Behavioural interactions between the naturalized American mink *Mustela vison* and the native riparian mustelids, NE Belarus, with implications for population changes

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Introduction

Since 1950-1970 in many eastern European countries, notably Russia, Belarus, Ukraine, Latvia, Lithuania, and Estonia, the European mink *Mustela lutreola* disappeared fast (Danilov & Tumanov, 1976; Tumanov & Zverev, 1986; Tumanov, 1992, 1996; Sidorovich, 1992, 1997; Maran & Hentonen, 1995; Sidorovich *et al.,* 1995; Maran *et al*., 1998). Several different hypotheses have been put forward to explain the demise of the European mink (Danilov & Tumanov, 1976; Ternovsky, 1977; Schropfer & Paliosha, 1989; Tumanov, 1992, 1996; Sidorovich, 1992, 1997; Ternovsky & Ternovskaja, 1994; Maran & Hentonen, 1995; Maran *et al*., 1998). At the same time as the decline of the European mink populations, the naturalised American mink grew in number very quickly (Gerell, 1967, 1968; Danilov & Tumanov, 1976; Tumanov & Zverev, 1986; Tumanov, 1992; Sidorovich, 1992, 1997; Sidorovich *et al.*, 1995). There is no substantial evidence that the decline in European mink populations is due to either a decline in prey abundance and availability or competition for prey (Sidorovich, 1997, in press.; Sidorovich *et al*., 1998). Possible impacts of other unfavourable factors such as hunting and habitat changes (including pollution) were also checked – leading to the conclusion that these factors could not be responsible for so fast and large-scale decline in European mink populations in Belarus or in Eastern Europe as a whole (Sidorovich, 1997). Therefore, the main task of the radiotracking study carried out was to reveal behavioural interactions between the two mink species –testing the idea that aggressive interference from the naturalized American mink towards European mink might be the main factor leading to the fast decline in this native predator. Also, high American mink density may as well affect the abundance and distribution of the other riparian mustelids inhabiting river valleys, such as the otter *Lutra lutra*, the polecat *Mustela putorius,* and the stoat *Mustela erminea.* The changes in populations of the polecat and the stoat were recorded during the American mink's expansion in Belarus (Sidorovich, 1997; Sidorovich *et al*., in press). Plausibly, these declines could also be caused by competition over resources and/or a direct interspecific aggression independent of resource use. Therefore, in order to study aggressive interference between the American mink and the polecat and the American mink and the stoat, these native mustelid species were also involved in the radiotracking study.

Study area

The study took place on the upper reaches of the Lovat River, Gorodok district, Vitebsk region, north-eastern Belarus (56°E, 32°N). The area has a rough glacial relief and is densely forested with mixed deciduous and coniferous woods interspersed with a few small villages and fields. There are two types of small rivers in the area: small, fast flowing rivers between five and eight meters wide and 0.5-1.5 m in depth which have high, steep wooded banksides and small floodplains, and small, slow flowing rivers between seven and 25 m wide and 1-2.5 m deep with wide (200-1000 m) floodplains of black alder swamps, and reed and sedge marshes. Also in the area, are many brooks and five glacial lakes, as well as various types of other wetlands of various sizes located outside of the river valleys (e.g. reed and sedge marshes, pools, black alder swamps, and pine bogs).

Fig. 1. European mink, Mustela lutreola *(photo: V.E. Sidorovich)*

Material and methods

The radiotracking studies were carried out in the period from early December 1995 to late January 2000. Radiotracking receivers were provided by Telonics Inc. (Mesa, Arizona) and neck-collars with transmitters were made by Biotrack Ltd. (Wareham, UK). During this period we radiotracked 15 European mink (10 males and 5 females), 45 American mink (29 males and 16 females), 7 polecats (6 males and one female) and 3 stoats (2 males and one female). The total number of radiolocations was 20,966: European mink – 11,234; American mink – 5,819; polecat – 2,891; stoat – 1,022. The duration of a radiolocation was up to 15 minutes or less if something changed e.g. either type of activity or coordinate or type of habitat. In the cold season in conditions of snow cover the radiotracking study was combined with snowtracking, mustelid tracks being identified according to Sidorovich (1999).

Amongst the different kinds of behavioural interactions we defined the following three patterns: a peaceful contact, an avoidance, and an aggressive encounter. An aggressive encounter was when the two radiotagged individuals displayed one of the following behaviours. This might be either a visual observation of the encounter or only hearing aggressive calls as the two radiotracked individuals met each other and, either during the activity or the radiotracking of one individual, this resulted in fast running away whilst being chased by the other individual for up to 500 m (slow and distant following between the individuals was not considered as chasing). An avoidance was defined if, when for a fairly long time (several hours or longer) the two radiotagged individuals inhabited a particular habitat patch (not larger than 300 m in diameter) without being close (in the same small area). Also, to define an avoidance, the radiotracked individuals should both be active in the same habitat patch simultaneously for an entire hour, at least. A peaceful contact was defined when the two radiotracked individuals came to the particular site and were either active or inactive, but without any evidence of aggression.

Results

The data obtained during the radiotracking study are presented in the two following parts. The first part consists of an analysis of the total data to clarify which kinds of behavioural interactions were most observed between riparian mustelids. In the second part, the stories of the two radiotracked European mink (a male and female which were better observed) in connection with an aggressive interference from radiotagged American mink are described, so showing better the strength of aggression from naturalized mink towards the native species.

Interspecific and intraspecific contacts between the riparian mustelids

During the radiotracking study on the American mink and the native riparian mustelids of the upper reaches of the Lovat River, it has been revealed that aggressive encounters between naturalised mink and native mink are fairly common. The data obtained are presented in Table 1. These results show that if an American mink came within a distance of 200 m of European mink, the American mink would drive away and chase the European mink. Of 56 cases when American mink and European mink were recorded at distances of 200-1,000 m, in 14 cases aggressive encounters between the species were registered. The aggressive encounters were mostly (13 out of 14 encounters recorded) initiated by male American mink, and were directed towards European mink of either sex. Only once was an aggressive attack by a female American mink on female native mink recorded. Following such attacks the European mink left the stream area and sheltered for up to 22 hours in habitats unusual for this species, such as forests or fields, e.g. under a fallen spruce or in rye. The European mink usually attempted to return to the stream, sometimes within 15 minutes, in which case they were normally subjected to repeated attacks. Most often (in 9 out of 14 cases) they returned within 30 minutes to 2 hours. Moreover, according to the two encounters which combined information from both radiotracking and visual observation, within European mink territories American mink tended to use its fresh tracks to search for European mink, and then drove them away. As to the behaviour of the European mink attacked, it usually avoided the aggressive American mink, but after its encounter with American mink and subsequent escape, tried to return to habitat typical for this species, i.e. stream banks.

Single aggressive encounters between male American mink and male polecat have been recorded, after which the polecat ran away, without being chased by the American mink. Also, mutual avoidance behaviour between American mink and polecat males was rather common (Table 1). It means that the two individuals stayed in the same habitat patch for a fairly long time (longer than one hour, up to 40 hours) and that they have never been recorded in one small area. This type of behaviour was fairly common for intraspecific interactions of European mink and for interspecific interactions of European mink and polecat (Table 1).

A single aggressive behaviour (a quite severe encounter) between two male European mink has been observed, whereas the American mink seems to be a more social species - intra-specific aggressive behaviour in the American mink population has never been recorded during a fairly long-term radiotracking study on many individuals. Moreover, we recorded three peaceful contacts between two male American mink and nine peaceful contacts between males and females of this species. It means that the two radiotracked individuals stayed close (e.g. in the same beaver burrow) without evident aggression. Five such peaceful contacts (3 between two males and 2 between males and females) were registered in the non-mating season (July, August, October, November, May). These five contacts continued for quite a long time, the maximum was 5 hours and 11 minutes when two male American mink were possibly sleeping in an abandoned beaver lodge. The other four peaceful contacts between radiotracked American mink continued for 10-32 minutes. In the European mink population, such peaceful behaviour also was observed (Table 1), but it was mostly recorded between males and females in the mating season (April), and only once between two males in the non-mating season (June).

We have only radiotracked three stoats (two males and one female) in the study area. Each stoat was captured in marsh habitats located within river and glacial lake valleys. After their release in the valleys they left these habitats over several days. We then radiolocated the stoats many times in adjacent open habitats (marsh and dry meadow) including the capture and release sites, but mainly when radiotagged American mink were absent. We had many American mink radiotagged which inhabited these areas, and whenever they appeared in the habitats, the radiotracked stoats moved out (but each time it seems that the reaction to the presence of American mink had a time lag). Nonetheless, doing both radiotracking and snowtracking, we have never recorded a behavioural interaction between the species which might be characterized as an aggressive encounter. As to behavioural interactions between American mink and otter, snowtracking of both species and radiotracking of the American mink, showed no evidence of aggressive interference between the species.

Life stories of the radiotracked European minks in connection with an aggressive interference from the American minks

In our long-term radiotracking study of the two mink species in the upper reaches of the Lovat River, several interesting stories recorded aggressive behaviour by American mink directed at European mink. We briefly describe only two of the more important stories related to both male and female European mink.

Female European mink

A female European mink was live-captured on 8 November, 1996 at the Zadrach glacial lake. She weighed 779 g and had body length of 38 cm. (Before the capture, this place was occupied by a female American mink (weight 590 g, body length 33 cm). After the release of the radiotagged female European mink at the lake, she relocated to the Uzhovsky brook located nearby. At that time, this place was inhabited by another female American mink (weight 810 g, body length 39 cm). Three days after a quite strange behaviour (running away from the stream bank to the surrounding spruce forest when the female American mink was active nearby), the female European mink left the brook and relocated to the fast flowing part of the Lovat small river. In two days, she occupied a place located at a distance of 4 km from the recently inhabited site while going along the streams. The female European mink lived in the new place during the winter of 1996-

1997, mostly feeding on common frogs *Rana temporaria* hibernating in the river. At that time, her activity was mostly concentrated on the small area along only about 200 m of the river, where the highest concentration of overwintering frogs was observed. Simultaneously, close to this place lived a male polecat (weight 1,020 g, body length 41 cm). No aggressive attitudes between these two native riparian mustelids had been recorded during three months, even though they were fairly often located at a distance of 150-300 m. Sometimes the male polecat visited the main foraging site of the female European mink, where he stole the remains of common frogs from her cache or captured common frogs, and remained close to her on snow cover or ice. Usually, at this time the female European mink was either sleeping in a beaver burrow or active at a distance of 150-300 m from the main foraging site. According to data obtained by both snowtracking and radiotracking, the polecat did this at least seven times. In the period between 13.11.1996 and 14.02.1997, the female European mink was recorded at the Lovat bank only. Starting on 15.02 (when in Belarus the mating season in the American minks normally has already began; Sidorovich, 1997), the female European mink fairly often ran away to the adjacent forest and stayed there at a random site, e.g. under a fallen spruce, or she only ran there a lot and then came back to the river bank. During that time, at least five attacks on the female European mink by two male American mink (weight – 1,420 and 1,100 g, body length - 43 and 40.5 cm) were observed. After the aggressive encounters she ran away to the forest, but each time tried to come back. In effect, the female European mink left her territory and relocated to a brook which flows together with the Lovat River. The newly inhabited place was located 1.5 km downstream from her recent territory. She lived at the brook until 2 May. During this period she at first fed on common frogs that still stayed in the brook and spawned nearby. Starting on 10 April she plausibly mated with a male European mink (non-radiotagged). They stayed together for at least 6 days. Another male European mink (radiotagged) also visited her, but after a short visit he left very rapidly -maybe driven away by the other male. Meanwhile, the water level in the small stream became shallow. At the end of April after spawning, the common frogs dispersed into the forest. There were few fish in the brook, and taking into account that the European mink is reluctant to feed on small mammals (Sidorovich, 1997, in press; Sidorovich *et al.*, 1998) and the lack of water-living prey in the brook, these plausibly forced the female European mink to leave the brook habitat and begin to look for another suitable site to give birth. This happened on 2 May. We radiotracked the European mink intensively and did not record aggressive encounters from any radiotagged American mink just before she left the small stream. Nevertheless, this might be because several radiotagged American mink visited this place during that time. After she left the small stream, the female European mink at first came up on a small, canalized river close to Bolotnitca village and located at a straight-line distance of 2.5 km from her recent site. According to track observations and the presence of the radiotagged individuals, each stream between those two sites and further downstream of the canal was occupied by American mink. Hence, it is possible that in every place the female European mink was driven away. After two days she suddenly disappeared, and we could not find her in a large area about 10 km in diameter. What happened to the kits which should have been born by her remains unknown. There might have been high kit mortality because the female European mink looked so hard for a suitable site to give birth just few days before.

