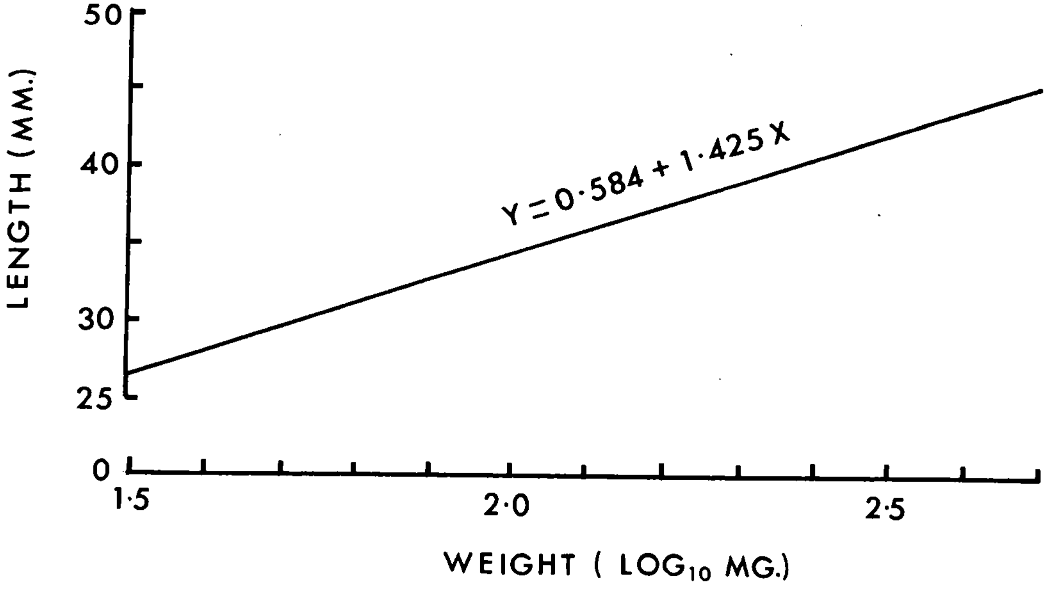

600
500
400
300
200
100
0
BACULUM WEIGHTS. (MG.)
ADULTS
JUVENILES
4
4
7
3
3
6
2
5
4
3
3
2
AUG
S
O
N
D
J
F
M
A
M
J
J
MONTHS

Fig. 8.04A Growth curve of the polecat baculum with regard to weight and length. The curve was fitted by using the regression equation of the line shown below.

Fig. 8.04B Regression line of length on $\log_{10}$ weight for the polecat baculum.


LENGTH (MM.)
50
40
30
25
0
Y = 0·584 + 1·425 LOG$_{10}$X
0
200
400
600
WEIGHT (MG.)


LENGTH (MM.)
50
40
30
25
0
Y = 0·584 + 1·425 X
1·5
2·0
2·5
WEIGHT (LOG$_{10}$ MG.)

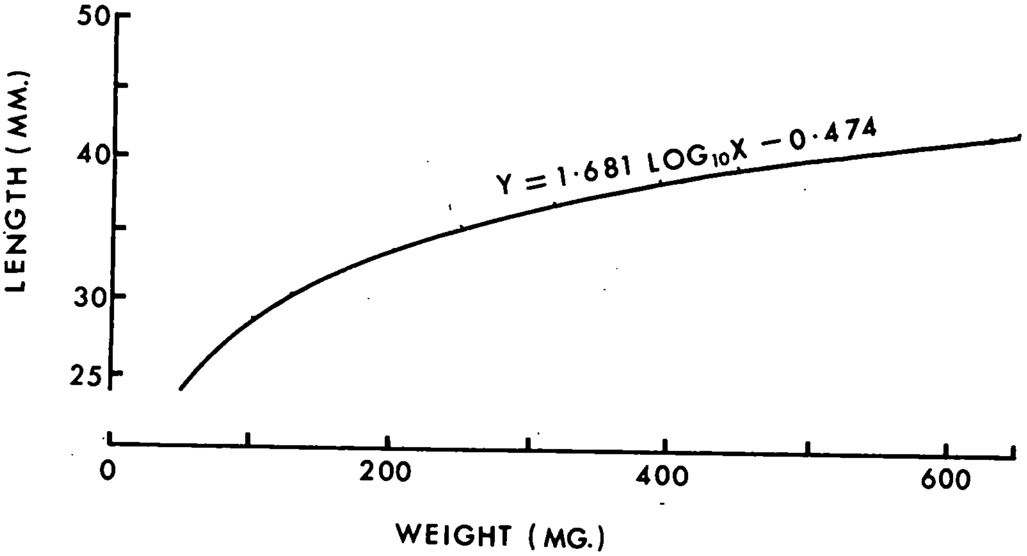
8.3 Comparison between polecat and ferret

25 ferret bacula were available for study. The curve of weight against length is shown in Fig. 8.05A. It was very similar to that of the polecat and comparison of the regression coefficients (Appendix 8.04) showed that the difference between them was not significant. The difference between the values for the constant 'a' in the regression equations was 10.58 mm. which meant that at any given weight the ferret baculum was about this amount shorter than the polecat baculum. This can be seen especially well on the curves when growth in length had ceased.

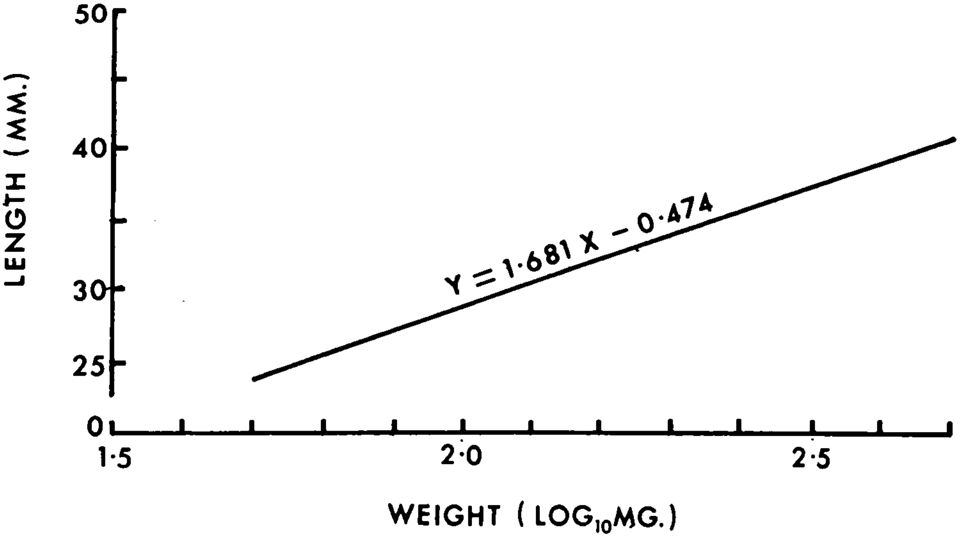
Although the increase of weight and length was similar for the two animals, the rate of increase of weight with time was not. Data for the ferret was not available over the whole weight range so that a strict comparison was not possible. Nevertheless, a mean baculum weight of 300 mg. was reached by young polecats at the age of approximately six months whilst a similar weight was reached by ferrets only at approximately 14 months. This invalidated the use of ferret bacula of known age as standards for estimating the age of polecat bacula, but indicated a striking difference between the two animals in the rate of development of this bone.

Fig. 8.05A Growth curve of the ferret baculum with regard to weight and length. The curve was fitted by using the regression equation of the line shown below.

Fig. 8.05B Regression line of length on $\log_{10}$ weight for the ferret baculum.



50
40
30
25
LENGTH (MM.)
Y = 1·681 LOG10X − 0·474
0
200
400
600
WEIGHT (MG.)



50
40
30
25
0
LENGTH (MM.)
Y = 1·681 X − 0·474
1·5
2·0
2·5
WEIGHT (LOG10MG.)

Discussion

Several authors have explored the possibility of using the baculum in mustelids as an indicator of age. This has been done by Deanesly (1935) for M. erminea, by Wright (1947) for M. frenata, and by Popov (1943) for a variety of mustelids including P. putorius and P. eversmanni. More recently, comprehensive accounts have been presented by Friley (1949) for Lutra c. canadensis and by Elder (1951) for Lutreola vison. Most of these authors claimed to be able to distinguish only two age groups i.e. juveniles and adults. Friley (1949), however, claimed to be able to distinguish four. This seems doubtful in view of the fact that he says that almost half of his specimens had no data at all attached to them, and the remainder had only the date on which the animal had been captured.

Elder (1951) using a sample of 242 mink bacula of known age, showed that the overlap between age groups older than 1½ years is so great that no distinction between them is possible by means of the baculum. The only useful distinction that he could make, and which is made here, is between juveniles and adults. For the polecat this stage ended just after the end of the calendar year in which the juveniles had been born and corresponded approximately to a mean baculum weight of 300 mg.