Male European mink

A male European mink was live-captured on 12 April 1997 at the Uzhovsky brook near the Zadrach glacial lake. He weighed 920 g and his body length was 39 cm. At that time, this place was also inhabited by a female American mink (weight 810 g, body length 39 cm). Two days after his release the radiotagged male European mink moved about 4 km upstream and then disappeared. On 20 April we found him inhabiting the three closely positioned brooks (up to 2 km of stretch) which flow into Zadrach Lake on its western side. He fed on common frogs spawning in the brooks. At the same time, this area was inhabited by two radio-

Species, sex	Distance between the radiotracked individuals (m)			Pattern of a behavioural interaction at small distance		
	200 –1,000	<200	very close	An aggressive encounter	An avoidance	Nothing happened, probably a peaceful contact
M.l. m-m	14	4	2	1	4	1
M.l. f-f	2	1	0	0	1	0
M.l. m-f	17	7	5	0	1	5
M.l. f - *M.v.* m	16	6	6	5	6	0
*M.l.*m - *M.v.* m	25	8	8	8	7	0
M.l. f - *M.v.* f	7	1	1	1	1	0
M.l. m - *M.v.* f	8	1	1	0	1	0
M.v. m-m	26	7	3	0	0	3
M.v. f-f	4	0	0	0	0	0
M.v. m-f	47	12	9	0	0	9
M.l. m - *M.p.*m	10	5	0	0	5	0
*M.l.*f - *M.p.*m	8	2	0	0	2	0
M.v. m - *M.p.*m	21	4	1	1	4	0
M.v. f - *M.p.*m	7	1	0	0	1	0
M.p. m-m	8	3	1	0	2	1
Denotation: *M.l.* - European mink, *M.v.*- American mink; *M.p.* - polecat, m - male, f - female.						

Table 1. Registered contacts between radiotagged American mink, European mink and polecats as number of observations (total of radiolocations is 19,994), on the upper reaches of the Lovat River, NE Belarus, 1995-1999

tagged male polecats (weight 1,009 and 1,008 g, body length 41 and 43cm). We did not record any aggressive attitudes from the male polecats towards the male European mink. A week after spawning, common frogs gradually spread in the neighbouring forest, and there were no fish or crayfish in these small streams. Taking into account that the European mink is reluctant to feed on small mammals (Sidorovich, 1997, in press; Sidorovich *et al.*, 1998), it is probable that the absence of aquatic prey in the brooks forced the male European mink to relocate to the shore. But there lived a male American mink (weight 960 g, body length 41.5 cm). We did not record any aggressive encounters between them, but in two days the male European mink again started to move around a lot. We found him at the fast flowing small River Servaika in a place located at a straight-line distance of 3 km from his recent site. In this area lived at least two other radiotagged male American mink. At first we did not observe any aggressive attitudes from either male American mink towards to the newly-arrived male European mink. In the end of May the male European mink gradually moved from the Servaika River to a poorer quality habitat near small streams located less than 1 km from the river. These brooks do not connect with the Servaika River and run in the other direction straight to the Lovat River. Nevertheless, sometimes the male European mink visited the Servaika River. There, that time, we began to observe aggressive encounters by American mink towards the male European mink. Several times the two male American mink (weight 1,022 and 1,150 g, body length 41.5 and 43.5 cm) came to the site where the male European mink stayed, attacked him, then drove away and chased him for approx. 300-700 m. After the attacks, the driven-away male European mink mostly stayed in an adjacent rye field and then tried to come back. In that period, we also registered several attacks from a third male American mink (weight 1,240 g, body length 45 cm) on the male European mink at the Servaika River. After the attacks the driven-away male European mink came back to the brook. In the middle of September the male European mink began to range, and was mainly radiolocated at different brooks flowing into the Servaika River within an area of about 3 km by 5 km, but often we could not find him in the area. We then lost the male European mink after numerous attempts to find him in a fairly large area of about 15 by 22 km.

Discussion

So, according to the above data, aggressive interference from American mink towards European mink is rather common in the behavioural interactions of these naturalized and native predatory species. Male American mink are especially aggressive and attack both sexes of European mink. The data obtained suggest that if a male American mink came within a distance less than 200 m from the position of an European mink, there was a high probability that he would drive away and chase the European mink. Moreover, according to the observations made, within European mink territories American mink (especially males) tend to search for European mink by their fresh tracks and then drive them away. Amongst 56 cases when American mink and European mink were recorded at distances of 200-1,000 m, aggressive encounters between the species were registered in 14 cases. So, the aggressive behaviour of American mink towards European mink of both sexes is direct and severe.

Radiotracking data showed that American mink drive European mink away from habitats, especially rivers. These European mink then find habitats at brooks. However, such small streams (length up to 10 km) are used more frequently by male than by female European mink; females clearly preferred small, fast flowing rivers (Sidorovich *et al.*, in prep.). A possible explanation for this may also be sought in the seasonal changes in common frog abundance: by the end of April frogs have dispersed from their spawning grounds in streams, resulting in a substantial reduction in the number of prey (Pikulik, 1985). This is especially pronounced in brook habitats characterized by very low fish and crayfish biomass. Therefore, at this time of year, brooks may be inadequate in terms of resources for female European mink which have increased requirements for litter rearing. For this reason female European mink may be unable to inhabit such small streams throughout the year, yet they are faced with a dilemma in their preference for small rivers, as these areas are inhabited by American mink who are physically stronger and more aggressive. Female European mink in these areas are at a competitive disadvantage, compounded by the fact that American mink attacks were observed mainly to have been by American mink males. The resulting stress and limited resources available to female European mink may lead to unsuccessful breeding, as well as to higher adult female and kit mortality. Indeed, low reproduction rates and extremely low numbers of females have been observed in declining European mink populations (Sidorovich, 1997). Taking into account the above results, it becomes clear why European mink populations have declined so quickly from dense populations to near extinction (Sidorovich *et al.*, 1995).

Following the American mink's expansion in the upper reaches of the Lovat River, the polecat population along the banks and shores was reduced by approximately half (Sidorovich 1997). Although polecats can coexist with European mink, American mink feed on small mammals more frequently than European mink, thus there is a high similarity in the diet of polecat and American mink, especially during the winter period (Sidorovich, 1997, in press; Sidorovich, *et al*., 1998). American mink is well adapted to forage in aquatic environments and on land (Dunstone, 1993). Perhaps, in aquatic ecosystems American mink is a more competitive species than the polecat and, as a result, polecat populations tend to decline at rivers, glacial lakes and wetlands. Moreover, aggressive interference by American mink directed at the polecat could impact its population, too. Furthermore, as with European mink, polecat females are at an even greater competitive disadvantage due to their smaller body size. In areas of high density American mink populations female polecats were rarely observed in wetland habitats, yet in the absence of American mink, polecat density in these habitats was high (approximately five individuals per 10 km) and females outnumbered males (1.5:1).

During the radiotracking study we found only a single aggressive attitude from an American mink male towards a polecat male. After that the polecat ran away without being chased by the American mink. At the same time, avoidance between males of these two species was rather common. As for female polecats, we had only one radiotracked, because it was very difficult to catch female polecats in the riparian habitat after the American mink attained a high population density. The female polecat live-captured in the Lovat River valley, radiotagged and released there, left the place in two days and inhabited village surroundings. We assumed that, if we had many radiotagged polecat females living in riparian habitats, similar results as to European mink females relating to aggressive interference from the American mink could be obtained. Consistency is no guarantee of a correct explanation, however, and it may be asked which factors other than competition (both over resources and through interference) with the naturalized American mink could lead to the near disappearance of polecat females in river valley habitats, in which they were previously so common. In the study area, no changes in otter habitat use and abundance were found after the American mink's expansion (Sidorovich, 1997; Sidorovich *et al*., in prep.). Only a temporary decline in otter populations was recorded in some regions of Belarus, this being due to over-exploitation (Sidorovich, 1992).

There is a high probability that stoat populations were strongly affected by American mink. The observed decline in stoats seems to be based on both competition over resources and interference by naturalized carnivores, *i.e*. the American mink and the raccoon dog (Sidorovich, in press). In the upper reaches of the Lovat River before the American mink's expansion, trappers who caught European mink usually also (by chance) caught one stoat for 8-10 European mink, whereas under current conditions (*i.e*. with a dense American mink population) the ratio between trapped stoat and mink is 1 stoat to 90-120 mink (both species, but mostly American mink). In the study area during the winters of 1986-1990 and before 1992, since American mink populations have been at a high level, from 8-13 stoats were recorded per km^2 of the Lovat floodplain (average = 11.5), whilst 5-9 stoats/km^2 (average = 6.9) were found in the same habitats in 1993-1995 and, in the winter of 1997-1998, we censused ≤ 4 stoats/km^2 only (average = 1.8). The differences are statistically significant ($t>5.5$, $P<0.01$).

Thus, the radiotracking study of behavioural interactions between the naturalized American mink and the native riparian mustelids appeared to be fairly fruitful in explaining the declines observed in native species populations in Belarus. There is much support for the contention that a similar pattern of interspecific relationships between these species is common in eastern Europe on the whole, and the aggressive interference revealed, at least partly caused the observed pronounced decline in the populations of European mink, polecat and stoat.

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Sexual variability in cranial form and morphology in wild and farmed American mink, *Mustela vison*, on Bering Island, Komandorian Archipelago, Russia

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Abstract

Craniometric and morphological variation between two populations (wild and farmed) American mink, *Mustela vison*, from the Commander Islands, Kamchatka (Russia) were examined using multivariate statistical analysis. Significant dimorphism in cranial form and morphology was found, although the degree of dimorphism varied between sexes and habitat. Four groups were examined: wild and farmed male mink and wild and farmed female mink. Three discriminant functions for craniology were calculated: first – for the separation of males from females; second – for wild and farmed males; third – for wild and farmed females. The reasons for mink dimorphism on the Commander Islands are discussed.

Key words: sex and age dimorphism, cranial variability, morphological characteristics, American mink, discriminant analysis, Commander Islands.

Introduction

As a result of the Commander Islands' geographic position in the most productive part of the North Pacific Ocean and their long distance isolation from industrial centers and main marine communications routes, these islands present a unique natural "laboratory". The natural communities of these islands were untouched until their discovery in 1741 during the second Kamchatian Expedition of Vitus Bering. The coastal region of Bering and Medny Islands supports a population of about 300,000 marine mammals (fur seals, *Callorhinus ursinus*, sea lions, *Eumetopias jubatus*, sea otters, *Enhydra lutris*, harbour seals, *Phoca vitulina vitulina*). But the terrestrial fauna of the islands includes only a native kind - blue arctic fox. The American mink, *Mustela vison* Schreber, was introduced to a Bering Island fur farm in 1969. A wild population appeared as a result of escapes from the fur farm and over a period of years they occupied all suitable habits on the island (Marakov *et al*., 1976). The investigation of wild and farmed mink populations on Bering Island is preferable to that of other populations and has great scientific interest as: 1) the wild animals are the direct offspring of farmed mink; thus the differences observed can be explained by habit changes and by greater variability trends on a small island (in contrast with the variation seen in free- crossing continental mink populations; Dayan & Simberloff, 1994); 2) the rates and degree of difference without gene flow from farmed population since the conclusion of fur farm activity (in 1997) can be evaluated.

Materials and methods

The study is based on the author's personal collection of 58 skulls of wild mink (38 males and 20 females) and 72 skulls from the Commander fur farm (28 males and 44 females) aged 8 months and older. The animals were trapped in the winter season from

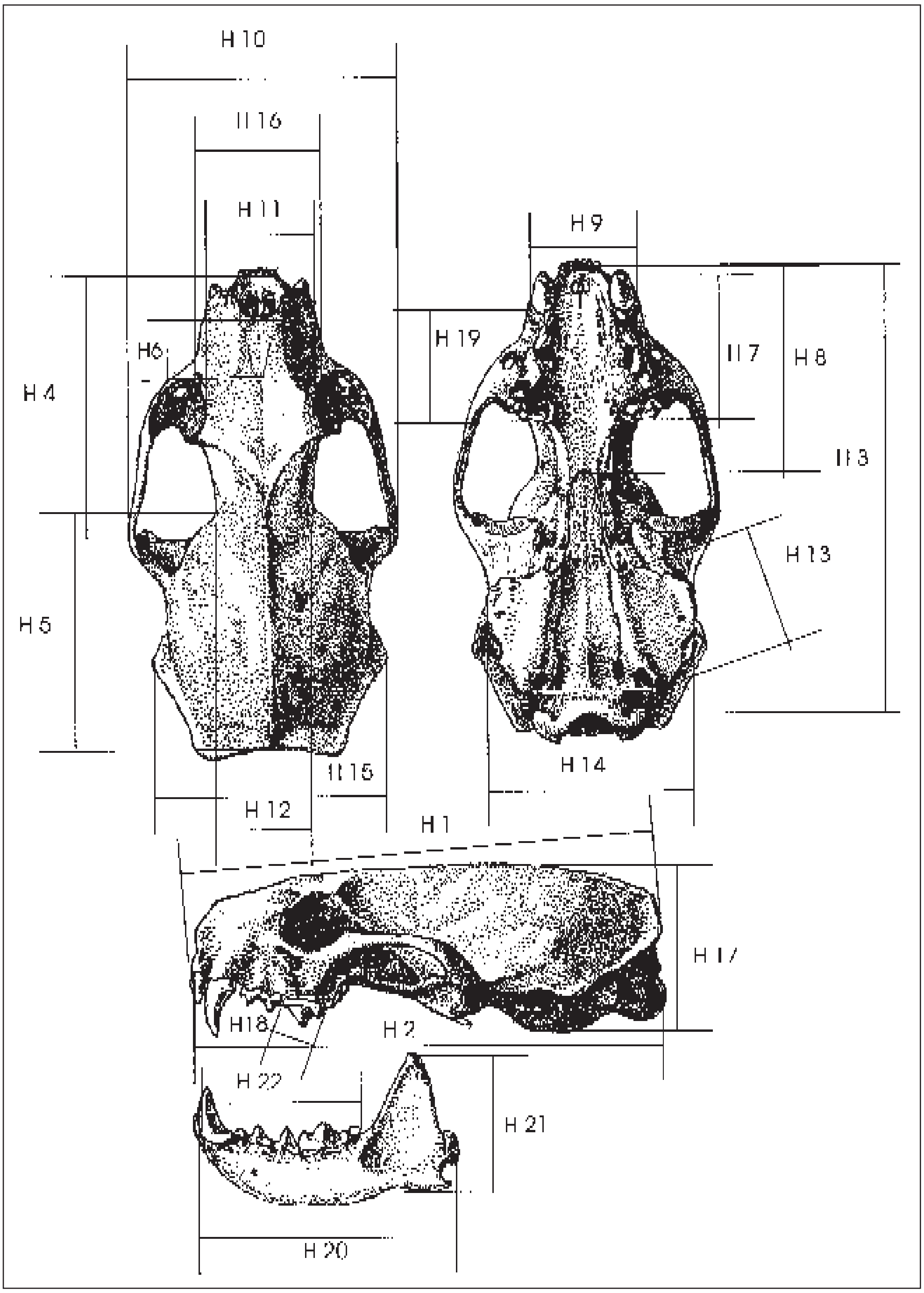
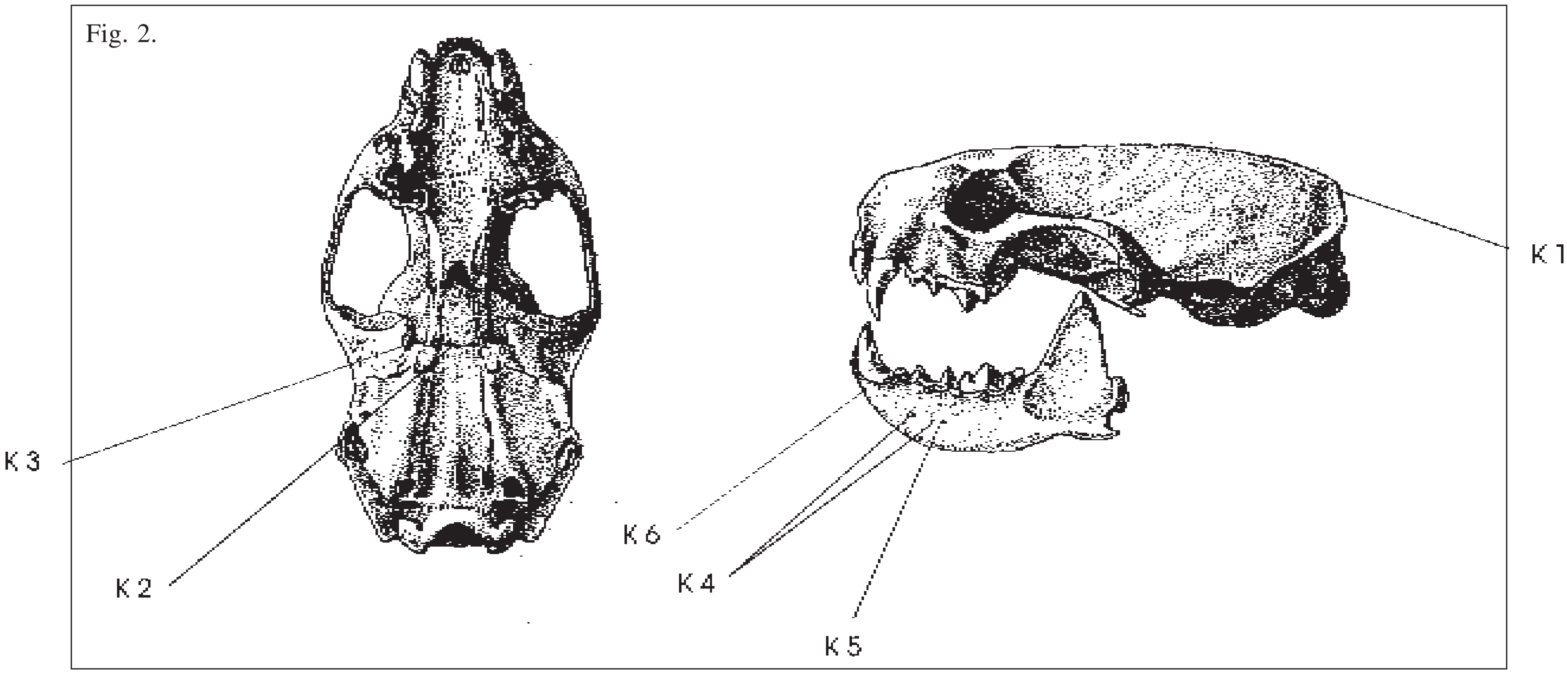


Fig. 1. Skull measurements of the American mink

Fig. 2.



1994 to 1997. Age estimates were based on cementum analysis of the upper canine tooth (Klevezal, 1988). The animals were separated into three ages classes: age class 1 – animals of 9-12 months old (before their first winter); age class 2 – animals of 12-19 months (before the second winter); age class 3 – animals after the second winter season (more than 19 months old).

Twenty two linear measurements were taken to an accuracy of 0.1 mm: H1 – total length of skull, H2 – condylobasal length, H3 – basal length, H4 – face capsule length, H5 – brain capsule length, H6 – nose bones length, H7 – length of upper tooth row, H8 – maxillar length, H9 – rostrum breadth, H10 – zygomatic breadth, H11 – interorbital breadth, H12 – postorbital breadth, H13 – ear capsule breadth, H14 – brain capsule breadth, H15 – mastoid breadth, H16 – ectorbital breadth, H17 – skull height with sagital crest and ear capsule, H18 – length of upper premolar teeth (Pm^3), H19 – length of upper premolar row, H20 – total mandible length, H21 – angular length, H22 – length of lower tooth row (Fig. 1).

Two of the characters were added in recognition of the shape of the skull: H23 – length index (H1 : V2, where H1 – total length of scull, V2 – length of body); H24 – breadth index (H12 : H3).

Some external and internal characteristics were taken from these animals (60 carcasses of wild and 32 carcasses of farmed males, 38 and 57 carcasses of wild and farmed females): V1 – weight of body (kg), V2 – length of body (cm), V3 – length of tail (cm), V4 – length of foot (cm), V5 – height at shoulderblade (cm), V6 – height at elbow (cm), V7 – circumference of chest (behind forepaws) (cm), C1 – weight of heart (gr), C2 – weight of liver (gr), C3, C4 - weight of right and left kidneys (gr), C5 – total length of intestines (from stomach to anus (cm).

The following morphological indices were calculated: C6 – index of heart weight (C1 : V1); C7 – index of liver (C2 : V1); C8, C9 – indices of right and left kidneys (C3 : V1; C4 : V1); C10 – index of intestines (C5 : V2).

Parameters like mean ($\bar{X}$), range ($\bar{X}$max, $\bar{X}$min), standard deviation (Sx), and Student's test were calculated for all measurements.

Six nonmetrical traits for the evaluation of the morphological differentiation were chosen (Ansorge, 1992; Ansorge & Stubbe, 1992): K1 – upper foramen occipitale present; K2 – for. sphenoidale present; K3 – emissary foramen beside the for. ovale present; K4 – two for. mentale present; K5 – accessory posterior for. mentale present; K6 – accessory anterior for. mandibulare present (Fig.2).

Bilateral traits were taken from both sides of the skull and calculated both separately and together. The frequencies of these traits were compared using the chi-square test.

	x (1)	x (2)	Sx (1)	Sx (2)	N (1)	N (2)
H1	67,867	60,228	3,439	2,146	66	64
H2	66,592	59,342	3,307	2,115	66	64
H3	62,079	55,117	3,034	2,032	66	64
H4	32,947	29,027	2,365	1,541	66	64
H5	35,168	31,366	1,481	1,256	66	64
H6	12,317	11,144	1,038	0,882	66	61
H7	21,367	19,284	1,088	0,673	66	64
H8	30,708	27,025	1,622	1,121	66	63
H9	14,338	12,231	0,796	0,546	66	64
H10	40,726	34,992	1,809	1,365	66	64
H11	15,255	13,037	0,891	0,712	66	63
H12	12,0,85	11,219	0,818	0,804	66	64
H13	17,502	15,977	0,845	0,845	66	64
H14	30,130	27,205	1,297	0,818	66	64
H15	35,011	30,423	2,032	1,351	66	64
H16	18,420	15,975	1,261	1,154	66	63
H17	24,697	22,133	1,087	0,733	65	64
H18	7,406	6,734	0,351	0,322	66	64
H19	17,052	15,783	1,025	0,588	66	64
H20	41,820	36,314	2,253	1,270	66	64
H21	19,095	16,228	0,996	0,655	66	64
H22	25,829	23,142	1,125	0,683	66	64
H23	16,146	16,634	0,622	0,561	63	64
H24	19,416	20,372	1,272	1,727	65	64

Table 1. Craniological parameters of males (1) and females (2) of Bering Island American mink

Table 2. Craniological parameters of farmed (1) and wild (2) males and females of American mink.

	Males						Females					
	x (1)	x (2)	Sx (1)	Sx (2)	N (1)	N (2)	x (1)	x(2)	Sx (1)	Sx (2)	N (1)	N (2)
H1	69,168**	66,908**	3,480**	3,116**	28	38	60,532	59,560	2,319	1,555	44	20
H2	68,007**	65,550**	3,531**	2,735**	28	38	59,743*	58,460*	2,229*	1,295*	44	20
H3	63,425***	61,087***	2,995***	2,692***	28	38	55,568**	54,125**	2,115**	1,435**	44	20
H4	34,221***	32,008***	2,126***	2,096***	28	38	29,352*	28,310*	1,608*	1,111*	44	20
H5	34,864	35,392	1,552	1,405	28	38	31,268	31,580	1,300	1,156	44	20
H6	12,729**	12,013**	0,924**	1,022**	28	38	11,398***	10,625***	0,905***	0,557***	44	20
H7	21,975***	20,918***	1,070***	0,870***	28	38	19,484***	18,845***	0,616***	0,590***	44	20
H8	31,271*	30,292*	1,588*	1,538*	28	38	27,281**	26,475**	1,338**	0,878**	43	20
H9	14,657**	14,103**	0,738**	0,764**	28	38	12,352**	11,965**	0,542**	0,464**	44	20
H10	40,939	40,568	1,738	1,867	28	38	35,107	34,740	1,457	1,132	44	20
H11	15,493	15,079	0,918	0,841	28	38	13,091	12,911	0,751	0,610	44	19
H12	12,121	12,058	1,018	0,648	28	38	11,111	11,455	0,756	0,875	44	20
H13	17,707	17,350	0,899	0,779	28	38	16,059	15,795	0,954	0,510	44	20
H14	30,443	29,900	1,471	1,117	28	38	27,205	27,205	0,910	0,584	44	20
H15	35,879**	34,371**	2,114**	1,713**	28	38	30,482	30,295	1,527	0,866	44	20
H16	18,607	18,282	1,240	1,274	28	38	16,082	15,726	1,237	0,916	44	19
H17	25,304***	24,238***	1,019***	0,905***	28	37	22,257*	21,860*	0,760*	0,603*	44	20
H18	7,579***	7,279***	0,353***	0,294***	28	38	6,798*	6,595*	0,277*	0,375*	44	20
H19	17,732***	16,550***	0,962***	0,749***	28	38	15,934**	15,450**	0,561**	0,516**	44	20
H20	42,732**	41,147**	2,244**	2,037**	28	38	36,459	35,995	1,359	1,007	44	20
H21	19,214	19,008	0,830	0,410	28	38	16,239	16,205	0,686	0,596	44	20
H22	26,425***	25,389***	0,982***	1,027***	28	38	23,277*	22,845*	0,688*	0,584*	44	20
H23	16,375*	15,985*	0,509*	0,650*	26	37	16,597	16,713	0,547	0,597	44	20
H24	18,930**	19,760**	1,254**	1,183**	27	38	20,030*	21,126*	1,626*	1,745*	44	20

* -p < 0,05 ** -p < 0,01 *** -p < 0,001

Results

1. Sex and age variation in cranial form

Statistical analysis of craniological measurements showed a high level of difference ($P < 0{,}001$; $df = 128$) between sexes (Table 1). Testing of wild and farmed animals of both sexes revealed differences in some parameters, moreover the skulls of farmed animals were bigger than those of wild ones (Table 2).