9.0 POPULATION CHANGES

9.1 Seasonal variation in numbers; life expectancy; and sex ratio

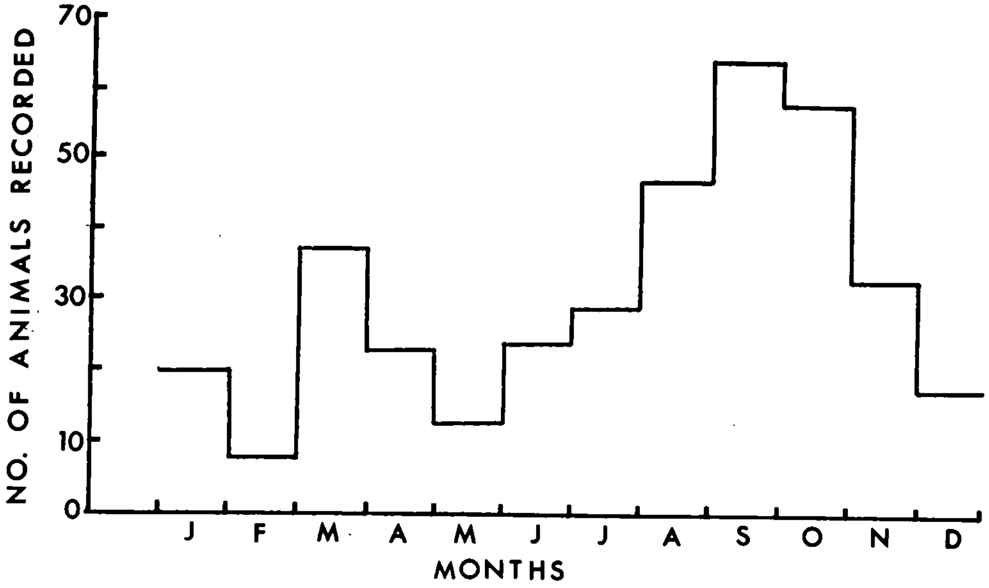
The total number of animals recorded from 1959 to 1966 for which the month of the records was known was 374. This number was divided up into months of occurrence (Table 9.01) and a histogram constructed (Fig 9.01). It can be seen that over half of the animals (54%) were recorded in the period from August to November inclusive. There seems little doubt that this peak represents mortality amongst the annual crop of young animals. Of 32 males whose juvenile/adult status was determined for the months of July to January inclusive, 27 were found to be juveniles, (Less than 1 year old). This gave a ratio of juvenile: adult deaths of 5.4:1 for the males.

If this ratio is taken as being the actual ratio of juvenile to adult males in the whole population, then the life expectancy at birth was 8.1 months. This was calculated from the formula given by Caughley (1967) for a stationary population immediately after a restricted breeding season (Appendix 9.01).

?

There was insufficient material available for a similar calculation to be made for females. The sex ratio of the total number of animals (74) for which the sex was determined during 1965-67 was 59 males: 15 females (almost exactly 4:1).

Fig. 9.01 Monthly variation in the number of polecats recorded from 1959 to 1966. (From the data in the Total column of Table 9.01).


NO. OF ANIMALS RECORDED
70
50
30
10
0
J
F
M
A
M
J
J
A
S
O
N
D
MONTHS

9.2 Causes of death

The total number of animals for which the cause of death was known from 1959 to 1967 inclusive was 405. The number of deaths from each cause is shown in Table 9.02 for the two periods 1959-62 and 1963-67. It can be seen that the most frequent recorded cause of death in both periods was a combination of road traffic accidents and trapping (87% and 87.8% for the two periods respectively). There must be many other causes of death in addition to those shown. The change of emphasis in the two factors between the two periods is not thought to be significant, since the first period includes Forestry Commission records, mainly of trapped animals, whilst the second does not.

Two of the animals found dead showed signs of poisoning by an anti-coagulant poison. The poison could have been ingested by eating dead or dying rats following its use for rodent control.

Discussion

The conclusions which can be drawn from the preceding observations can only be tentative. It seems likely that the polecat population sampled during the study period consisted mainly of young animals (0-2 years old). Only 4 out of all the males examined for age (46) were judged to be possibly two years old or more. Such an age structure is typical of a population which is in an expanding phase. It must be assumed that, in spite of the high number of juvenile deaths in the latter half of each year, a sufficient number of young survived to the breeding season not only to maintain the population but even to augment it. This view is supported by the observed increase in the area of distribution of the species (c.f. Section 4.0).

The observed sex ratio of 4 males: 1 female is difficult to account for but a similar situation has often been observed in mustelids. Yeager (1950) recorded a ratio of 33 males: 6 females in the pine-marten, amongst the oldest 20% of the population. In the stoat Deanesley (1935) found 61% of males; and Flintoff (1935) found 63% of 6,221 examined. Elder (1945), also for the stoat, found 80% males when the population was low and 60% when it was increasing.

Herter (1959) said (translated from the German) "most authors are of the opinion that, for the European polecat, there are more males than females". He also quoted from Volcanezki (1935) the sex ratio of four litters of steppe-polecats (total of 53 animals) as 1.4 males: 1 female.

It was not possible in the present study to discover whether the sex ratio observed in the sample was true for the whole population or not. It has been argued (e.g. Wynne-Edwards 1962. pp 108-109) that the males in territory holding animals, such as the polecat, move about more widely than the females in the process of defending and marking the territory. They are caught more frequently in traps as a result. It is not known, however, whether there are more males in the population in addition to this.

It is possible that there was heavier selection acting against the females during juvenile life. The sexual dimorphism which was evident in the adult (c.f. Section 5.2) is quite marked even before the young leave the nest. Food shortage and overcrowding could well alter the balance in favour of the males. If this effect reinforced an unequal sex ratio at birth it could partially explain the observed excess of males.

10.0 DIET

Food remains from a total of 38 stomachs were examined as described in Appendix 3.01. Use was made of the key devised by Day (1966) for identifying mammal hairs. Some of the insects were kindly identified by P. M. Miles.

10.1 Prey species

The following items were identified:-

MAMMALS

brown hare	- *Lepus europaeus*	cannot be separated on hair features
or		
rabbit	- *Oryctolagus cuniculus*	
water-vole	*Arvicola amphibius*	
short-tailed vole	*Microtus agrestis*	
wood mouse	*Apodemus sylvaticus*	
hedgehog	*Erinaceus europaeus*	

BIRDS

AMPHIBIANS AND REPTILES

common frog	*Rana temporaria*
common lizard	*Lacerta vivipara*

INVERTEBRATES

These included:
Lepidoptera - *Amathes (Noctua)* probably *xanthographa* - larvae
Diptera - Nematocera - tipulid larvae
Hymenoptera - *Bombus* sp. adult
Coleoptera - adults
Insect eggs - presumably from carrion
Phalangidae - adult

There was also much plant material, most of it in small quantities and presumably taken in accidentally whilst eating prey. Miscellaneous items included sheep's wool, suet and stones.

10.2 Frequency of occurrence of prey

There is no entirely satisfactory way of presenting information of this sort, so that the findings of this study are set out below in two ways. The frequency of various items is shown as a percentage of stomachs with contents and also as a percentage of the total number of prey items found in the study. Visual assessment of the quantities of remains found showed that mammals and amphibians appeared to be the most important. The quantity of invertebrate remains was small, even though the frequency of occurrence was high. Many of them were probably already part of stomach contents of frogs and rodents eaten.

Britain 1965-67

	% stomachs	% prey
Mammals	52.6	35.1
Birds	21.0	14.0
Amphibians and Reptiles	39.5	26.3
Invertebrates	36.8	24.6
Plants	42.1	0
Miscellaneous	10.5	0

Discussion. A table such as that presented above is only a guide to the sort of food that an animal eats. Ideally the information which is required is what proportion of the animals total energy requirements are being supplied by each prey species.

An advance on the methods used here was described by Lockie (1959) for foxes and (1961) the pine-marten. He worked out a number of correction factors which when multiplied by the dry weight of various food remains gave the original fresh weight of prey eaten.

Other writers have used simpler methods although Englund (1965a and b) for foxes, measured the wet volume of food remains.

Very little has been recorded about the diet of polecats, certainly not in Britain. For Finland Kalela (1940) said (translated from the German) that during snow free periods "...... the majority withdraw to water-sides, pastures, and marshes, even those which are distant from (human) settlements. On these "natural" biotopes a varied diet is available in the summer - small mammals, young birds, fish and frogs, to name only the most important components." Herter (1959) mentioned the polecat's liking for water and added, (translated from the German) - "This can be accounted for by the many frogs which occur in this moist habitat. On the other hand, however, Usinger (1931) and others have held that polecats in captivity evidently prefer warm-blooded vertebrates and insects to frogs, which I can confirm from my own experience. Perhaps amphibians are a sort of reserve food supply for wild polecats". Both authors agreed that polecats seek out human habitations in the winter, attracted mainly by rats and mice, but often stealing eggs and poultry as well.

Kratochvil (1952) examined 70 stomachs of the European and steppe-polecat (the proportion of each is not stated) during the winter of 1951-52 in Czechoslovakia and gave some figures for P.putorius.

Grigor'ev, Teplov and Tichvinskii (1931) (quoted in Ognev, 1962) gave figures for P. putorius in the Soviet Union over the period 1928-30 (149 stomachs examined). The two sets of figures are shown below with some of the categories combined.

	Czechoslovakia % prey items 1951-52	Soviet Union % total stomachs	
		1928-29	1929-30
Mammals	50.8	46.6	71.6
Birds	5.9	11.5	10.0
Amphibians and reptiles	17.6	24.9	8.9
Fish	-	1.9	14.1
Insects	11.7	-	-

Strict comparison of these various findings is impossible but it seems that the bulk of the polecat's food is made up of small mammals, chiefly rodents, with amphibians and reptiles (mainly the former) making up much of the remainder. The proportion of birds found in the present study was rather higher than in the published figures but this is not considered to be of great significance. Insects were taken frequently but not in any quantity.

11.0 PARASITES

The various groups of parasites are listed below with any relevant comments.

Ectoparasites consisted entirely of fleas (Siphonaptera) and ticks (Mestatigmata). The former were identified by means of the key provided by Smit (1957); the latter were very kindly identified by R. J. C. Page.