The statistical analysis indicated significant differences in some skull measurements within age classes 1, 2, and 3. The conclusion of female skull growth during the first year of life was revealed (except for two skull parameters within age classes 2 and 3) in contrast with males where some skull parts are still growing before the second year of life (Table 3).

Three discriminant equations were calculated: for males and females (1), wild and farmed males (2), wild and farmed females (3). The coefficients of classification and summary stepwise analysis are shown in Tables 4 and 5, but I have made some modification to these functions (Afifi & Asen, 1979):

1. ♀♀ > Z = 1,82 H10 + 2,54 H21 – 1,66 H4 + 5,42 H18 + 1,67 H13- 3,72H19 + 2,57 H22 + 1,62 H17 = 168,445 > ♂♂
2. ♂♂ wild > Z = 1,54 H19 – 1,24 H5 – 1,31 H10 + 2,49 H17 – 1,07 H24 + 4,97 H18 + 1,63 H15 – 1,92 H21 -1,03 H16 = 9,622 > ♂♂ farmed
3. ♀♀ wild > Z = 2,78 H7 + 2,98 H17 – 2,26 H21 – 1,56 H14 + 1,54 H6 - 0,47 H24 =46,62 > ♀♀ farmed

2. Nonmetrical skull divergence

The frequencies of occurrence of 4 bilateral and 2 unilateral traits showed significant differencies for 4 traits in wild and farmed females ($\chi^2 = 33{,}171$; $p< 0{,}01$; $df = 13$; Table 6): the presence of for. sphenoidale, presence of emissary foramen beside for. ovale on left and both sides of the skull, presence of accessory anterior for. mandibulare on both sides of the skull. The significant differences between wild and farmed males were observed in 2 traits, but total differences were not significant ($\chi^2 = 20{,}76$; $p> 0{,}05$; $df = 13$; tab.4): the presence of upper for. accepitale and presence of accessory anterior for. mandibulare at right mandibulare.

3. Morphological parameters of mink

The investigation of morphology determined sexual differences except for the heart index (C6; Table 7). All of the farmed animals were heavier and bigger in some external measurements than wild ones. No significant differences were noted in the length of body (V2), length of foot (V4), height at shoulderblade (V5), weight of heart (C1), indices of kidneys (C8, C9) and intestines (C10), length of male intestines (5).

	Males									Females								
	x (1)	x (2)	x (3)	Sx (1)	Sx (2)	Sx (3)	N 1	N 2	N 3	x (1)	x (2)	x (3)	Sx (10)	Sx (2)	Sx (3)	N 1	N 2	N 3
H4	32,18*	33,67*	33,43	2,151	2,285	2,336	25	15	20	28,79	28,75	29,42	1,507	1,386	1,613	35	8	16
H7	21,0*	21,81*	21,54	1,082	0,869	1,136	25	15	20	19,19	19,13	19,51	0,644	0,848	0,697	35	8	16
H11	14,78**	15,41**	15,57	0,575	0,885	1,006	25	15	20	12,97	12,65*	13,28*	0,714	0,855	0,613	34	8	16
H12	12,13	12,31*	11,72*	0,729	0,997	0,690	25	15	20	11,34	11,08	10,77	0,795	0,769	0,695	35	8	16
H14	29,60*	30,62*	30,28	1,335	1,213	1,108	25	15	20	27,16	26,99	27,31	0,863	0,967	0,723	35	8	16
H15	34,09*	35,79*	35,46	2,142	1,648	1,924	25	15	20	30,30	30,10	30,74	1,466	1,549	1,026	35	8	16
H16	17,67*	18,38*	19,16	0,955	1,052	1,199	25	15	20	15,69	15,48*	16,73*	1,075	1,210	1,078	34	8	16
H18	7,29*	7,56*	7,48	0,362	0,338	0,324	25	15	20	6,76	6,76	6,73	0,339	0,277	0,249	35	8	16
H19	16,74*	17,57*	17,05	1,091	0,838	0,994	25	15	20	15,79	15,53	15,86	0,633	0,597	0,550	35	8	16
H22	25,56*	26,35*	25,88	1,046	0,929	1,147	25	15	20	23,17	22,95	23,21	0,730	0,396	0,730	35	8	16
H23	15,98*	16,40*	16,03	0,561	0,523	0,751	24	14	19	16,57	16,84	16,67	0,609	0,249	0,630	35	8	16

Table 3. Some changes in cranial form of males and females of three age groups group 1 - age 0+; group 2 - age 1+; group 3 - age 2-7 years.

Parameters	Males p = 0,508	Females p = 0,492
H10	10,625	8,809
H21	5,804	3,266
H4	- 18,426	- 16,764
H18	51,033	45,610
H13	24,367	22,693
H19	- 16,024	- 12,303
H22	25,681	23,110
H17	20,564	18,942
Constant	- 821,016	- 652,571
	Farm males p =0,409	Wild males p = 0,590
H19	- 1,181	- 2,720
H5	8,772	10,013
H10	6,813	8,121
H17	9,645	7,155
H24	16,459	17,533
H18	50,509	45,542
H15	2,676	1,045
H21	- 7,224	- 5,315
H16	- 1,461	- 0,433
Constant	- 719,188	- 709,566
	Farm females p = 0,678	Wild females p = 0,322
H7	80,33	77,55
H17	39,85	36,87
H21	3,13	5,39
H14	20,95	22,51
H6	- 21,47	- 23,01
H24	16,94	17,41
Constant	- 1587,54	- 1540,92

Table 4. Classification function for males and females, farmed and wild males, farmed and wild females of American mink.

	Males and females			
	Step	F entr/rem	p-level	F – value
H10	1	437,246	0,000	437,246
H21	2	8,259	0,005	236,202
H4	3	12,114	0,001	176,464
H18	4	8,971	0,005	142,433
H13	5	5,582	0,019	119,603
H19	6	4,823	0,030	103,815
H22	7	5,532	0,020	93,343
H17	8	5,045	0,027	85,256
	Farm and wild males			
H19	1	30,675	0,000	30,675
H5	2	12,759	0,001	24,774
H10	3	4,286	0,043	18,880
H17	4	6,895	0,011	17,348
H24	5	5,179	0,027	15,950
H18	6	4,128	0,047	14,736
H15	7	4,504	0,038	14,094
H21	8	2,999	0,0,89	13,172
H16	9	3,494	0,067	12,658
	Farm and wild females			
H7	1	22,088	0,000	22,088
H17	2	6,622	0,013	15,444
H21	3	7,074	0,010	13,771
H14	4	2,835	0,098	11,381
H6	5	4,729	0,034	10,679
H24	6	2,579	0,114	9,595

Table 5. Summary of stepwise analysis for males and females, farmed and wild males, farmed and wild females of American mink.

Table 6. Frequencies of occurrence of nonmetrical traits in the skull of wild and farmed American mink from Bering Island

	Farm males		Wild males		Farm females		Wild females	
Parameters	Frequency (%)	N	Frequency (%)	N	Frequency (%)	N	Frequency (%)	N
K 1	86,2*	29	97,3*	37	84,1	44	91,3	23
K 2	44,8	29	56,8	37	31,8*	44	62,5*	24
K 3 – r	44,8	29	64,9	37	36,4	44	58,3	24
K 3 – l	58,6	29	54,1	37	34,1*	44	60,9*	23
K 3 – b	31,0	29	45,9	37	13,6*	44	39,1*	23
K 4 – r	93,1	29	97,4	39	84,1	44	87,5	24
K 4 – l	96,6	29	89,4	38	93,2	44	83,3	24
K 4 – b	93,1	29	86,8	38	79,5	44	75,0	24
K 5 – r	62,1	29	66,7	39	40,9	44	62,5	24
K 5 – l	58,6	29	52,6	38	50,0	44	66,7	24
K 5 – b	37,9	29	47,4	38	27,3	44	45,8	24
K 6 – r	10,3*	29	33,3*	39	22,7	44	25,0	24
K 6 – l	24,1	29	26,3	38	15,9	44	29,2	24
K 6 – b	6,9	29	13,2	38	6,8*	44	20,8*	24

K1, K2, K3, K4, K5, K6 - nonmetrical skull traits (see text)
* -p < 0,05   r - right side of the skull; l - left side of the skull; b - both sides of the skull

Table 7. Morphological parameters of farmed (1) and wild (2) males and females of American mink.

	Males						Females					
	x (1)	x (2)	Sx (1)	Sx (2)	N (1)	N (2)	x (1)	x (2)	Sx (1)	Sx (2)	N (1)	N (2)
V1	1,267***	0,866***	0,317	0,175	30	59	0,702***	0,496***	0,154	0,071	55	38
V2	41,984	41,163	2,379	2,652	31	60	36,214	35,632	1,872	1,261	57	38
V3	20,897***	18,592***	1,538	1,477	29	59	17,346***	16,229***	1,575	1,109	57	38
V4	6,106	5,868	0,435	0,667	32	60	5,209***	4,873***	0,392	0,508	57	37
V5	14,741	14,354	0,881	1,008	27	41	12,389	12,180	0,706	0,627	45	25
V6	8,339*	8,013*	0,578	0,665	28	40	7,067**	6,700**	0,507	0,354	45	25
V7	16,393***	14,278***	1,988	1,281	28	27	13,900***	11,500***	1,106	0,827	45	20
C1	11,845	10,843	1,277	2,444	12	50	6,816	6,718	0,812	1,248	28	34
C2	92,094***	44,600***	17,233	13,366	12	50	55,924***	30,162***	11,904	6,007	28	34
C3	6,730***	4,704***	1,758	1,021	13	50	3,934***	3,076***	0,737	0,605	28	34
C4	7,100***	4,826***	1,951	1,071	13	50	4,080***	3,221***	0,689	0,625	28	34
C5	194,538	186,188	22,337	13,525	13	48	159,232**	150,682**	11,655	11,212	28	33
C6	9,665***	12,383***	1,120	2,140	12	50	9,733***	13,756***	2,160	2,493	28	34
C7	78,415***	50,608***	13,901	12,912	13	50	79,244***	61,651***	11,887	11,192	28	34
C8	5,486	5,280	1,133	0,880	13	49	5,666	6,154	1,231	1,048	28	33
C9	5,812	5,503	1,380	0,957	13	50	5,863*	6,430*	1,052	0,945	28	33
C10	4,642	4,530	0,538	0,437	13	48	4,372	4,231	0,373	0,297	27	33

* -p < 0,05 ** -p < 0,01 *** -p < 0,001

Discussion and conclusion

The investigation confirmed the data of previous researchers about the decrease in some cranial parameters of wild American mink when compared with farmed animals (Dayan & Simberloff, 1994). Kruska (1996) revealed some decreases of the brain of farmed mink, which was confirmed in our study: the breadth index of wild mink is bigger in farmed ones. Male indices of length and breadth (H23, H24) were less than females indices (relative skull size of females is bigger).

The wild animals are lighter and shorter than farmed ones (these differencies can derive from feeding imbalances). The weight of the internal organs of wild mink is lighter too, but their relative heart index is greater. The sex dimorphism of external and internal parameters was established too, but liver and kidney indices of females are greater than of males.

The same investigation of mustelids revealed the optimal craniological parameters for discriminant scores: for American mink – from two (dental length and length of the first molar) to twelve (Wiig & Lie, 1980; Wiig, 1986); the greatest significance in discrimination of skulls according to sex is expressed by cranial capacity, the width at the zygomatic arches, the greatest width of the neurocranium (Kobrynczuk and Roskosz, 1994); for American martens – the total skull length, width of the canine tooth and length of the canine root were most accurate for sex determination (Pool, *et al.*, 1994). Univariate analysis of variance found highly significant sexual dimorphism in nine skull measurements of otter from different regions of Europe (Lynch *et al.*, 1996).

The uniqueness of the Commander Island American mink population lies in its homogeneous genetic origin ; this factor excludes the influence of all others except natural selection. It is very early to speak about evolution in the wild Bering Island mink population, but we think that this study confirmes the opinion of some researchers that the morphology of mustelids can change rapidly in insular settings (e.g. the geographic isolation and unique selective regime of *Martes americana* on Queen Charlotte Island ; Giannico & Nagorsen, 1988)

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Note on status and foraging of the Pantot or Palawan stink-badger, *Mydaus marchei*

Hans KRUUK

Introduction

This paper describes some field observations on status and habitat utilization of the Palawan stink-badger or Pantot (*Mydaus marchei*) in the Philippines (Fig. 1 *see back cover*).