11.1 Siphonaptera (with comments on distribution from Smit 1957a)

Archaeopsylla erinacei erinacei Bouché.

8 ♀♀ taken from one host. Principal and only host is the hedgehog so that these were presumably stragglers, probably acquired from prey. New host record.

Nosopsyllus fasciatus Bosc.

1 ♀ Common throughout the British Isles on Rattus spp. but also on the wood-mouse, house-mouse and short-tailed vole.

Rhadinopsylla pentacantha. Rothschild

1 ♀ Fairly common in British Isles on voles and the wood-mouse.

Paraceras melis melis. Walker

27 ♀♀ , 6 ♂♂ All from one host. Common England, Wales and Ireland principally on the badger but also on the fox. New host record. This number of fleas could not be stragglers but must have either been acquired from a badger sett in

which the polecat had taken up residence or could conceivably have been breeding in the polecat's own den. The size of the infestation was most unusual.

Of all the British mustelids the badger is the only one which could be said to have a permanent home. It is also the only one which has a flea specific to itself and with which it is often infested i.e. P.m.melis. The other mustelids, the polecat included, occupy dens which are only seasonal. They rarely have fleas on their bodies except those recently acquired from prey.

11.2 Metastigmata Two species of ticks were found. These were Ixodes hexagonus Leach 1815 and Ixodes canisuga Johnston 1849. The numbers and stages of each tick which were found are shown in Table 11.21.

I. canisuga occurs mainly on dogs and foxes, although it has also been recorded from the sheep, ferret, mole, horse, badger and red-squirrel: also from nests of the sand-martin. This occurrence on the polecat appears to be a new host record.

I.hexagonus the Hedgehog Tick, has a wide range of hosts in Britain (Arthur 1953). One or more stages have been recorded from the hedgehog, stoat, weasel, fox, badger, otter, and polecat. It is said to have spring and autumn peaks of activity.

Endoparasites were found in only three individuals. All were kindly identified by Dr. Gwendolen Rees.

11.3 Cestoda Two animals had respectively one and two individuals of the tapeworm Taenia tenuicollis Rudolphi 1819. This species has previously been recorded from the stoat, weasel and European polecat on the Continent. It also occurs in the mink in North America. Intermediate hosts in Europe are Microtus arvalis and Talpa europaea.

11.4 Nematoda

One animal had a number of nematodes in the stomach. These were Molineus patens Day 1815, a parasite found in Europe, Asia, and North America in a variety of mustelid hosts including P.putorius and Vormela sarmatica.

One skull was found to have erosion of the bone in the supra-orbital region typical of that caused by the nematode Skrjabingylus nasicola Leuckart 1842. This parasite occurs in the frontal sinuses of a variety of mustelid hosts. Intermediate hosts in Britain are not known, but elsewhere larval stages have been recorded from several species of slugs and snails. Its occurrence in the polecat has been recorded by Lewis (1967).

11.5 Micro-organisms

One animal had an extensive abscess of the head and neck region, with involvement of the right eye and erosion of the bone. A swab from the infective material was kindly examined by Miss Bernice Caul, who recorded the following observations:-

> Gram staining showed the presence of Gram positive cocci, Gram negative rods, and Gram negative filamentous rods.
>
> Aerobic culture showed a haemolytic coliform (Gram -ve rods) in profusion; and a few non-haemolytic streptococci (the Gram +ve cocci).
>
> Anaerobic culture produced the same organisms. Fusiformis (the Gram - ve filamentous rods) failed to grow in culture but was probably the cause of the pus.

GENERAL DISCUSSION AND CONCLUSIONS

There is still much to be learned about the polecat P.putorius both in Britain and in Continental Europe. However, it is felt that the work described in the previous sections has elucidated many details about this animal which were not previously known.

There is little doubt that the polecat is undergoing a period of expansion in Britain at the present time both in area and numbers. It can be assumed that this expansion is due to some change which has produced an increase in the birth rate, a decrease in the death rate, or both. One factor which must be considered in this context is the reduction in the number of gin-traps in use. Before the first epidemic of myxomatosis in Britain, in 1954, tens of thousands of these traps were used by trappers to supply rabbits for the commercial market. Pembrokeshire, Carmarthenshire and south Cardiganshire were amongst the most important areas in Britain for this trade. It was common practice, when dealing with any particular area, to begin by trapping all the local ground predators, especially stoats, weasels, foxes and polecats. This was done to prevent damage to trapped rabbits which would have reduced their market value. This procedure was so effective that stoats and weasels were considered to be locally extinct in West Wales as recently as 1952. (Matthews 1952).

The first myxomatosis epidemic so reduced rabbit numbers in Britain that commercial trapping was no longer economical. It was this factor, and not the subsequent legislation in 1958, which reduced the number of gin-traps being used. They are still widely used in small numbers partly for catching hares, rabbits and rats, but mainly for destroying mammal and bird predators on large estates. As a result of the disappearance of wholesale trapping of rabbits, stoats and weasels appear to have been re-establishing themselves during the last ten years in West Wales, and polecats are common once more. The wild cat seems to be making a similar recovery in Scotland. It seems likely that the polecat will further extend its range in the near future, probably into the parts of Pembrokeshire where it does not yet occur; and possibly into Glamorganshire also.

The gin trap was almost certainly responsible for the extermination of the polecat in Scotland where the animal was intensively trapped for fur during the nineteenth century. Ritchie (1920) published a graph showing the number of skins on sale and their value at the Dumfries Fur Market from 1830 to 1875. The number fell steeply during this period and their price rose as they became scarcer. By 1870 there were no skins on sale and polecats were virtually extinct in Scotland. Four survivors were caught in the early part of the present century. These were the animals described as a Scottish sub-species by Tetley (1945).

In Europe P. putorius has a very extensive distribution which is also expanding at present but for different reasons to that suggested above. Its spread in Finland is exceptionally well documented and has been described by Kalela (1940; 1948; 1952). He showed that its spread from the 1880's to the 1930's coincided with a long-term change in the climate which gave rather warmer winters with less snowfall. He believed that snow cover and low winter temperatures interfered with the polecat's food supply at a critical time of the year. They do not hunt small rodents beneath the snow in the way that stoats and weasels do and freezing temperatures cause a shortage of frogs, which are another important item of diet. The number of polecats caught in Finland dropped to one tenth of its previous value after the hard winters of the years from 1939 to 1942. During the winter polecats tend to move to the proximity of human habitations where rats and mice are abundant.

Winter temperatures in Wales are relatively high and snowfall is usually light, especially along the coastal belt. It is unlikely that climatic factors of the sort described above would ever limit the area of distribution of the polecat in Wales, yet an association with farm outbuildings during the winter has been observed here also. In Scotland winters are relatively severe, especially in the Highlands, and this fact may well have tipped the balance against the polecat during the last century when trapping was already causing a decline in numbers. Although rats and mice are often the main attraction around farms in the winter, the polecat is sometimes guilty of destroying poultry as well. Such damage is uncommon, however, and the offending animal can usually be dealt with easily by trapping. There seems little justification, on the other hand, for indiscriminate trapping of the sort which most large estates still employ against predators.

Heptner (1964) regarded the pattern of distribution of P. putorius and P. eversmanni in Europe and Asia as representing the closing stages of an historical process. The ancestral polecat population was once continuous across Eurasia with considerable variation in form from west to east. The forms at either end of this distribution were probably very different so that, when glaciation interrupted the continuity of the area during the Pleistocene, the two separated populations evolved into divergent races. These met one another when the ice retreated and although they were capable of hybridising they generally remained reproductively isolated because of their differences in habitat preference. This still remains true even though their areas of distribution now overlap to a considerable extent. Hybrid populations are not known even though hybrid individuals do sometimes occur, nor has there been any destruction or displacement of one species by the other. Thus they can be regarded as well defined species.

The population in Britain presumably represents the extreme western end of the original distribution, isolated since the disappearance of the land bridge to Europe. It would be surprising if some differences could not, therefore, be detected between polecats in Britain and those in Continental Europe. Differences in physical dimensions have already been discussed in Section 5.2. In addition it is possible that the frequency of occurrence of the complete frontal band pattern of the face, discussed in Section 5.1, may differ in the two areas. This was the sort of distinction which was suggested by Pocock (1936) but he was looking for an absolute criterion whereas this distinction is only relative, as has been shown. It is possible that the frequency of the complete band may be related to temperature in the way that the colour change of the stoat from brown to white is.

It has often been said that the polecat no longer exists as a definable species in Britain because of the way that the stock has hybridised with escaped ferrets. The consistent uniformity of both coat pattern and skull features found in this study show that, whatever number of ferrets may have mixed into the polecat stock, their characteristic features have been swamped by a vigorous native population. In this connexion it is interesting to note the very low frequency of the "red" variety in the present study. Although the variety is said to have arisen in the Tregaron Bog area around the turn of the century and even to have spread northwards along the coast for some time, there are few recent records. The single record in the present study is the first from this particular locality since another solitary record in 1926. The gene for this colour variety is recessive to black.

The lack of variation in the wild animal is easily understandable. Apart from recessive genes for such features as erythrism and albinism, variation in wild animals is usually of a small order since only minor deviations from the best adapted form are still able to compete successfully. In captivity, however, many features can be retained and developed which would be harmful in the wild but in this situation are "neutral" or even beneficial. Thus the ferret occurs in a wide variety of colours and sizes; it is also different in behaviour to the polecat, being easily handled and less ready to bite. It has been suggested that the tameness of the ferret is due to the reduction in the size of its brain but no evidence for this has been presented. It would be interesting to know what part of the brain, if any, is affected by the post-orbital constriction.