The animal that is called pantot (or sometimes skunk) in the Philippines is a small badger, 30-40 cm long (maximum 46 cm, Long & Killingley, 1983) with a short stumpy tail of some 4 cm. It weighs 2-2.5 kg, and the shape of its body and head is somewhere between that of a Eurasian badger and a small pig. It is covered in short, dark brown or black fur, with a large white or light yellow patch on its head. The rather long and hairless snout is distinctly pig-like, and it has small, round ears. Its hind quarters are rounded. The front feet have long, blunt claws. The species is listed by IUCN as 'vulnerable'.

The only previous field information on the pantot is described in a short note by Grimwood (1976), who found the animal to be common on the islands of Palawan and Busuanga. Little is known of its foraging and habitat selection, and there is no published information on its behaviour, or on its more recent status.

Area

The pantot occurs only in the Philippines (Heaney *et al.*, 1998), on the three Calamian islands of Palawan (14,900 km²), Busuanga (390 km²) and Calauit (24 km²), a total area of no more than one third of the size of the Netherlands. This is the smallest geographical range of any of the badgers, and one of the smallest of all species of carnivore.

Palawan is about 425 km long, and consists of a central range of densely forested mountains, with coastal plains dominated in many areas by rice paddies. The population of some 650,000 people is expanding at a rate of 3.9% p.a. (Anon., 1998), and agriculture is expanding in parallel, at the cost of natural vegetation. Busuanga is more uniformly hilly, with fewer rice fields but also less remaining natural forest; the population of about 16,000 people is expanding at a rate of 7.6% p.a. Thus, the small geographical range of the pantot is likely to see substantial changes in habitat in the near future.

Data were collected on the pantot in southern Palawan (near Aborlan, 118°29´E, 9°25´N), and on south-east Busuanga (120°10´E, 12°7´N), during February 1999.

Observations

The pantot is almost exclusively nocturnal, and direct observations were made by torch light between 21.00h and 01.00h. The animals responded to torch light only within a few metres distance. In addition, the wet muddy habitat of the animals made it possible to follow their tracks and find their diggings in daytime. Tracks of the pantot are readily recognizable because of their plantigrade shape with clear badger-like clawmarks in front, and their size (3-3.5 cm width, Fig. 2). The animal walks with left and right feet quite far apart, the hind feet falling into the step of the front feet.

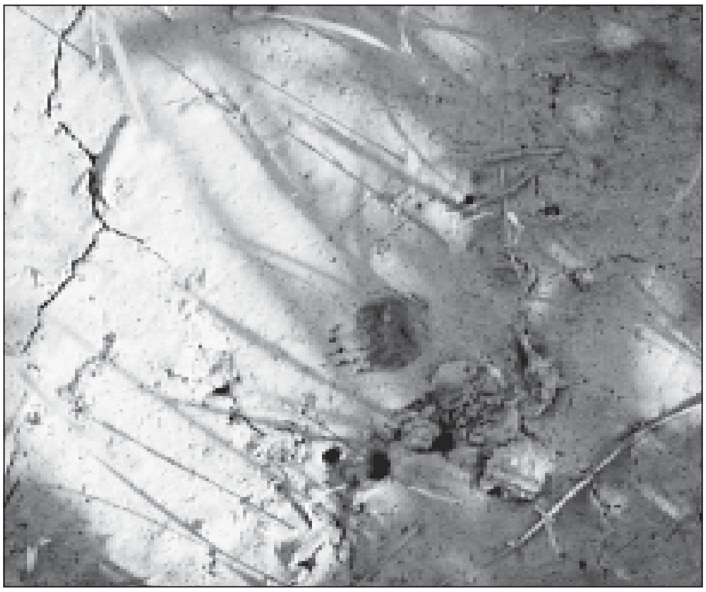

Fig. 2. Print of forefoot of the Pantot. The width is 32mm. Photo: H. Kruuk

The species is remarkably tame, and it responds to human presence rather like a European hedgehog by first freezing, then after several minutes quietly wandering off before continuing with foraging. If harassed (e.g. by dogs, or when hit by a vehicle), the pantot ejects an anal gland secretion over a distance of one metre or more (Grimwood, 1976); I did not observe this, but local farmers assured me that one could smell this pungent excrete even a kilometre away, and for this reason both people and domestic dogs have great respect for the animal. Because of its defense it is one of the very few species in Palawan that is not readily eaten by people. All informants described the pantot as 'common' on both Palawan and Busuanga.

Grimwood (1976) comments on the lack of aggression of the pantot, and it does not bite even when touched with a stick or picked up. It appears to rely totally on its chemical defense.

When foraging the pantot meanders quietly and slowly, grubbing around on the surface or in the top layer of soil with its pig-like snout, occasionally using its long claws to scratch up a small prey. Tracks that I followed over an accumulative distance of about 2 km connected an estimated 150 sites where the animals had dug small pits to catch invertebrates, each pit 1-6 cm deep, occasionally much deeper. Often the animals foraged on muddy soil covered with a thin layer of water, typical for rice paddies. In several places the pantots churned up an area of 1-2 m², a behaviour similar to that of wild boar though on a much smaller scale.

The main prey (direct observation and from the animal's tracks) consisted of small fresh-water crabs, and various insects such as molecrickets (*Grillotalpa sp.*). One scat found on a pantot track contained only small beetles.

Where the pantot was foraging in rice paddies I also found tracks of the Short-clawed otter (*Aonyx cinerea*), similarly foraging on crabs in the same places, as previously observed in Thailand (Kruuk *et al.* 1994).

During the observation of one pantot, the animal after finishing with foraging dug a den in a dam (bund) between rice paddies, taking less than five minutes to dig deep enough to be totally out of sight, and it stayed there. A similar use of 'instant dens' has been noted also for the Honey badger (*Mellivora capensis*, Kruuk & Mills 1983).

All the observations on foraging of the pantot were made on rice paddies, or on natural, damp grassland, or on open damp soil along streams. Clearly the animals made extensive use also of neighbouring scrub, at least for shelter and possibly also for foraging, but there is little doubt that paddy fields and other damp open areas are the major foraging sites. Paddy fields close to scrub areas were used more often than rice fields surrounded only by other paddies.

Discussion

The pantot's foraging behaviour, consisting of rooting for invertebrates in damp or submerged vegetation types, has enabled the species to adapt to the changing agricultural landscape throughout its range, and it is common. The extensive rice paddies everywhere, with their abundant invertebrate life, provide an excellent foraging habitat for the species, and it has benefitted from the expanding rice cultures in the same way as the Eurasian badger (*Meles meles*) benefitted from man-made pastures in western Europe (Kruuk, 1989).

The pantot is also not under threat because of persecution, being well able to defend itself. Despite the relatively small geographical range of this Philippine endemic, therefore, there seems little justification in maintaining the status of 'vulnerable' for the Palawan stink-badger.

Acknowledgements

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Red List of Threatened Species

The last hard copy of the *IUCN red list of threatened animals* was published in 1996. From now on a centralised version of the Red List will be maintained as a *non-public database* which will be updated continually as information is provided by recognised Red List Authorities. A *public database* will also be maintained, which will be available on the World Wide Web, to be updated annually. This will be the official IUCN Red List of Threatened Species.

The transfer of new information from the non-public database to the Web will be done once a year and this update will incorporate all changes made during the previous year. A table indicating all changes from the List of the previous year will also be made available on the Web.

For the 2000 Red List all changes, corrections, additions, etc. should be submitted to the Red List Programme Officer by 30 June 2000. For the 2000 List we would like to include documentation on habitats, major threats, and overall population trends for each species.

In the April 1988 number of *Small Carnivore Conservation* (18:22-23) we published a list of all the Mustelidae, Herpestidae, Viverridae, and Procyonidae mentioned in the *1996 IUCN Red list of threatened animals*.

If anybody feels that he/she has any relevant information on one or more of the species (or subspecies) mentioned in the above mentioned list he/she is very welcome to contact the Red List Authority for Mustelids, Viverrids & Procyonids:

Harry Van Rompaey, Jan Verbertlei, 15,
2650 Edegem, Belgium
E-mail: Harry.VanRompaey@ping.be

E R R A T U M

In number 21 on page 11: The central part of Russia (second paragraph)... "in general within the territory of the former USSR is 30-50 thousand individuals" should read '... 30-35 thousand individuals

A regional collection plan for mustelids in Europe

Leif BLOMQVIST [1] and Tiit MARAN [2]

Introduction

Zoos today are evolving from animal collections towards institutions playing an active role in species conservation through education, research and support of *in situ* projects. It is therefore generally accepted to include long-term development plans which also contain institutional collection planning. Regional zoo associations are well placed to identify the strengths of zoos within their own regions and can draw attention to conservation priorities and requirements for different breeding programmes. Simultaneously as the number of breeding programmes for endangered species (EEP = Endangered Species Breeding Programme) within the *European Association of Zoos and Aquaria (EAZA)* during the last years has shown a dramatical increase, the need for organised collective planning following conservation requirements on regional as well as on a global scale, is considered to be of primary significance. One of the *Taxon Advisory Groups' (TAG)* major responsibilites within the EEP programmes, is to evaluate the regional carrying capacity and recommend how the available space should be used for their taxon. This planning process results in the development of a *Regional Collection Plan (RCP)*.

The EEP *Small Carnivore TAG (SCTAG)* has recently been divided into four different sub-groups (Glatston & Robinson 1998), each of which will develop a proposal for their specific taxon. The presentation below informs about the proposal of a RCP for mustelids kept in captivity within the European region.

Why should more attention be paid to mustelids ?

The mustelids are the most diverse group of carnivores, and can be found in all continents except Australia and Antarctica. The members of this family are consequently adapted to most diverse habitats. Due to their secretive lifestyle, mustelids, however, belong to the least known carnivores of the world. Several species have not even been properly described by science and many may disappear before studied in detail. Although mustelids have never played such a prominent role in man's culture as many other carnivores, some species are still significant in economical terms. Due to a lack of experience with mustelids, they are still considered unattractive zoo animals which are difficult to keep and which often tend to exhibit stereotypic patterns of behaviour. With some exceptions, they are therefore rarely seen in zoos. Provided with attractive enclosures which can be constructed for much lower costs than for most of the other carnivores, mustelids can, however, be most attractive zoo animals. The mustelid sub-group therefore recommends the enhancement of public interest in mustelids and the promotion of their exhibition. The primary focus on mustelids is currently to acquire more basic information through captive breeding in order to gain more knowledge about their conservation requirements. There is also an urgent need to contribute to initiating surveys on the status of mustelids in several tropical regions like Indonesia. We therefore suggest that the European zoo community should provide more space for threatened mustelids and to invest in *ex situ* and *in situ* activities for the whole family.

Criteria used for taxon priorisation within the mustelid sub-group

A number of criteria were involved in the collection planning process and various factors were given different weights. The criteria were elaborated on the ground of the following four basic considerations:

- * ***genetic uniqueness of the (sub)species***
- ** ***principal vulnerability of the (sub)species***
- *** ***endangerement of the (sub)species***
- **** ***level of responsibility of the European region***

Five criteria were defined and used for prioritisation. Criteria like their status in the wild, as well as their endemism to the European region, were determined to be of greater importance in the process of prioritisation, and a weighted scale was therefore generated for the criteria mentioned below (Table 1).

For taxonomy, the mustelid sub-group followed the systematics set out by Wilson & Reeder (1993). The Action Plan for the Conservation of Mustelids and Viverrids (Schreiber *et al.,* 1989), the IUCN Red Data Book (IUCN, 1996), the draft of the CAMP for Small Carnivores (Wirth *et al.,* 1993), as well as The Mammals of the USSR (Heptner *et al.,* 1967), were used as information sources of the species' wild status and habitat utilization.

1. Species/Subspecies (score 0-1)

If the whole species is considered to be under conservation concern, it was given a higher rank than if only one subspecies is threatened while other suspecies might be regarded as safe:

- *Score **0** - only a specific subspecies is under conservation concern;*
- *Score **1** - the whole taxon is under conservation concern.*

2. Wild status (score 0-6)

The IUCN Red List (1996) consists of a review of relevant information on the wild status of the mustelid taxa. The Mustelid working group assessed the vulnerability of mustelids using the following six main categories:

- *Score **0** - the taxon is considered Secure when not considered threatened;*
- *Score **2** - the taxon is considered to be at a Lower Risk because its range area is restricted;*
- *Score **4** - the taxon is regarded as Vulnerable when facing a probability in the medium-term future;*
- *Score **5** - the taxon is regarded as Endangered when facing a high probability of extinction in the near future;*
- *Score **6** - the taxon is regarded as Critically Endangered when facing a high probability of extinction in the immediate future.*

3. Taxonomic uniqueness (score 0-1)

A concept of ranking species on the basis of their taxonomic uniqueness, giving monotypic genera a higher conservation priority than multi-species genera, was agreed upon. If therefore a taxon was unique at the genus level, it was given a higher score than if not unique.

- *Score **0** - Not unique*
- *Score **1** - Unique*

Species / Subspecies	Subspecies/ species (0 – 1)	IUCN Red List (0 – 6)	Taxonomic uniqueness (0 – 1)	Habitat uniqueness (0 – 1)	Reg. Importance (0 – 3)	Total Score	EEP Captive Status and Management Recommendations. Number of collections in brackets
European mink** *Mustela lutreola*	1	5	0	1	3	10	28.43.8 (11). Continue with EEP programme. Expand population to +400 animals. Support: research on behaviour, demography and genetics; in situ conservation. Encourage holders to maintain >10 animals
European marbled polecat *Vormela p. peregusna*	0	4	1	1	3	9	3.3.0 (3). Establish an EEP and expand population. Founders of nominate subspecies needed. Support in situ conservation. Investigate validity of subspecies.
Wolverine** *Gulo g. gulo*	0	4	1	1	3	9	16.25.0 (14). Continue EEP programme and expand population to + 250. Phase out animals of unknown origin and recommend holders to keep nominate form only. Investigate validity of subspecies. Support in situ conservation. Encourage genetic research of free-ranging population.
Pine marten *Martes martes*	0	0	0	1	3	4	34.27.3 (33) May be regionally managed for educational purpose. Reduce the population in favour of more unknown species (e.g. *M. flavigula*).
European polecat *Mustela putorius*	0	0	0	0	3	3	54.48.24 (29). May be regionally managed for conservation and education.
Steppe polecat* *Mustela eversmanni*	0	0	0	1	2	3	15.16.25 (5) May be kept for educational purpose. Taxonomic research needed.
Sable *Martes zibellina*	0	0	0	1	2	3	3.4.0 (3) Expand population for educational purpose, new founders needed.
Siberian weasel *Mustela sibirica*	0	0	0	0	2	2	5.7.2 (1). Kept in range countries for education.
Stone marten *Martes foina*	0	0	0	0	2	2	32.36.5 (34). Reduce population in favour of more unknown species (e.g. *M. flavigula*). May be kept for educational purpose.
Yellow-throated marten* *Martes flavigula*	0	0	0	0	2	2	1.3.0 (1) Expand population for educational purpose and behavioural research. Support captive breeding as pilot studies for conservation breeding of Nilgiri (*M. gwatkinsii*) and Taiwan martens (*M. f. chrysospila*).
Honey badger *Mellivora capensis*	0	0	1	0	1	2	2.3.0 (2). Phase out from the region.
Badger Meles meles	0	0	1	0	1	2	47.51.13 (52). Reduce population in favour of higher ranked large-sized mustelids (e.g. *Gulo gulo*). May be locally managed for conservation and educational purpose.
Stoat *Mustela erminea*	0	0	0	0	1	1	7.4.0 (3). May be kept for educational purpose.
Weasel *Mustela nivalis*	0	0	0	0	1	1	3.2.1 (3). May be kept for educational purpose.
American mink *Mustela vison*	0	0	0	0	1	1	11.12.14 (9). Not recommended to be kept in region. Phase out in favour of *M. lutreola.*
American marten *Martes americana*	0	0	0	1	0	1	1.0.0 (1). Phase out in region.
Fisher *Martes pennati*	0	0	0	1	0	1	1.1.0 (1). Phase out in region.
Tayra* *Eira barbara*	0	0	1	0	0	1	1.1.0 (1). Phase out in region in favour of *M. flavigula.*
Lesser grison *Galictis cuja*	0	0	0	0	0	0	2.2.0 (1). Phase out in region.
Zorilla *Ictonyx striatus*	0	0	0	0	0	0	4.5.0 (5). Phase out in region.
North-african striped weasel *Ictonyx libyca*	0	0	0	0	0	0	2.2.0 (2). Phase out in region.
Striped skunk *Mephitis mephitis*	0	0	0	0	0	0	45.42.0 (32). Reduce substantially the population in favour of higher-ranked mustelids (e.g. *V. peregusna*) May be kept for educational purpose.

** Mustela eversmanni amurensis - VULNERABLE * Martes flavigula robinsoni - ENDANGERED * Eira barbara senex - VULNERABLE*
*** EEP & ESB managed*

Table 1. Priorities and management recommendations for mustelid population in EEP region.

4. Habitat uniqueness (score 0-1)

Species which are associated with a narrow spectrum of habitats, were considered more vulnerable to extinction than species, which dwell in a wide array of habitats and were therefore ranked higher than the latter.

- *Score **0** - taxon is distributed over a variety of habitats*
- *Score **1** - taxon is associated with a specific habitat*

5. Regional importance (score 0-3)

Taxa which are endemic to the European or Eurasian regions were more strongly emphasised than taxa found also in other continents. The relative importance of each mustelid taxon for the Eurasian region were therefore scored as:

- *Score **0** - not existing in Europe*
- *Score **1** - present in Eurasia, but also in other continents*
- *Score **2** - existing only in Eurasia*
- *Score **3** - endemic to Europe*

The sum of the above mentioned five scores gave an estimate of each species/subspecies' ranking within the region, as summarised in Table 1. Of the three highest ranking taxa, two already have an EEP status with existing breeding programmes (European mink & wolverine), while the third species, the European marbled polecat, is recommended to be elevated to the same status. Many of the taxa which are considered *Secure* in the wild and which are of less regional importance to the Eurasian region, are also kept in too small numbers to be viable on a long term basis, and they should therefore be phased out in favour of other higher ranking species or species which might have either regional importance or an educational value.

This RCP will naturally require periodic re-evaluation and modification in response to the changing conservation needs of mustelid taxa. At this stage of the evaluation, we have only considered mustelids currently kept in Europe. A future evaluation of threatened taxa which presently are not to be found in this region, should be provided to recommend the inclusion of new species management programmes into the Mustelid RCP.

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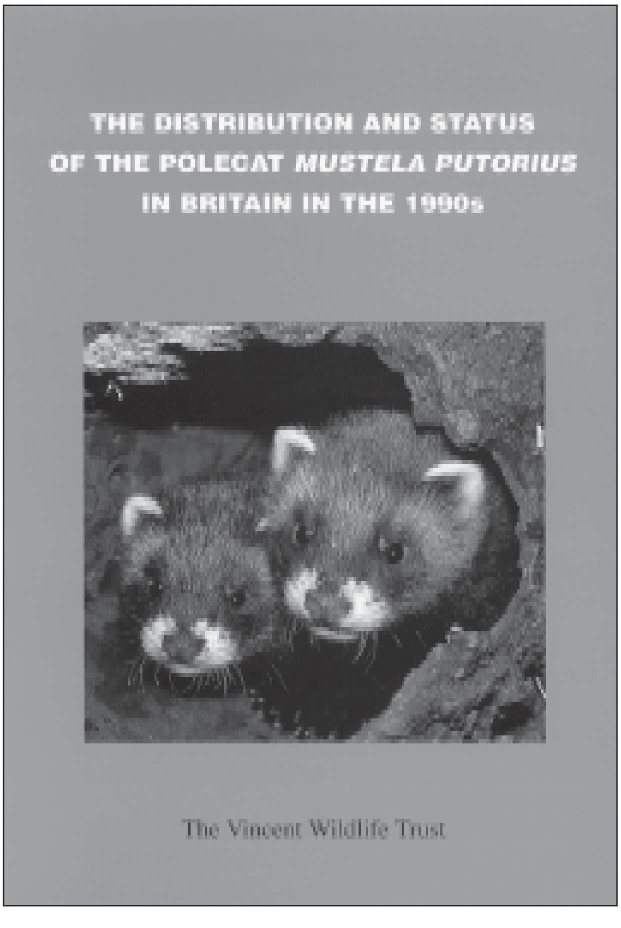
Recent publications



POLECAT IN BRITAIN

Birks, J. D. S. & Kitchener, A. C., eds. 1999. *The distribution and status of the polecat* Mustela putorius *in Britain in the 1990s.* London: The Vincent Wildlife Trust. 152 pp.

This report presents the results of five years of survey and research work on the polecat *Mustela putorius* in Britain. The main sections include a review of previous distribution surveys, the findings of a new distribution survey by The Vincent Wildlife Trust (VWT) from 1993-1997, the development of a method for monitoring polecats, a summary of the relationship between polecats and feral ferrets, and a description of recent studies on polecat ecology in Britain. The work reveals that the polecat's recolonisation of its former range is continuing, and the report makes recommendations for conservation action.

A population density minimum estimate of 38,381 was made for the whole of Britain. Separate estimates for Wales (17,691), Scotland (483), and England (20,207) are given. This suggests that polecats are now more numerous in England than in Wales, their main stronghold in the early 1900s.

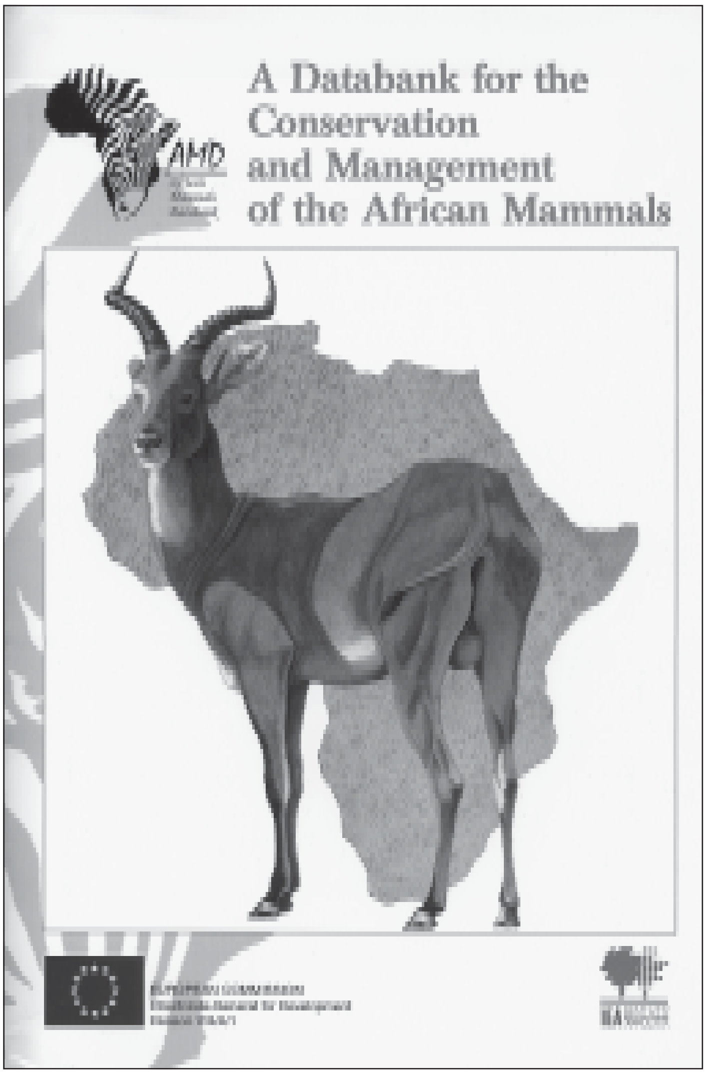
AFRICAN MAMMALS DATABANK

IEA. 1999. *A databank for the conservation and management of the African mammals.* Istituto di Ecologia Applicata. Via L. Spallanzani, 32, 00161 Roma, Italy. 1,149 pp.
E-mail: iea@mclink.it

In this work a broad approach is used to analyse the geographical ranges of the medium and large mammals of Africa, considering the continent in its entirety. Conservation priorities for animal species have long been based on the traditional Threat Categories adopted by the IUCN Red Data Books. Although the IUCN lists have been fundamental in identifying the species most in need of conservation support, a tool is required to place this information into the context of spatial dynamics and to enable the comparison of priorities on a continental scale - beyond the limits of national priorities and opportunities.

Information on the distribution patterns is currently very poor for most of the African species and in order for the new IUCN Threat Category system to fully exploit its capabilities the global distribution range of each species must first be analysed. The project was designed to collect, store, organise and pre-analyse data for distribution to the community of institutions and individuals worldwide concerned with the design and implementation of conservation projects in Africa.

The GIS (Geographical Information System) technology provides a powerful tool to store and analyse data for the identification and evaluation of conservation actions.



A total of 281 species, belonging to 12 orders and 28 families are included in the data bank. All species belonging to the orders of Primates, Carnivora, Perissodactyla (exception see below), Hyracoidea, Tubulidentata, Artiodactyla, Pholidota, and Lagomorpha are included. Although small, Macroscelidea, considered of particular conservation concern, are also included. Seven species of Rodentia, three species of Tenrecidae not endemic to Madagascar, and the entire family of Erinaceidae are included. Three notable species are excluded, both rhinoceros species and the elephant. The two species of rhinos because data on the last few areas in which they are found are being kept from the public. The elephant was excluded because a detailed database is kept in Nairobi by the IUCN/SSC Elephant Specialist Group.