The differences found in this study between polecat and ferret skulls throw little further light on the relationship of the two forms to one another and to the Asiatic polecat, although they are most interesting from the point of view of skull development.

Attention in the past has been concentrated on the post-orbital constriction, which the Asiatic polecat and ferret have in common, as indicating a close relationship between these two. However, as pointed out by Ashton and Thomson (1954) there are other less obvious features to be considered. Their results tended to show a closer relationship between the ferret and the European polecat. Heptner (1964) regarded the Asiatic polecat as representing a more specialised carnivore than the European species since it eats mainly large rodents such as ground squirrels and marmots. He thought that this was the reason for its bigger skull ridges and wider zygomatic arches. Further work on wild populations of both species of polecat, and experimental crossing of each one with the ferret, would be of great morphological and evolutionary interest.

The lack of specialisation shown by the polecat is probably one of the reasons for its successful persistance in areas where trapping pressure has always been low, as is the case in most of mid-Wales. A variety of suitable habitats exist in this area particularly marginal land, small woodlands and wide hedgebanks. These habitats contain a great number of prey species well suited to the polecat's abilities as a hunter. It probably relies heavily on scent and hearing when hunting. Sight is only used at close range so that it does not specialise in the capture of fast moving prey as does the stoat, for example (Eibl-Eibesfeldt 1955).

On first comparing the polecat and mink the two appear to be very similar both in general appearance and behaviour. It might be thought, therefore, that they would come into direct competition with each other wherever they occur together in the same area. From observations in south-west Wales, the only part of Britain where both are found, this does not appear to be the case. Polecats exploit the food resources of a wide variety of habitats and although they frequently hunt on wet ground and along river banks, they do not normally pursue prey in the water. Mink, however, are not only capable of utilising terrestrial prey species but also hunt in the water. They are adapted for swimming by having partly webbed hind-feet and probably have other sensory and physiological adaptations. Their swimming ability enables them to hunt water-fowl and they also catch fish with great dexterity so that, whilst their diet almost certainly overlaps to some extent with that of the polecat, they are able to exploit a food supply which is not readily available to the latter. It seems likely, therefore, that there is little competition between the two species, and no reason for supposing that the mink will displace the polecat, but close field studies would be very worth while.

More information is also needed about the reproductive cycle, especially that of the female since this must have an important effect on population structure and balance. Causes of death are little understood, not only in the polecat but in scarcely any wild animal. Food supply during the winter must often be a limiting factor and possibly parasites and disease may be too. Trapping probably now accounts for only a small proportion of polecat deaths in Britain but both it and the Asiatic polecat are trapped extensively for fur both in Europe and Asia. Figures kindly supplied by a London firm of hide brokers (Anning, Chadwick and Kiver Ltd.) show that they alone handled 120,000 skins of the European polecat from the Soviet Union and Czechoslovakia during the five years 1962-67. This must only be a proportion of the total output, unless numbers have been very much reduced, since Generosov (1926) gave a figure of 149,000 pelts exported from European Russia in the one year of 1925. Nevertheless these figures do give some idea of the vast scale of commercial trapping operations which may be affecting polecat numbers.

There seems little fear that the polecat will ever again be subjected to this sort of pressure in Britain and it appears to have a secure place amongst the native fauna within the foreseeable future at least.

SUMMARY

1. The polecat, Putorius putorius (L). was investigated in Britain from 1965 to 1967. Its occurrence was found to be confined to Wales and the English Border Counties, but it is considered to be in an expanding phase both with regard to numbers and area of distribution.

2. Physical features are described. The coat pattern was found to be uniform and different to that of the closely related fitch ferret. Variations in the face pattern were found to correspond with summer and winter coats.

3. Body dimensions were recorded. These were slightly smaller than those of animals from Continental Europe, by comparison with published figures. An annual cycle was observed for male body weight. It is suggested that this was due to the accumulation and dispersal of fat and was related to the breeding season.

4. Comparison of polecat and ferret skull dimensions showed that the polecat had a somewhat broader skull than the ferret. Possible reasons for this are discussed. Juveniles of both forms had a greater breadth and volume of the braincase than the adults. A possible explanation for this is suggested.

5. The male was shown to have a restricted breeding season which was at its height from March to May. Development of the testis began in December whilst day length was still decreasing. Some details of female reproduction are presented.

6. The polecat baculum is described. It was investigated as a guide to age and shown to be of some value for this purpose during part of the year. The growth of the baculum in the polecat is compared with that in the ferret.

7. Variation in numbers, causes of death, and the sex ratio are discussed.

8. The diet was investigated and found to consist mainly of small rodents, amphibians, and birds, with some insects. A list of prey species is given.

9. External and internal parasites are listed.

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Note on statistical methods

Data were treated by normal procedures which are described in standard texts. The test for normality is given in Goulden (1956).

The significance of changes taking place with time were assessed by analysis of variance in which the total variation present was sub-divided into

i) that which measured variation between groups
ii) that which measured variation between individuals within groups i.e. error variation.

The relationship between baculum weight and length was in the form of a curve (Figs 8.01A and 8.02A). The data for weight was transformed to $\log_{10}$ weight and regression analysis carried out on the transformed data (Figs. 8.01B and 8.02B). The curve was drawn by transforming back from $\log_{10}$ weight. The difference between the regression coefficients was tested by joint regression analysis.

The means and standard errors for skull and other dimensions were calculated by normal procedures using a programme devised for an Olivetti Programma desk computer. Variances and sums of squares were obtained at the same time and used for comparing means. Variance ratio tests were used to decide whether comparison was valid and differences between means were assessed by t-tests.

The conventional significance level ($P < 0.05$) has been accepted for most of the procedures but for comparison of skull dimensions a more stringent criterion was used ($P < 0.02$).

The tables and appendices are marked with significance as follows:-

* $P = 0.05 > 0.01$
** $P = 0.01 > 0.001$
*** $P = 0.001 >$

APPENDIX 3.01 GENERAL METHODS

1. A serial number was assigned and the sex, date of capture, locality, O.S. Grid Reference and name of sender entered onto an index card, together with any relevant details.

2. The fur was examined and brushed for ectoparasites. Any found were put into 70% alcohol to be identified later.

3. The animal was weighed (nearest 1.0 gm.) and the head and body, tail, and hind-foot lengths measured. The first two were found by placing pins at the nose tip, pelvis, and tail tip with the animal flat on its back. The pins were then removed and the distances between them measured with a steel tape (nearest 0.5 cm.). The hind-foot was measured with a caliper (nearest 1.0 mm.).

4. External reproductive details were noted.

5. The pelt was removed, stripped of flesh and fat, and dried on a wooden frame. 40 pelts were retained and a further 25 discarded after observations had been made on them.

6. The body cavity was opened and the gut removed. The stomach and intestine were opened into a sieve. Any internal parasites were removed, and solid food remains were preserved for later examination.

7. The reproductive condition was examined as described in Appendix 6.01.

8. The left humerus, left femur, skull, and baculum in the males, were put into 5% ammonia for at least 24 hours to soften the flesh and then boiled and brushed clean. They were bleached with hydrogen peroxide. Where long bones were missing from the left side, those from the right were substituted.

9. A number of ferret skulls, bacula and skins was prepared for comparison with those of the polecat.

Appendix 5.4 SKULL MEASUREMENTS

The numbers of skulls available for examination were as follows:-

	JUVENILE		ADULT	
	MALE	FEMALE	MALE	FEMALE
POLECAT	6	3	31	7
FERRET	5	6	19	10

A series of measurements was made on each skull similar to those made by Ashton and Thomson (1954) on the British Museum collection. Two of their measurements were omitted because the exact method of measurement was in doubt. An additional measurement was introduced. This was the volume of the braincase which was measured by filling the skull cavity with fine, dry silver sand which was then poured into a 10ml. or 25ml. graduated cylinder. The method was accurate to about ± 0.1ml.

Skulls were considered to be still juvenile when any one of the sutures - nasal-maxillary, basal, or palatal - was open. This placed the age of maturity higher than that set by Ashton and Thomson (1954) since Ashton (pers. comm.) stated that their criterion for juveniles was the retention of milk teeth. Tables 5.41 A-E show the means and standard errors for the measurements made.

Comparisons of means were made by variance ratios and t-tests for each sex separately. The variance ratio was exceeded in 12 out of 130 comparisons which meant that these means could not be properly compared. The polecat and ferret were compared; also adults and juveniles of each form.

APPENDIX 6.01 EXAMINATION OF THE REPRODUCTIVE ORGANS

MALE

1. The external appearance of the testes was noted. There was found to be no scrotum but outside the breeding season the testes were small and lay well below the surface of the skin, embedded in the abdominal fat. As they enlarged during the breeding season they came to lie nearer the skin so that they showed as visible swellings on the surface.

2. When the skin was removed the gross appearance of the testes was noted.

3. Each testis with its associated epididymis was dissected free, cut loose from the vas deferens, and the connective tissue capsule removed.

4. A cut was made in one epididymis and the exuding fluid examined for sperm under a microscope.

5. Both testes were placed in aqueous Bouin's solution to fix them. When fixed they were removed, blotted free of surplus fixative and weighed (nearest 1.0 mg.)

6. Selected testes were sectioned and stained with haematoxylin and eosin for histological study. Diameters of testis tubules were measured on these sections with a micrometer eye-piece.

FEMALE

1. The vulva was examined and measured

2. The state of the nipples was examined and they were checked for lactation.

3. On opening the body cavity the state of the reproductive tract was noted in situ. The uterus was measured and examined for embryo swellings. Mammary tissue was noted.