BOVINE TUBERCULOSIS AND BADGERS

J. Bourne, C. A. Donnelly, D. R. Cox, G. Gettingby, J. McInerney, I. Morrison, & R. Woodroffe. 2000. *An epidemiological investigation into bovine tuberculosis.* 2nd Report. London : Ministry of Agriculture. (www.maff.gov.uk/tb)

The second interim report of the Independent Scientific Group provides a useful update on the implementation of the 1997 Krebs Report recommendations. The scope of the programme has been greatly extended, in order to attempt to arrive at a scientifically robust, cost-effective, and sustainable policy to control or ultimately eradicate bovine TB in cattle. The government's five point strategy is hence aimed at protecting public health, possible vaccines for cattle or badgers, research into transmission of TB, and the twin aspects of cattle management and the badger culling trial in 10 triplet study areas to ascertain the contribution of badgers to further cattle herd breakdowns and whether culls are a realistic local option for minimising risk. Blanket culls are ruled out as politically unacceptable. Cattle husbandry risk factors are being studied through the improved TB 99 questionaire surveys which are more rigorous than the previous TB 49 forms which attempted to identify the source of TB in herd outbreaks.

Clearly, this holistic approach will eventually produce answers to formulate a better TB control policy. As an academic exercise it is commendable, albeit according to some, about 20 years too late ! And neither current cattle policy nor the Bourne badger cull itself in a mere 2,000 km^2 will solve the current rise in cattle TB. From a low point of 89 TB herds and 600 cases in the late 1970s, there are now some 800 new herds and 7,000 cases and TB is back to 1960s levels, apart from having spread from tiny southwest pockets to an area from the Midlands to Cornwall. GB had a textbook success policy up until the mid-70s, and it will be necessary to go back to annual testing and movement bans into TB-free areas in order to bring TB back under control.

Sadly, the Report cites two key Irish studies without however appreciating why they underpin earlier successes (*Vet. Rec.* : Neill 1988, 123:340 and McIlroy 1986, 118:718). Speed of disease development depends on dose of bacilli, such that by natural transmission (low dose) whilst on annual tests 73% of cases have lung lesions, over half the lesions are under 1 cm diameter and not very infectious, by 11 months postinfection. That is why annual tests are the gold standard worldwide.

Martin Hancox

Assessing IUCN classifications of poorly-known species: Madagascar's carnivores as a case study

Luke DOLLAR

Introduction

The number of species in decline or under threat of extinction far surpasses that which we have sufficient resources to preserve (Pimm *et al*., 1995). In light of this problem, a subset of areas has been identified in which the largest number of threatened species is most heavily concentrated. These "biodiversity hotspots" feature high proportions of endemic species that are experiencing rapid habitat declines or other conservation threats (Myers *et al*., 2000). With an overall rate of endemism greater than 85% (Jolly *et al*., 1984) and less than 10% of its original standing forests remaining (Green & Sussman, 1990), Madagascar ranks at the top of hotspot priority lists.

Although the original extent of Madagascar's primary vegetation measured more than 594,000 km^2, only 59,038 km^2 of primary forest cover remains and only 11,548 km^2 of this area is currently designated for protection (Myers *et al*., 2000). Within this habitat remain large concentrations of taxa found nowhere else on Earth. All 32 primate species (Mittermeier *et al*., 1994), 95% of herpetofauna (Raxworthy & Nussbaum, 1997), >75% of plants (Myers *et al*., 2000), 53% of avifauna (Langrand, 1990), and 75% of carnivores (Table 1) found on Madagscar are endemic. The eight species (and one subspecies) of endemic carnivore found on Madagascar are the focus of the analysis presented in this paper.

Just as we must decide in which parts of the world we can most effectively concentrate our conservation capital, it is necessary to assess which species are of greatest conservation concern and need the most attention. The World Conservation Union (IUCN), has adopted a categorization system that weighs many factors including species' distribution, abundance, population and habitat trends, etc. to discern where our conservation focus needs to be most immediately concentrated (see IUCN, 1994; Baillie & Groombridge, 1996). However, we do not know as much as we would like about many species that are declining or nearing extinction. A problem thus arises in that the conservation status of many poorly known species may not be accurately assessed (Mace, 1995), if at all. This problem may be exacerbated by the non-uniform or inconsistent use of uncertain data (Regan *et al*., 2000).

Uncertainty in data may take the form of vague, indirect, or incomplete information about a species (Regan *et al*., 2000). The ideal response in dealing with uncertain data in species of conservation concern is to improve knowledge via initiation of direct research or improvement and extension of previous surveys or data collection. However, such action is not always feasible and can certainly not be immediately applied to all species of conservation concern. A lack of absolutely complete or rigorously quantified information about the ecology, habitat, or population trends occurring in organisms of conservation concern should not preclude us from attempting to discern how these species should be categorized. To help increase consistency and reliability in categorizing the conservation status of species for which we have uncertain, varied, or vague data, Akçakaya *et al.* (in press) present a method of dealing with uncertain data in a uniform manner. They describe a technique which implements the use of fuzzy set theory and allows for use and specification of uncertain data in a consistent manner.

The method proposed and used by Akçakaya *et al*. (in press), available in software form as *RAMAS Red List* (by Applied Biomathematics; Akçakaya & Ferguson, 1999), is here implemented in assessing the IUCN categorization and listing criteria for the endemic carnivores of Madagascar. Despite their position atop the food chain of a highest-priority biodiversity hotspot, there is a relative paucity of data on this assemblage. Most of the information on their distributions, ecology, population trends, and conservation threats is quite recent and is still being collected and disseminated (e.g., Albignac, 1973; Dollar, 1999*a,b*; Dollar & Dunham, in prep; Dunham, 1998; Goodman, 1996; Goodman & Pidgeon, 1999). An important but uncertainly-known assemblage in need of conservation attention, the Malagasy carnivores provide an excellent case study in which to use this new tool for categorizing species under the IUCN classifications of conservation status.

Methods

Using *RAMAS Red List* software (by Applied Biomathematics; Akçakaya & Ferguson, 1999), I assess the IUCN categorizations and listing criteria of the Madagascar carnivores and make recommendations on their conservation classification. For a thorough description of the techniques and mathematics implemented via the use of *RAMAS Red List*, the reader should refer to Akçakaya & Ferguson (1999) and Akçakaya *et al.* (in press). Data on a species' general biology, population size and trends, distribution and abundance, and habitat trends are incorporated in the classification of species under IUCN categories. *RAMAS Red List* not only affords use of ranges of "fuzzy" data sets, but allows for delineating the degrees of uncertainty in the data. As uncertainty within the data set varies, the amount of weight placed on and within the measures in question is reflected in the IUCN classifi-

Family	Subfamily	Genus	species	subspecies	common name	Current IUCN category	Listing criteria
Viverridae	Cryptoproctinae	Cryptoprocta	ferox		fossa	Vulnerable	B1+2e
Viverridae	Euplerinae	Eupleres	goudotii	goudotii	fanalouc	Endangered	B1+2c
Viverridae	Euplerinae	Eupleres	goudotii	major		unlisted	n/a
Viverridae	Euplerinae	Fossa	fossana		fanaloaka	Vulnerable	B1+2c
Herpestidae	Galidiinae	Galidia	elegans	3 pelagic ssp.	ring-tailed mongoose	unlisted	n/a
Herpestidae	Galidiinae	Galidictis	fasciata	striata	broad striped mongoose	Vulnerable	A1cd+2cd
Herpestidae	Galidiinae	Galidictis	grandidieri		Grandidier's mongoose	Endangered	B1+3b
Herpestidae	Galidiinae	Mungotictis	decemlineata		narrow-striped mongoose	Vulnerable	B1+2c
Herpestidae	Galidiinae	Salanoia	concolor	n/a	salano	Vulnerable	B1+2c

Table 1.

Area of known occurrence	Domain Size (ha)	C. ferox	E. g. goudotii	E. g. major	F. fossana	G. elegans	G. grandidieri	G. fasciata	M. decemlineata	S. concolor
RNI Andohahela	63100	1	1		1	10		10		
RNI Andringitra	31160	1	9		9	9		9		
RNI Ankarafantsika	60520	1								
RNI Betampona	2228	1			1	2		1		2
RNI Marojejy	60150	1			7	7		7		
RNI Tsaratanana	48622			1						
RNI Tsimanampetsotsa	43200	1					6			
RNI Tsingy de Bemaraha	152000	1								
RNI Zahamena	73160	3	3		3	3		3		3
NP Isalo	81540	1								
NP Mantadia	10000	7	7		7	7		7		
NP Masoala	210200	1	1		1	7		7		7
NP Montagne d'Ambre	18200	1	7		7	7				
NP Ranomafana	41600	4	4		4	4		1		
RS Analamerana	34700	1				7				
RS Ankarana	18220	1	7		7	7				
RS Andranomena	6420	1							1	
RS Anjanaharibe	32100	1			7	7		7		
RS Beza Mahafaly	600	1								
RS Foret d'Ambre	4810	1								
RS Kalambatritra	28250	1								
RS Manongarivo	35250	7	7		7	7				
RS Manombo	5020	1			8					
RS Perinet	810	1	1		1	7				
Reserve Analabe	7000	1							1	
Reserve Beranty	265	1								
Reserve Kirindy	10000	1							1	
Reserve Mananara	20000	1	1		1	7		1		1
Total Known Occupied Area (ha)	1099125	1050503	521700	48622	621193	650878	43200	543698	23420	305588

Table 2.

cation analysis (Akçakaya & Ferguson, 1999). By allowing the entry of a range of data with varying degrees of uncertainty, *RAMAS Red List* provides a means of quantitatively assessing the IUCN classification of a poorly-known species in a more uniform way. As this tool is applied in a re-evaluation of current Red List categorizations, listing criteria, and supporting data, the conservation status of uncertainly known species can be measured more consistently (Akçakaya *et al*., in press).

Current population sizes were estimated for those species for which home range data exist (*C. ferox*: Dollar *et al*., 1997 and unpub. data; *F. fossana*: Dollar, unpub. data; *G. elegans*: Britt, 1999 and Dunham, 1998; *S. concolor*: Britt, 1999). Area of occupancy was divided by known individual home range sizes (corrected for overlap) to estimate population size for each of the above four species. Where a variety of data estimates on species' area of occupancy or home range size exists, a set of uncertain "fuzzy" numbers incorporating the minimum and maximum values produced was entered into *RAMAS Red List.* As no direct quantitative population trend data were available for this analysis, trends or changes in population size over the past and next 10 years were extrapolated by correlating various published rates of habitat destruction (Green & Sussman, 1990) to current population size estimates. Population size and trends for the remaining five species of endemic Malagasy carnivore were not considered in this analysis owing to a lack of available data on these species' population or home range sizes.

Extent of occurrence, area of occupancy, number of subpopulations or localities, and degree of fragmentation are among the distribution and abundance data incorporated in classifying species into IUCN categories (Akçakaya *et al*., in press). Extent of occurrence is defined as the maximum convex polygon incorporating all known localities of occurrence for the species in question (IUCN, 1994). For the Madagascar carnivores that are known from more than a single or very few localities, this polygon comprises the majority of the area of habitat of particular type remaining. The maximum possible measure of extent of occurrence, based on measures taken from satellite images of particular habitat types in which the species in question occurs, was also incorporated into the data set's range of uncertain numbers. Specifically, Nelson & Horning (1993) estimate that Madagascar has 34,167 km^2 of rainforest habitat, 17,224 km^2 of spiny forest, and 6,697 km^2 of western hardwood forest remaining. Defined as the area within the "extent of occurrence" occupied by a species (IUCN, 1994), area of occupancy is a relatively smaller, more accurate measure of the area in which a species is extant. Minimum measures of area of occupancy and numbers of subpopulations/localities were tallied based on available information regarding known distributions of carnivore species within protected areas throughout Madagascar (Table 2).

With these data and estimates assembled for each species, all readily available information relevant and required for classifying species under IUCN categories was entered into *RAMAS Red List.* When information on a species is sufficiently comprehensive, an explicit IUCN categorization and listing criterion are proposed by *RAMAS Red List.* In cases where available data are too deficient or uncertain to make a specific classification recommendation, a range of potential IUCN categories is made by the program. These recommendations were then further examined according to the letter of the IUCN categorization criteria (IUCN, 1994; Baillie & Groombridge, 1996) before final recommendations for current classifications of the endemic Malagasy carnivores were made.

Results and discussion

The results produced by *RAMAS Red List* and final recommendations of IUCN categories and listing criteria for the endemic Malagasy carnivores are presented in Table 3.

Cryptoprocta ferox

Previously listed as Vulnerable, *C. ferox* (Fossa) was classified under this category because of a small extent of occurrence and a low number of fragmented localities containing a declining number of mature individuals (Baillie & Groombridge, 1996). The fossa is recommended for uplisting to Endangered based on estimates of a population size of < 2,500 mature individuals existing in fragmented areas in continuing decline. This new categorization proposed by *RAMAS Red List* is upheld.

Eupleres goudotii goudotii

E. g. goudotii (Fanalouc) was listed as Endangered in the 1996 IUCN Red List. This classification is upheld as valid under re-examination, but for different reasons. The fanalouc was previously justified as Endangered owing to an erroneously noted small extent of occurrence in a total of less than five fragmented locales experiencing continued decline. Upon further examination, it is apparent that the previous assessment of number of subpopulations was underestimated. Occurring in at least 11 known areas, the fanalouc would not classify for Endangered status under its previous listing criteria.

Using the data available, *RAMAS Red List* notes that the possible IUCN categories in which the fanalouc can be classified ranges from Vulnerable to Critically Endangered. The fanalouc is regarded as the least relatively abundant Malagasy carnivore in areas where it occurs (Albignac, 1973). Based on scant current literature (Dollar, 1999*b)* and unpublished data (Dollar & Dunham, in prep; Dollar & Rakotoarison, in prep), it is recommended that the fanalouc's classification of Endangered be upheld based on a population estimated to number less than 2,500 individuals across fragmented localities in continuing decline.

Eupleres goudotii major

Previously unlisted under IUCN criteria, *E. g. major* is recommended for classification as Endangered because of an area of occupancy of less than 500 km^2, comprised of only one confirmed locality (Hawkins, 1994) and continued decline of its known habitat.

Fossa fossana

F. fossana (Malagasy civet) was previously listed as Vulnerable owing to an area of occupancy of less than 2,000 km^2 and continued decline in the area, extent, and quality of its known habitat (Baillie & Groombridge, 1996). The classification of the Malagasy civet as Vulnerable is upheld in this analysis, but the criteria for listing are different than previously reported. Although the estimate that affords this categorization is at the extreme end of suspected population decline (as extrapolated from reported deforestation rates), it is nevertheless recommended that the Malagasy civet be classified as Vulnerable. This is due to a suspected population reduction that falls in a range larger than or equal to 20% over the past 10 years accompanied by a decline in the extent and quality of its habitat. This suspected decline is exacerbated by the fact that the Malagasy civet is often trapped for food (pers. obs.) and that it is the most direct competitor of the widely-distributed, non-endemic Small Indian Civet (*Viverricula indica*).

Galidia elegans

Unlisted in previous IUCN categorizations of the endemic Malagasy carnivores, *G. elegans* (Ring-tailed mongoose), is here recommended for classification as Vulnerable for many of the same reasons as the Malagasy civet. Distributed in almost the exact same localities as the Malagasy civet, the ring-tailed mongoose likely suffers from the same habitat (and therefore population) declines and competition pressures from introduced competitors – which include feral cats (*Felis silvestris*) and dogs (*Canis familiaris*) as well as *V. indica*.

Galidictis fasciata

As in 1996, *G. fasciata* (Broad-striped mongoose) is recommended for classification as Vulnerable. Although *RAMAS Red List* produced only a range of potential categories for classification (most certainly because of a lack of available population data) ranging from Vulnerable to Critically Endangered, the distribution, population and habitat pressures faced by the broad-striped mongoose are largely the same as those experienced by the Malagasy civet and the ring-tailed mongoose. Given these similiarities, the broad-striped mongoose is also classified as Vulnerable under similar listing criteria.

Galidictis grandidieri

Because of its limited area of occupancy and confirmed existence at only one locality and suspected continuing decline in its habitat, *G. grandidieri* (Grandidier's mongoose or Giant striped mongoose) was classified as Endangered in the 1996 Red List. Although *RAMAS Red List* suggests a classification as Critically Endangered, no listing criteria can be discerned to confidently uphold this change in listing. As a result, the previous recommendation categorizing Grandidier's mongoose as Endangered is upheld.

Mungotictis decemlineata

Although known from three localities, *M. decemlineata* (Narrow-striped mongoose) has the smallest minimum estimated area of occupancy incorporated in this analysis. *RAMAS Red List* recommends a change in categorization to Critically Endangered from the previous listing as Vulnerable, but data are too uncertain to afford identification of specific listing criteria to support this extreme change. A listing of Endangered is recommended for the narrow-striped mongoose (A. Dunham, pers. comm.) owing to a limited extent of occurrence and area of occupancy accompanied by a continuing decline in habitat.

Salanoia concolor

As with the Malagasy civet, this analysis upholds the previous listing of *S. concolor* (Brown-tailed mongoose or Salano) as Vulnerable, but under different listing criteria. Originally listed as Vulnerable because of its area of occupancy of less than 2,000 km^2 and continued decline in the area, extent, and quality of its known habitat (Baillie & Groombridge, 1996), this area of occupancy is here found to be larger than previously calculated. New information on the suspected decline in population as extrapolated from deforestation rates, exacerbated by competition from non-endemic competitors, leads to a recommended upholding of the salano's categorization as Vulnerable.

Species	Current IUCN category	Listing criteria	RAMAS Categorization	RAMAS listing criteria	Recommended classification	Recommended listing criteria
C. ferox	Vulnerable	B1+2e	EN	C2a	Endangered	C2a
E. g. goudotii	Endangered	B1+2c	VU-CR	range: none determined	Endangered	C2a
E. g. major	unlisted	n/a	CR	range, none determined	Endangered	B1+2bc
F. fossana	Vulnerable	B1+2c	VU	A1cde; D2	Vulnerable	A1cde
G. elegans	unlisted	n/a	VU	A1ce; D2	Vulnerable	A1ce
G. fasciata	Vulnerable	A1cd+2cd	VU-CR	range; none determined	Vulnerable	A1cde
G. grandidieri	Endangered	B1+3b	CR	range; none determined	Endangered	B1+2
M. decemlineata	Vulnerable	B1+2c	CR	range; none determined	Endangered	B2bc
S. concolor	Vulnerable	B1+2c	VU	A1ce, C1+2a, D2	Vulnerable	A1ce; C1

Table 3.

Conclusions

Too little data are still often too little data to be effectively used in listing many species under IUCN categories under the current listing criteria. This is exemplified by the non-identification of specific listing criteria by *RAMAS Red List* in the above analyses of *E. g. goudotii, E. g. major, G. fasciata, G. grandidieri, and M. decemlineata.* In fact, only a range of listing categories could be recommended for *E. g. goudotii* and *G. fasciata* based on the data presented to *Red List.* More research on the basic ecology, distribution, and abundance of these four species (and one subspecies) is strongly needed.

RAMAS Red List and the methods proposed by Akçakaya *et al*. (in press) do not provide us with a "silver bullet" for eliminating the difficulties and constraints of making IUCN classifications under uncertainty. Combined with expert opinion and continued acquisition of more reliable data on species of conservation concern, however, the analysis products from *RAMAS Red List* can help us more accurately and consistently assess the IUCN classifications of species for which we have inconclusive information.

At present, seven endemic Malagasy carnivores are included on the IUCN Red List: five Vulnerable and two Endangered. Based on current analyses, nine Malagasy carnivores should be classified under IUCN Red List parameters. Three species previously listed as Vulnerable (*F. fossana, G. fasciata,* and *S. concolor*) are upheld in this position. Two species previously listed as Vulnerable (*C. ferox* and *M. decemlineata*) should be reclassified as Endangered. *E. g. goudotii* and *G. grandidieri*, previously classified as Endangered, are upheld in their previous classification. Two new Malagasy carnivores, *E. g. major* and *G. elegans* are introduced for IUCN classification as Endangered and Vulnerable, respectively.

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News from the 18th Mustelid Colloquium

The 18th Mustelid Colloquium took place last September at Schloss Zeillern, a Renaissance castle located in a small village of lower Austria. The topic of the Colloquium was to bring together all the people that, for practical work, research or study, are interested in mustelid species.

A major part of the contributions to the discussions, as either oral comunications or posters, came from central-eastern Europe and at least half of the comunications were in German (German and English were the languages of the symposium). This is a brief summary of the principal arguments mentioned. The *18th Mustelid Colloquium Abstracts (1999)* contains the contributions cited.

European badger *(Meles meles)*

Sett use, territory size and sociality were some of the topics of the oral comunications and posters presented at the *18th Mustelid Colloquium*, concerning the European badger (*Meles meles*).

A research group of the University of Barcelona (E) is carrying out a long-term survey of a badger population in Collserola Park, near the Catalan town. A census of the setts was carried out, with the help of several volunteers, on the whole area. Setts use was studied following radio-tagged animals [Bonet-Arboli V. *et al.* - Badger (*Meles meles*) sett use and characteristics in a Mediterranean habitat. Comunication].

Radio-tracking was also the method used to map the diurnal resting sites in a population in Mid-Jutland (DK) [Van Teeffelen A. *et al*. - Diurnal resting of European badger (*Meles meles*) in Denmark. Poster (not in the abstracts)], and to study a low density population in Switzerland in a multi-purpose still running project [Do Linh San E. - Dispersal and other movement patterns of the European badger (*Meles meles*) in a low density population: a radio-tracking and genetic study. Poster (not in the abstracts)].

A study regarding the impact of roads crossing badgers territories was carried out in Denmark, using bait marking method and an analysis of the footprints detected in several sites of the study area [Harder A.M. - A study of badgers (*Meles meles*) and roads. Comunication].

The WCRU of the Oxford University (UK) presented a study on sociality in badgers using a GIS analysis [Johnson D.D.P. *et al*. - A GIS Analysis of Social Spacing in the European Badger (*Meles meles*) in the UK. Comunication]. First results of this interesting approach seem to contradict the prediction of RDH (Resource Dispersion Hypothesis), which is currently the accepted explanation for social grouping in badgers. The research group will make further investigations about this.

Also other aspects of badger biology were debated: food, age determination and diseases [Bauder, B. *et al*. - Histoplasmosis in badger (*Meles meles*) in Austria. Poster; Leyssac N. & Madsen A.B. - Age determination of badgers from dentine lines. Poster; Matyastik T. & Bicik V. - Contribution to knowledge of food spectrum of European badger (*Meles meles*). Comunication; Matyastik T. *et al*. – Occurrence of European badger (*Meles meles*) in Northern Moravia. Poster].

European mink *(Mustela lutreola)*

European mink is a threatened species, and the introduction of the American mink (*Mustela vison*) has only made things worse. During the *Colloquium*, several interesting contributions explained the situation in East Europe: status of the species and plans for conservation [Festl W. – Building-up of a captive breeding stock for the European mink (*Mustela lutreola*) in co-operation with scientists and wildlife parks. Comunication; Gotea V. – First field survey of the European mink in Danube Delta, Romania. Comunication; Katchanovsky V. – The threat to European mink (*Mustela lutreola* L.) in the center of its present area (Tver region, Russia). Poster; Maran T. – European mink conservation efforts in Estonia. Comunication].

Otter *(Lutra lutra)*

Many genetic studies have been carried out to find out the best conservation measures for the otter [Herzog S. – Monitoring the genetic variation of the European common otter (*Lutra lutra*), an indispensable precondition to any long-term conservation measure. Comunication]. In one of the studies presented the material for DNA-fingerprinting analysis has been achieved from fresh otter spraints [Jansman H. – Genetical and hormonal monitoring of otters by analysis of spraints. Comunication].

One field work pointed out the status of the species in Austria [Kranz A. & Polednik L. – Distribution, status and conservation of otters (*Lutra lutra*) in Lower Austria. Comunication]. Other aspects of otter ecology and biology, from the concentration of pesticides to the variations in mtDNA, to the development of cubs, were shown in several posters and discussed during one of the round tables (chairman: Claus Reuther).

Pine marten *(Martes martes)*

How do Pine marten react to the fragmentation of habitats? This is the problem faced in two works, in Germany [Allgöwer R. – Die Zerschneidung von Baummarder-Lebensräumen. Wie aussagefähig sind Umfragen? Comunication] and in Holland [Martens A. J. – Dispersal behaviour of the pine marten (*Martes martes*), a simulation of movement patterns. Comunication].

Polecat *(Mustela putorius)* and **Steppe polecat** *(Mustela eversmanni)*

These two species show a range overlap in the eastern part of Austria. The aims of the project presented at the Colloquium are: To find out if hybridization occurs between the two species; if yes, to what degree, in which regions and how to recognize the hybrids? The authors provide a morphometric approach and a genetic one, with species-specific molecular markers [Suchentrunk F. *et al*. – Introgressive hybridization between *Mustela putorius* and *M. eversmanni* in Eastern Austria? A project plan and first results. Comunication].

Others

Many other topics ave been discussed during the round-tables and other species have been the subject of comunications and posters: Stone marten, Weasel and Stoat and the Giant otter. I am sorry for mentioning only a part of the contributions to the symposium.

The appointment for the *19th Mustelid Colloquium* will be in 2000 on the Bodensee.

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Recent literature

Mustelids

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