4. The ovaries were examined for corpora lutea swellings.

Appendix 5.41. Calculation of moments for length of male polecat skull (prosthion to occipital condyles).

Group interval (mm.)	f	d	fd	fd^2	fd^3	fd^4
58-59	1	-4	- 4	16	-64	256
60-61	1	-3	- 3	9	-27	81
62-63	6	-2	-12	24	-48	96
64-65	5	-1	- 5	5	- 5	5
66-67	16					
68-69	7	1	7	7	7	7
70-71	5	2	10	20	40	80
72-73	3	3	9	27	81	243
N =	44		2	108	-16	768
a_1, a_2, a_3, a_4			0.0455	2.454	-0.364	17.45
v_1, v_2, v_3, v_4 (moments)			0.0455	2.452	-0.699	17.546

$$\alpha_3 = \frac{-0.699}{2.452^{3/2}} = \underline{0.073}$$

$$\alpha_4 = \frac{17.546}{2.452^2} = \underline{2.918}$$

N.B. α_3 = 0 for the normal or any symmetrical distribution.

α_4 = 3 for the normal curve.

Item	df	MS
Between groups	9	3.596 *
Within groups	29	1.633

Appendix 5.31. Analysis of variance - gross body weight of polecat by months.

Item	df	MS
Between groups	5	241.2 **
Within groups	21	47.38

Appendix 8.03. Analysis of variance - mean baculum weight of polecat by months (August-January).

Item	df	MS
Regression	1	6.740 ***
Residual	46	0.0302

Appendix 8.01. Regression analysis - weight against length of polecat baculum.

Item	df	MS
Regression	1	4.515 ***
Residual	24	0.038

Appendix 8.02. Regression analysis - weight against length of ferret baculum.

Item	df	MS
Joint regression	1	11.212 ***
Heterogeneity of individual regressions	1	0.043
Joint residual	70	0.129

Appendix 8.04. Joint regression analysis - weight against length of polecat and ferret bacula.

Appendix 9.01. Calculation of life expectancy

Caughley's formula for life expectancy for a stationary population immediately after a restricted breeding season is given as:-

$$\frac{(2n - j)}{2j} = \text{L.E. in years}$$

j = 0 - 1 year old animals

n = total sample size

In the present study the juvenile/adult status of 32 polecats was determined from July-January inclusive and 27 were found to be juveniles. Thus:-

n = 32

j = 27

$$\text{L.E.} = \frac{(2 \times 32 - 27)}{2 \times 27} = \frac{37}{54} = 0.68 \text{ years}$$

This is equivalent to <u>8.1 months</u>.

	Collection skins		Observations		TOTAL	
	Frontal Band +	Patches only	Frontal Band +	Patches only	Frontal Band +	Patches only
JANUARY	9		1		10	
FEBRUARY	2				2	
MARCH	6		1		7	
APRIL	1		2		3	
MAY	1		2		3	
JUNE	1			1	1	1
JULY		1		4		5
AUGUST		2		3		5
SEPTEMBER		5		2		7
OCTOBER		3	1	5	1	8
NOVEMBER	5		1	1	6	3
DECEMBER	2		1		3	

TABLE 5.11

Occurrence of frontal band and cheek patches by months for collection skins and additional observations (Total of 65 animals)

		ALL AGES						
		MALE			FEMALE			
		No.	Mean	S.E.	No.	Mean	S.E.	Females as % males
***	1. Head and body length	45	38.0 cm.	0.4	12	33.5 cm.	0.5	88
**	2. Tail length	45	14.0 cm.	0.1	12	12.5 cm.	0.2	91
***	3. Hind-foot length	48	5.7 cm.	0.03	11	5.4 cm.	0.05	95
***	4. Gross Weight	46	987 g.	30	9	623 g.	46	63
		ADULTS						
***	5. Humerus length	32	47.1 mm.	0.3	6	40.5 mm.	0.3	86
***	6. Femur length	26	51.2 mm.	0.5	5	43.9 mm.	0.5	86

Table 5.21. Comparison of physical features in male and female polecats. Measurements were made with the following accuracy.

1 and 2 nearest 0.5 cm., 3 nearest 1.0 mm., 4 nearest 1.0 g.,
5 and 6 nearest 0.1 mm.

	Condylo-basal length (m.m.)				Zygomatic breadth (m.m.)			
	Female		Male		Female		Male	
	No.	Mean	No.	Mean	No.	Mean	No.	Mean
Czechoslovakia	40	59.2	55	67.2	40	34.1	55	41.3
Britain	7	60.4	31	67.0	7	34.8	31	41.5

	Head and body length (cm.)				Tail length (cm.)			
	Female		Male		Female		Male	
	No.	Mean	No.	Mean	No.	Mean	No.	Mean
Czechoslovakia	44	35.8	50	41.7	44	13.2	50	15.4
Britain	12	33.5	45	38.0	12	12.5	45	14.0

	Hind foot length (cm.)			
	Female		Male	
	No.	Mean	No.	Mean
Czechoslovakia	44	4.9	50	6.2
Britain	11	5.4	48	5.7

Table 5.22 Comparison of some dimensions of polecats from Czechoslovakia and polecats from Britain (Czech data from Kratochvil 1952; corrected to first decimal place).

MONTH	NO.	MEAN (G.)	S.E.
AUGUST	3	613	105
SEPTEMBER	4	677	60
OCTOBER	4	1014	36
NOVEMBER	6	993	65
DECEMBER	3	1066	49
JANUARY	8	994	48
FEBRUARY	2	1161	73
MARCH	5	1232	25
APRIL	4	1114	91
MAY	3	958	67
JUNE	2	906	118
JULY	2	1046	67

Table 5.31. Monthly variation in gross body weight in the male polecat. (means and S.E's).

Table 5.41 Cranial dimensions of the polecat and ferret and a comparison of mean values. Significance level is 2% at least, except where indicated

1. Prosthion - most posterior part of occipital condyles.
3. Maximum bizygomatic breadth
4. Distance between most lateral points on occipital crests
5. Minimum frontal breadth
6. Basion - inion
7. Height of skull staphylion - ant. bifurc. temporal crest
8. Basion-opisthion
9. Breadth of foramen magnum
10. Maximum length of bullae
11. Maximum breadth of bullae
12. Minimum distance between bullae
13. Endobasion - staphylion
14. Orale - staphylion
15. Orale - posterior palatine foramen
16. External breadth of palate at PM3.
17. External breadth of palate at canines
18. Minimum distance between orbits
19. Maximum breadth of piriform aperture
20. Prosthion - rhinion
21. Breadth of orbit
22. Height of orbit
23. Minimum distance, orbital - alveolar margin
25. Vert. distance, coronion - inferior border of ramus
26. Maximum breadth of mandibular condyle
27. Maximum distance lateral borders of mandibular condyles
28. Volume of braincase

	Polecat			Ferret			
	Adult male			Adult male			
	No.	Mean (mm.)	S.E.	No.	Mean (mm.)	S.E.	
1.	31	67.0	0.5	19	66.3	0.7	
3.	25	41.4	0.4	19	39.8	0.5	*
4.	31	36.4	0.3	19	36.8	0.5	
5.	31	16.5	0.1	19	14.6	0.2	***
6.	31	18.8	0.2	19	18.5	0.3	
7.	31	21.5	0.2	19	20.9	0.3	
8.	31	9.1	0.1	18	9.3	0.1	
9.	31	10.7	0.1	19	10.4	0.1	
10.	30	17.2	0.1	18	18.1	0.3	
11.	30	10.8	0.1	19	11.0	0.1	
12.	31	7.6	0.1	19	6.8	0.1	***
13.	31	31.2	0.3	19	31.0	0.3	
14.	31	30.8	0.3	19	30.4	0.4	
15.	31	13.2	0.2	19	12.6	0.1	**
16.	28	23.3	0.2	19	22.5	0.3	*
17.	31	16.9	0.2	19	16.5	0.2	
18.	31	18.2	0.2	19	17.4	0.3	**
19.	30	7.7	0.1	19	7.5	0.1	
20.	31	11.8	0.1	19	11.7	0.2	
21.	29	9.8	0.1	19	9.8	0.1	
22.	30	9.8	0.1	19	9.6	0.1	
23.	30	8.3	0.1	19	8.4	0.2	
25.	30	19.9	0.2	19	19.3	0.6	
26.	31	11.8	0.1	19	11.4	0.2	
27.	30	37.4	0.3	19	36.0	0.4	
28.	26	9.7ml.	0.1	18	7.7ml.	0.1	***

Only those differences are indicated which were also found in female skulls.

Table 5.41A - comparison of adult males.

	Polecat Adult female			Ferret Adult female			
	No.	Mean (mm.)	S.E.	No.	Mean (mm.)	S.E.	
1.	7	60.4	0.5	10	58.9	0.9	
3.	7	34.8	0.3	10	33.8	0.3	**
4.	7	31.8	0.2	10	31.6	0.4	
5.	7	15.8	0.1	10	13.5	0.2	***
6.	7	16.4	0.1	10	15.5	0.3	
7.	7	19.1	0.2	10	18.0	0.3	
8.	7	9.0	0.2	10	8.4	0.2	
9.	7	10.2	0.2	10	9.9	0.1	
10.	7	16.0	0.3	10	16.0	0.3	
11.	7	9.4	0.2	10	9.1	0.2	
12.	7	6.9	0.1	10	6.0	0.1	***
13.	7	28.3	0.4	10	27.8	0.5	
14.	7	27.3	0.4	10	26.8	0.3	
15.	7	11.6	0.2	10	11.1	0.1	*
16.	7	20.7	0.1	10	20.3	0.3	*
17.	7	14.2	0.1	10	13.6	0.2	
18.	7	15.7	0.2	10	14.5	0.1	***
19.	6	6.6	0.1	10	6.7	0.1	
20.	7	10.1	0.2	10	10.3	0.1	
21.	7	8.9	0.1	10	9.2	0.1	
22.	7	8.9	0.1	10	8.9	0.1	
23.	7	6.9	0.1	10	6.5	0.2	
25.	7	16.8	0.2	10	16.4	0.4	
26.	7	9.8	0.2	9	9.3	0.2	
27.	7	32.7	0.2	9	31.4	0.5	
28.	7.	7.9ml.	0.2	10	6.2ml.	0.2	***

Only those differences are indicated which were also found in male skulls. Item 15 significant at 5% level only.

Table 5.41B comparison of adult females.

	Polecat			Polecat			
	Adult male			Juvenile male			
	No.	Mean (mm.)	S.E.	No.	Mean (mm.)	S.E.	
1.	31	67.0	0.5	6	67.0	1.0	
3.	25	41.4	0.4	6	39.7	0.9	*
4.	31	36.4	0.3	6	36.1	0.8	
5.	31	16.5	0.1	6	17.4	0.2	**
6.	31	18.8	0.2	6	18.0	0.4	
7.	31	21.5	0.2	6	21.2	0.4	
8.	31	9.1	0.1	6	9.5	0.1	
9.	31	10.7	0.1	6	10.5	0.1	
10.	30	17.2	0.1	6	17.5	0.4	
11.	30	10.8	0.1	6	10.7	0.2	
12.	31	7.6	0.1	6	7.8	0.1	
13.	31	31.2	0.3	6	30.9	0.5	
14.	31	30.8	0.3	6	30.7	0.5	
15.	31	13.2	0.2	6	13.4	0.4	
16.	28	23.3	0.2	6	23.5	0.5	
17.	31	16.9	0.2	6	16.6	0.4	
18.	31	18.2	0.2	6	17.6	0.4	
19.	30	7.7	0.1	6	7.6	0.2	
20.	31	11.8	0.1	6	11.6	0.2	
21.	29	9.8	0.1	6	9.8	0.2	
22.	30	9.8	0.1	6	9.8	0.2	
23.	30	8.3	0.1	6	8.0	0.2	
25.	30	19.9	0.2	6	19.8	0.5	
26.	31	11.8	0.1	6	11.5	0.3	
27.	30	37.4	0.3	5	37.0	0.8	
28.	26	9.7ml.	0.1	6	10.4ml.	0.1	*

Table 5.41C. Comparison of adult and juvenile polecats (males only)
Items 3 and 28 significant at 5% level only.

	Ferret Adult male			Ferret Juvenile male			
	No.	Mean (mm.)	S.E.	No.	Mean (mm.)	S.E.	
1.	19	66.3	0.7	5	64.7	0.4	
3.	19	39.8	0.5	5	38.7	0.5	
4.	19	36.8	0.5	5	35.7	0.8	
5.	19	14.6	0.2	5	16.2	0.2	xxx
6.	19	18.5	0.3	5	17.8	0.4	
7.	19	20.9	0.3	5	20.2	0.1	
8.	18	9.3	0.1	5	9.1	0.1	
9.	19	10.4	0.1	5	10.2	0.3	
10.	18	18.1	0.3	5	17.8	0.4	
11.	19	11.0	0.1	5	10.8	0.3	
12.	19	6.8	0.1	5	6.9	0.2	
13.	19	31.0	0.3	5	30.2	0.4	
14.	19	30.4	0.4	5	29.7	0.1	
15.	19	12.6	0.1	5	12.2	0.2	
16.	19	22.5	0.3	5	23.3	0.6	
17.	19	16.5	0.2	5	15.8	0.2	
18.	19	17.4	0.3	5	16.4	0.3	
19.	19	7.5	0.1	5	7.7	0.1	
20.	19	11.7	0.2	5	11.7	0.2	
21.	19	9.8	0.1	5	9.8	0.2	
22.	19	9.6	0.1	5	9.6	0.2	
23.	19	8.4	0.2	5	8.2	0.1	
25.	19	19.3	0.6	5	19.2	0.4	
26.	19	11.4	0.2	5	10.9	0.2	
27.	19	36.0	0.4	5	36.6	0.4	
28.	18	7.7ml.	0.1	5	9.2ml.	0.2	xxx

Table 5.41D. Comparison of adult and juvenile male ferrets. Only those differences are indicated which were also found in the female skulls.

	Ferret Adult female			Ferret Juvenile female			
	No.	Mean (mm.)	S.E.	No.	Mean (mm.)	S.E.	
1.	10	58.9	0.9	6	59.5	0.3	
3.	10	33.8	0.3	6	34.9	0.3	
4.	10	31.6	0.4	6	31.9	0.2	
5.	10	13.5	0.2	6	14.7	0.2	**
6.	10	15.5	0.3	6	16.0	0.2	
7.	10	18.0	0.3	6	18.6	0.3	
8.	10	8.4	0.2	6	8.2	0.2	
9.	10	9.9	0.1	6	9.4	0.1	
10.	10	16.0	0.3	6	16.7	0.2	
11.	10	9.1	0.2	6	9.9	0.1	
12.	10	6.0	0.1	6	6.1	0.2	
13.	10	27.8	0.5	6	28.0	0.2	
14.	10	26.8	0.3	6	27.2	0.2	
15.	10	11.1	0.1	6	11.3	0.2	
16.	10	20.3	0.3	6	20.6	0.3	
17.	10	13.6	0.2	6	13.7	0.2	
18.	10	14.5	0.1	6	14.6	0.4	
19.	10	6.7	0.1	6	6.8	0.1	
20.	10	10.3	0.1	6	10.5	0.2	
21.	10	9.2	0.1	6	9.3	0.2	
22.	10	8.9	0.1	6	8.7	0.2	
23.	10	6.5	0.2	6	7.1	0.1	
25.	10	16.4	0.4	6	17.0	0.2	
26.	9	9.3	0.2	6	9.4	0.1	
27.	9	31.4	0.5	6	32.6	0.4	
28.	10	6.2ml.	0.2	6	7.5ml.	0.2	**

Table 5.41E. Comparison of adult and juvenile female ferrets. Only those differences are indicated which were also found in male skulls.

	JUVENILE			ADULT		
	No.	Mean (g.)	S.E.	No.	Mean (g.)	S.E.
AUGUST	4	0.14	0.01	-	-	-
SEPTEMBER	3	0.17	0.03	2	0.64	0.18
OCTOBER	6	0.26	0.04	2	0.68	0.33
NOVEMBER	5	0.16	0.01	2	0.35	0.02
DECEMBER	3	0.33	0.10	-	-	-
JANUARY	NO DISTINCTION MADE DURING THIS PERIOD			8	0.63	0.05
FEBRUARY				2	1.61	0.37
MARCH				5	2.04	0.31
APRIL				3	2.02	0.19
MAY				4	2.00	0.13
JUNE				3	1.67	0.11
JULY				2	0.65	0.06

Table 6.01. Monthly variation in the mean weight of the polecat testis (means and S.E's). On Fig.6.01 the values for adults from August-December have been transposed to follow that for July.

Month	JUVENILE	ADULT
	Mean tubule diameter(μ)	Mean tubule diameter(μ)
August	51.5	
September	44.7	102.5
October	54.7 80.6 } 67.6	101.5
November	53.6	90.5
December		97.6
January		113
February		149
March		152
April		197
May		167
June		115 121 } 118
July		83.5

Table 6.02

Monthly variation in mean testis tubule-diameter in the polecat. (Each value is the mean of 50 measurements on one testis except where indicated.) The adult values for September-November have been transposed on Fig. 6.02 to follow the value for July.

Date	Uterus Length (MM)	Uterus Diameter (MM)	Vulva Diameter (MM)	Status
12th September	38	1	4	Juvenile
12th November	40	1	-	Juvenile
18th November	29	3	2	Juvenile
28th July	34	3.5	9	Adult Post-Partum
7th March	42	2	7	Adult Pre-Breeding
14th November	33	1	-	Juvenile

TABLE 7.01. Some measurements of the reproductive tract in female polecats.

Date	Status	Total Nipples Found	Nipples recently in use
18th November	Juvenile	8	0
28th July	Adult	8	6
8th September	Adult	7	7
22nd September	Adult	8	6
4th January	Adult	9	9
20th July	Adult	9	9

TABLE 7.02. Comparison of nipple numbers in female polecats.

	JUVENILES			ADULTS
	No.	Mean (MG.)	S.E.	WTS. OF SINGLE BACULA (MG.)
AUGUST	4	95	13.6	575
SEPTEMBER	4	136	45.8	-
OCTOBER	7	152	22	478
NOVEMBER	3	159	27	389 558
DECEMBER	3	205	33	-
JANUARY	6	290	36	512
	ALL ADULTS			
FEBRUARY	2	370	59	
MARCH	5	348	10	
APRIL	4	481	12	
MAY	3	412	56	
JUNE	3	386	14	
JULY	2	382	16	

Table 8.03. Monthly variation in the mean weight of the polecat baculum (means and S.E's and additional single adult weights). The mean values for the period only from August–January were used for the analysis of variance, Appendix 8.03.

MONTH	1959-62	1963-66	TOTAL 1959-66
January	10	10	20
February	0	8	8
March	21	16	37
April	15	8	23
May	6	7	13
June	18	6	24
July	17	12	29
August	10	37	47
September	21	43	64
October	31	27	58
November	14	19	33
December	8	10	18

Table 9.01

Variation in the number of polecats recorded for each month 1959-66. (excluding all records for which month was not known).

	1959-62			1963-67		
Cause of death	Number	% of deaths		Number	% of deaths	
Road Traffic	61	30.5	87	117	57.0	87.8
Traps	113	56.5		63	30.8	
Dogs	11	5.5		7	3.4	
Shooting	9	4.5		7	3.4	
Snares	1	0.5		3	1.4	
Found Dead	5	2.5		8	3.9	
Total Recorded Deaths	200			205		

Table 9.02

Causes of death of polecats killed in the two periods 1959-62 and 1963-67. Forestry Commission records are included in the first period but not the second.

Serial No.	Month	Ixodes hexagonus			Ixodes canisuga		
		Adult♀♀	Nymphs	Larvae	Adult♀♀	Nymphs	Larvae
151	Jan.		11	2			
-	Feb.						
75	Mar.	4	12	1			
79	Mar.	2	5	3			
78	Mar.	2	6	6			
86	Apr.	1					
170	Apr.	3					
88	May	3	2				
-	Jun.						
94	Jul.		1			1	
179	Jul.	2	65	1	1	5	
103	Aug.		1	85			
43	Sep.	12	7				
54	Oct.	7	2	1			
55	Oct.		1	11			
31	Nov.	1	3	1			
64	Dec.	4	53				
65	Dec.		12				

Table 11.21.

Monthly variation in the numbers of I. hexagonus and I. canisuga occurring on the polecat.

REFERENCES

ALLANSON, M. (1931). The reproductive cycle in the male ferret. J. Physiol. 71.20.

ALLANSON, M. (1932). The reproductive processes of certain mammals. III. The reproductive cycle of the male ferret. Proc. Roy. Soc. B. 110. 295.

ARTHUR, D. R. (1953). Records of Ixodes hexagonus Leach from S.E. England and S. Wales. Entomologist. 86. 76-77.

ASHTON, E. H. & THOMSON, A.P.D. (1955). Some characters of the skulls, and skins of the European polecat, the Asiatic polecat, and the domestic ferret. Proc.zool.Soc.Lond. 125. 317-33.

ASHTON, E. H. (1955). Some characters of the skulls of the European polecat, the Asiatic polecat, and the domestic ferret. Proc.zool.Soc.Lond. 125. 807-9.

BENOIT, J. (1926). Anatomical, cytological and histophysiological researches on the excretory ducts of the testis in mammals. On general cytological problems relative to the glandular cells. (in French). Arch. Anat. Hist. et Emb. 5. 173-412.

BISSONNETTE, T. H. (1932). Modification of mammaliam sexual cycles; reactions of ferrets (Putorius vulgaris) of both sexes to electric light added after dark in November and December. Proc.Roy.Soc.B. 110. 322.

BISSONNETTE, T. H. (1935). Modification of mammalian sexual cycles. III. Reversal of the cycle in male ferrets (Putorius vulgaris) by increasing periods of exposure to light between October second and March thirtieth J.exp.Zool. 71. 341.

BRINK, F. H. van den, (1958). Die Säugetiere Europas westlich des 30. Langengrades. 225 pp. Paul Parey - Hamburg - Berlin.

CABRERA, A. (1932). Los Mamiferos de Marruecos. Trab. Mus. Nac. Cient. Nat. Ser. Zool. 57. Madrid.

CAUGHLEY, G. (1967). Calculation of population mortality rate and life expectancy for thar and kangaroos from the ratio of juveniles to adults. N. Z. Jl. Sci. 10. 578-84.

CONDRY, W. M. (1954). British polecat in Wales. Oryx. 2. 238-40.

CREED, R. F. S. (1960b). Observations on reproduction in the wild red fox (Vulpes vulpes). An account with special reference to the occurrence of fox - dog crosses. Br. vet. J. 116. 419-26.

DARLINGTON, D. (1957). The convolutional pattern of the brain and endocranial cast in the ferret. J. Anat., Lond. **91**. 52-60.

DAY, M. G. (1966). Identification of hair and feather remains in the gut and faeces of stoats and weasels. J. Zool. **148**. 201-217.

DEANESLEY, R. & PARKES, A. S. (1933). The effect of hysterectomy on the oestrus cycle of the ferret. J. Physiol. **78**. 80.

DEANESLEY, R. (1935). The growth and reproduction of certain mammals. Part IX. Growth and reproduction in the stoat, (*Mustela erminea*.) Phil. Trans. B. **225**. 1-62.

DONOVAN, B. T. (1967). Light and the control of the oestrus cycle in the ferret. J. Endocr. **39**. 105-113.

EIBL-EIBESFELDT, I. (1955). Zur Biologie des Iltis. (*Putorius putorius L*). Verh.dtsch.zool.Ges.Erlangen 1955. Zool.Anz.Suppl. **19**. 304-14.

EIBL-EIBESFELDT, I. (1956). Angeborenes und Erworbenes in der Technik des Beutetötens. (Versuche am Iltis, *Putorius putorius L*). Z.Saügetierkd. **21**. 135-137.

ELDER, W. H. (1945). Determination of weasel sex ratios by pelt examination. J. Wildl. Mgmt. **15**. 114-116.

ELDER, W. H. (1951). The baculum as an age criterion in mink. J. Mammal. **32**. 43-50.

ELLERMAN, J. R. & SCOTT, T. C. S. MORRISON. (1951). Checklist of Palaearctic and Indian Mammals. 1758-1946. London. Brit. Mus.Nat. Hist.

ENGLUND, J. (1965a). Studies on food ecology of the red fox (*Vulpes v.*) in Sweden. Viltrevy. **3**. 377-485.

ENGLUND, J. (1965b). The diet of the fox (*Vulpes vulpes*) on the island of Gotland since myxomatosis. Viltrevy. **3**. 507-530.

FARRIS, E. J. (1950). The care and breeding of laboratory animals. New York, London.

FLINTOFF, R. J. (1935b). Stoats and weasels, brown and white. North Western Nat. **10**. 29-34.

FLUX, J. E. C. (1967). Reproduction and body weights of the hare, *Lepus europaeas* Pallas, in New Zealand. N. Z. Jl. Sci. **10**. 357-401.

FORREST, H. E. (1907). A Handbook of the Vertebrate fauna of North Wales. London.

FRILEY, C. E. jr. (1949). Age determination, by use of the baculum, in the river otter, *Lutra c. canadensis* Schreber. J. Mammal. 30. 102-110.

GENEROSOV, V. J. (1926). Pushnoi promysel. Bogatstva. SSR. XII.

GOETHE, F. (1938). Observations on the scent trail of the tree marten. (in German). Deutscher Jäger. 13.

GOETHE, F. (1940). Beiträge zur Biologie des Iltis. Z. Säugetierkunde 15. 180-223.

GOULDEN, C. H. (1956). Methods of statistical analysis. 2nd. edn. Chapman and Hall, London.

GRIGOR'EV, N. D., TEPLOV, V. P., & TICHVINSKII, V. J. (1931). Quoted in OGNEV, 1962.

HALE, H. B. (1949). Ageing cottontail rabbits by bone growth. J. Wildl.Mgmt. 13. 216-25.

HAMILTON, W. J. (1934). The early stages in the development of the ferret: Fertilisation to the development of the prochordal plate. Trans.Roy.Soc. Edinburgh. 58. 251-278.

HAMMOND, J. & MARSHALL, F.H.A. (1930). Oestrus and pseudopregnancy in the ferret. Proc. Roy. Soc. Lond. B. 105. 607-630.

HAMMOND, J. jr. (1951). Control by light of reproduction in mink and ferrets. Nature. London. 167. 150.

HAMMOND, J. jr. (1952). Control of reproductive and pelt changes in ferrets; some experiments with animals kept entirely on artifical light. J. Agric. Sci. 42. 293-303.

HAMMOND, J. jr. (1954). Light regulation of hormone secretion. In "Vitamins and Hormones". XII. New York.

HAMMOND, J. & WALTON, A. (1934a). Notes on ovulation and fertilisation in the ferret. J.exp.Biol. 11. 307.

HAMMOND, J. & WALTON, A. (1934b). Pregnancy during the anoestrus season in the ferret. J. exp. Biol. II 320-325.

HART, D. S. (1951). Photoperiodicity in the female ferret. J. exp. Biol. 28. 1.

HARVEY, N. E. & MACFARLANE, W. V. (1958). The effect of day length on the coat shedding cycles, body weight and reproduction of the ferret. Aust. J. biol. Sci. 2. 187-99.

HEPTNER, W. G. (1964). Über die morphologischen und geographischen Beziehungen zwischen M. putorius & M. eversmanni. Zeitschr. f. Säugetierk. 29. 321-30.

HERTER, K. & HERTER, M. (1953). Kaspar Hauser Versuche mit Iltissen. Zoologischer Anzeiger. 151. 175-185.

HERTER, K. (1953). Über das Verhalten von Iltissen. Z.f. Tierpsychol. 10. 56-71

HERTER, K. (1959). Iltisse und Frettchen. A. Ziemsen Verlag. Wittenberg Lutherstadt.

HILL, M. & PARKES, A. S. (1932) Studies on the hypophysectomised ferret. 1 Technique. Proc.Roy.Soc. B. 112. 138.

HILL, M. & PARKES, A.S. (1934). Effect of absence of light on the breeding season of the ferret. Proc.Roy.Soc. B. 115. 14.

HILL, M. (1939). The reproductive cycle of the male weasel (Mustela nivalis). Proc.zool.Soc., Lond. 109B. 481-512.

HULL, D. & SEGALL, M. M. (1966). Distinction of brown from white adipose tissue. Nature, Lond. 212. 469-72.

KALELA, O. (1940). Über die Einwanderung und Verbreitung des Iltis P. putorius. L. in Finnland. Ann. Ac. Sc. Fennicae., Ser. A. 54. Nr. 6.

KALELA, O. (1948). Changes in the distribution of the polecat in Finland. Eripainos: Suomen Riista. II, 1948. 93-96.

KALELA, O. (1952). Changes in the geographic distribution of Finnish birds and mammals in relation to the recent changes in climate. Fennia. 75. 38-59. Helsinki.

KOSTRON, K. Quoted in KRATOCHVIL, 1952.

KRATOCHVIL, J. (1952). La nourriture et les races du P.putorius. French summary. Acta. Univ. Agr. Silv. Brno. 1. 1-18.

LEVER, R. L. (1959). The diet of the fox since myxomatosis. J. Anim. Ecol. 28. 359-75.

LEWIS, J. W. (1967). Observations on the skull of Mustelidae infected with the nematode Skrjabingylus nasicola. J.Zool., Lond. 153. 561-64.

LOCKIE, J. D. (1959). The estimation of the food of foxes. J. Wldl.Mgmt. 23. 224-7.

LOCKIE, J. D. (1961). The food of the pine-marten Martes martes in West Ross-shire, Scotland. Proc. zool. Soc. Lond. 136. 187-195.

LOCKIE, J. D. (1966). Territory in small carnivores. Symp. zool. Soc. Lond. 18. 143-165.

MARKLEY, M. H. & BASSETT, C. F. (1942). Habits of captive marten. Amer. Midl. Nat. 28. 604-16.

MARSHALL, A. J. (1961). editor and author - Biology and comparative physiology of birds. Vol. II. Academic Press. New York & London.

MARSHALL, A. J. & COOMBS, C. J. F. (1957). The interaction of environmental, internal and behavioural factors in the rook, Corvus f. frugilegus. L. Proc. zool. Soc., Lond. 128. 545-89.

MARSHALL, F. H. A. (1904). The oestrus cycle in the common ferret. Quart. J. micr. Sci. 48. 323.

MARSHALL, F. H. A. (1933). Cyclical changes in the vagina and vulva of the ferret. Quart. J. exp. Physiol. 23. 131.

MARSHALL, W. H. (1961). Ecology of mustelids in New Zealand. Animal Ecology Division, Information Series. No. 1.

MATHESON, C. (1963). The distribution of the red polecat in Wales. Proc. zool. Soc. Lond. 140. 115-20.

MATHEY, R. (1958). Les chromosomes des Mammiferes eutheriens. Liste critique et essai sur l'evolution chromosomique. Archiv der Julius Klaus-Stiftung. 33. 253-297.

MATHEWS, L. H. (1952). British Mammals. Collins, London.

MAZÁK, V. (1965). Beitrag zur Verbreitung des Steppeniltisses, Putorius eversmanni Lesson 1827, in der Tschechoslowakei. Věstn. Čs. spol. zool. 29. 85-96.

McCANN, C. (1956). Observations on the polecat in New Zealand. Rec. Dom. Mus. Wellington. 1955. 2. 151-65.

McKEOWN, T. & ZUCKERMAN, S. (1937). The stimulation to ovulation. J.Anat.Lond.72. 153.

McPHAIL, M. K. (1933a). Studies on the hypophysectomised ferret, VIII. Inhibition of ovulation in the mated oestrus ferret. Proc.Roy.Soc.B. 114. 124.

McPHAIL, M. K. (1933b). Induction of ovulation in the unmated oestrus ferret. J. Physiol. 80. 78.

MILLAIS, J. G. (1905). The Mammals of Great Britain and Ireland. 2.

MILLER, G. S. (1912). Catalogue of the Mammals of Western Europe. British Museum, London.

MILLER, G. S. (1933). The origin of the ferret. Scot. Nat. 1933. 153-4.

MOORE, W. J. (1967). Muscular function and skull growth in the laboratory rat, (Rattus norvegicus.) J. zool., Lond. 152 287-96.

MURR, E. (1931). Beobachtungen über die Paarung des Frettchens. Zool. Gart. Lpz. 4. 289.

MURR, E. (1932). Beobachtungen über den Geburtsvorgang beim Frettchen. Zool. Gart. Lpz. 5. 37.

MURR, E. (1933). Aus der Fortpflanzungsbiologie des Frettchens (Putorius furo). Z. Säugeteirkd. 8. 26.

NAAKTGEBOREN, C. (1961). Beobachtungen der Geburt des Frettchens. Bijdr. Dierk. 31. 65-73.

NATURE IN WALES. Journal of the West Wales Naturalists' Trust. Vol. 8. No. 3. to Vol. 10. No. 4. Summer 1963 to September 1967.

NEAL, E. G. (1964). Section on the badger in "The Handbook of British Mammals" edited SOUTHERN, H. N. Blackwell, Oxford.

OGNEV, S. I. (1962). Mammals of the U.S.S.R. and Adjacent Countries. Vol. III Carnivora. Israel Programme for Scientific Translations, Jerusalem. (Russian original 1935, Moscow - Leningrad).

ONDRIAS, J. C. (1960). Secondary sexual variation in the body skeletal proportions of European Mustelidae. Ark. Zool. 12. 577-83.

ONDRIAS, J. C. (1961). Comparative osteological investigations on the front limbs of European Mustelidae. Ark.Zool. 13. 311-20.

OWEN, C. (1964). The status of Putorius in North Africa. Bulletin of the Mammal Society. 22. 11-22.

PITT, F. (1921). Notes on the genetic behaviour of certain characters in the polecat, ferret, and polecat-ferret hybrids. J. Genet. 11. 99-115.

POCOCK, R. I. (1936). The polecats of the genera Putorius and Vormela in the British Museum. Proc.zool.Soc.Lond. 1936. 691-723.

POOLE, T. B. (1964). Observations on the facial pattern of the polecat. Proc.zool.Soc.Lond. 143. 350-352.

POOLE, T. B. (1966). Agressive play in polecats. Symp. zool. Soc. Lond. 18. 23-44.

POPOV, V. A. (1943). A new age index in Mustelinae. C.R. Acad.Sci. U.S.S.R. 38. 258-68.

REMPE, U. (1957). Beobachtungen über Brunst, Paarung, Tragzeit, Geburt and Kreuzungen bei Mitgleidern der Untergattung Putorius. Sond. Säugetierkund. Mitteil. 5. 111-113.

REMPE, U. (1962). Über die Formenvermannigfaltigung des Iltis in der Domestikation. Zeitschrift für Tierzüchtung and Züchtungsbiologie. 77. 229-233.

REMPE, U. (1965). Lassen sich bei Säugetieren Introgressionen mit multivariaten Verfahren nachweisen?.. Z.zool. Syst. Evolutionforschung. 3. 388-412.

RITCHIE, J. (1920). The influence of man on animal life in Scotland. A study in faunal evolution. Cambridge.

ROBINSON, A. (1918). The formation, rupture and closure of ovarian follicles in ferrets and ferret-polecat hybrids, and some associated phenomena. Trans.Roy.Soc. Edinburgh. 52. 303.

SCHÄFF, E. (1911). Die wildlebenden Säugetiere Deutschlands. Neudamm.

SCHMIDT, F. (1943). Naturgeschichte des Baum- und des Steinmarders. Monogr. Wildsäuget. Lpz. 10. 1-258.

SIMPSON, G. G. (1945). The Principles of Classification and a Classification of Mammals. Bull.Amer.Mus.Nat.Hist. 85. 1-114.

SMIT, F. G. A. M. (1957). Handbooks for the identification of British Insects. (Siphonaptera). Royal Ent. Soc., London.

STRABO (1st Century, B.C.). The geography (translated by H. L. Jones) London Heinemann.

TAYLOR, W. L. (1952). The polecat (Mustela putorius) in Wales. J.Anim.Ecol. 21. 272-274.

TETLEY, H. (1939). On the British polecats. Proc.zool.Soc.Lond. B.109. 37-39.

TETLEY, H. (1945). Notes on British polecats and ferrets. Proc. zool.Soc.Lond. 115. 212-217.

THOMSEN, H. P. & MORTENSEN, O. A. (1946). Bone growth as an age criterion in the cottontail rabbit. J.Wldl.Mgmt. 10. 171-174.

USINGER, A. (1931). Vom Iltis. Pelztiersucht. m. Kleintierz. 7. 199-204.

VOLCANEZKIJ, I. (1935). Gefangenschaftsbeobachtungen am Steppeniltis, (Putorius eversmanni Less.) Zool. Garten. (NF). 7. 262-273.

WALTON, K. C. (1964). The distribution of the polecat (Putorius putorius) in England, Wales and Scotland, 1959-62. Proc.zool.Soc.Lond. 143. 333-336.

WODZICKI, K. (1950). Introduced mammals of New Zealand. N. Z. Dep. sci. industr. Res. Bull. 98.

WRIGHT, P. L. (1947). The sexual cycle of the long-tailed weasel, (M. frenata). J. Mammal. 28. 343-52.

WYNNE-EDWARDS, V. C. (1962). Animal Dispersion in relation to social behaviour. Edinburgh and London.

YEAGER, L. E. (1950). Implications of some harvest and habitat factors in pine marten management. Trans. 15th. N. Amer. Wildlife Conf. 319-34.

ZEUNER, A. F. E. (1963). A History of Domesticated Animals. London.

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