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Note on the occurrence of parasites of the wild nutria (*Myocastor coypus*, Molina, 1782)

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Summary

We examined the endoparasites of wild nutria from the native region of South America. Individuals were infected with nineteen species, including Nematoda (82.0 %), Protozoa (46.1 %), Trematoda (33.3 %) and Cestoda (12.8 %). Coccidia (*Eimeria* sp. or *Isospora* sp.), *Strongyloides myopotami* and *Trichuris myocastoris* were the most abundant and prevalent parasites. The diversity of parasite collected on individual hosts ranged from one to four species. There was no significant association between either the age or the sex of the nutria and the prevalence of parasitism, except that the number of infested nutria less than 1 year by Nematoda was significantly higher than in older individuals. Additionally, *Cryptosporidium* spp. and *Giardia* spp. were demonstrated in fecal samples, although scarcely. In general, the accessions were found in good bodily condition and carrying low parasite burdens. These numbers appeared insufficient to indicate gastrointestinal parasitism or parasitic disease.

Keywords: parasite; *Myocastor coypus*; nutria; Argentina; prevalence

Introduction

The nutria or coypu (*Myocastor coypus*) is a histricomorph rodent native of South America belonging to the *Capromydae* family (Catzeflis *et al*., 1995). This large semiaquatic herbivore has been introduced to many countries through meat production and fur-farming. In 1922 argentineans began raising nutria in captivity and this practice spread worldwidely but the species has been traditionally continued to be hunted in their natural range as a source of fur and meat (Vietmeyer, 1991; Martino *et al*., 2008). Nutria is not endangered in South America although its number and range have been reduced due to loss of habitat by intensive agricultural areas, road casualty, predation or overhunting (Gosling *et al*., 1988; IUCN, 2009). Wild nutrias are afflicted by numerous endo- and ectoparasites (Scaramella & Motti, 1988; Scheuring, 1990). Most of these are of little consequence; some may serve as vectors for zoonotic diseases, however, or cause clinical disease in young or immune-compromised individuals. Some information concerning the parasitological aspects of this farm-bred rodent is available, but very little data is present in the literature of free-ranging animals (Babero & Lee 1963; Martino *et al*., 1998). The present study was part of a continuing cooperative effort by the laboratories engaged to monitor the health status of this native rodent in Argentina. Thus, the objective of the present survey was to present some data on the occurrence and prevalence of endoparasites found in wild nutrias from their indigenous area.

Materials and methods

One hundred and eight nutria carcasses, were originated from mostly rural environments scattered throughout south east of the vast Buenos Aires province (37° 50' S, 57 ° 34' W) between december 2009 and june 2010. These pelted and frozen carcasses, obtained from local hunters or road kills, were submitted to us for examination. The age and sex was determined primarily from dentition, genital development, and the body length (Kinler *et al*., 1987). Animals were then categorized into two groups: immature (juveniles and subadults under 1 year of age) and mature (any adult animal at least 1 year of age). Physical condition was assessed from endogenous fat deposits and muscle mass. A general inspection at necropsy was performed, and isolation of helminths was attempted on the gastrointestinal tract (GI), and the major viscera. The stomach and intestines were opened separately in water, their contents removed and linings scraped. The larger helminths were collected directly by macroscopical examination, and the remainder of the GI

Table 1. Prevalence and mean intensity of parasites collected from nutria, 2009-2010

Parasite species (location)	No. collected (sex)	Immature (n = 46) P, MI (%)	Mature (n = 62) P, MI (%)	All nutria P (%)	*P*-value
Nematoda	32 (13M,19F)	17.6	12.0	29.6	0.049*
Heligmosomum sp. (SI)	5 (4M,1F)	0	4.6, 2.1	4.6	0.063
Strongyloides myopotami (SI, C)	29 (13M,16F)	9.2, 12.3	17.5, 7.0	26.7	0.245
Trichuris myocastoris (C)	15 (10M,5F)	5.5, 2.2	8.3, 4.1	13.8	0.546
Trichuris sp.*** (C)	2 (0M,2F)	0	1.8, 25.2	1.8	0.248
Capillaria hepatica (L, BD)	4 (1M,3F)	0.9, 36	2.7, 21.1	3.6	0.465
Capillaria spp.*** (B,T)	2 (1M,1F)	1.8, 2.0	0	1.8	0.248
Tricostrongylus colubriformis (SI)	6 (2M,4F)	1.8, 4.4	3.7, 11.9	5.5	0.558
Tricostrongylus sp.*** (ST,SI)	3 (1M,2F)	0.9, 2.0	1.8, 1.1	2.7	0.659
Trichinella spp.	0			0	
Cestoda	5 (2M,3F)	1.8	2.7	4.6	0.740
Taenia sp.*** (SI)	4 (2M,2F)	1.8, 19	1.8, 3.0	3.7	1.000
Rodentolepis avetjanae (SI, C)	1 (1M)	0.9, 2.0	0	0.9	0.364
Anaplocephala sp.*** (SI)	1 (1M)	0.9, 1.0	0	0.9	0.364
Hyminolepis octocoronata (SI)	2 (2F)	1.8, 2.0	0	1.8	0.248
Trematoda***	13 (5M,8F)	4.6	7.4	12.0	0.682
Dicrocoelium lanceolatum (L)	3 (1M,2F)	0.9	1.8	2.7	0.659
Dicrocoelium sp.** (PA)	1 (1F)	0	0.9	0.9	0.386
Fasciola hepatica (L)	12 (4M,8F)	3.7	7.4	11.1	0.509
Sporozoa***	24 (14M,10F)	14.8	9.2	24.0	0.382
Coccidia (*Eimeria* sp. or *Isospora* sp.)	18 (6M,12F)	5.5	11.1	16.6	0.267
Cryptosporidium spp.	4 (1M,3F)	0.9	2.7	3.7	0.465
Giardia spp.	2 (2F)	0	1.8	1.8	0.248

P - prevalence (number of animals infested / number examined expressed as a percentage); MI - mean intensity (the mean number of parasites per infested animal); M - males; F - females; ST - stomach; SI - small intestine; PA - pancreas; BD - bile duct; C - colon/cecum; T - trachea; B - bladder; L – liver; * Significant difference with 95% confidence limits; ** Unidentifiable; *** Numbers not determined

contents were washed in sieves of 500 μm and 100 μm mesh size. The helminth specimens isolated from the different viscera were preserved in 70 % ethanol and glycerol (9:1) and subsequently counted using a stereoscope. Nematodes were cleared in clove oil. Trematodes and cestodes were stained in acetoalum carmine, cleared in clove oil and mounted in Canada balsam. Identification was done according to Soulsby (1965), Dawes (1968), Verster (1969), Georgi (1974) and Scheuring (1990). Due to partial decomposition of the GI contents in some nutria, parasite identification could not always be made at species level. Fecal samples (0.05 to 0.15 g) were obtained from the rectum and examined for the presence of Sporozoa. The formalin-ether concentration method was employed to make fecal smears; these were stained with the modified Ziehl-Neelsen method for the detection of *Cryptosporidium* spp. oocysts (Jokipii *et al*., 1983). A 5 g fecal sample from rectum was also preserved in vials of polyvinyl alcohol fixative for subsequent trichrome staining and then examined for 15 minutes at 500x magnification for the presence of *Giardia* spp. cysts and trophozoites. A centrifugal sugar flotation technique (sp gr, 1.27) was used to demonstrate coccidian oocysts in a 1-g fecal sample (Allen & Ridley, 1970). Finally, 20 g muscle samples (principally tongue, masseter and diaphragm) were examined for parasitic larvae of *Trichinella* spp. by means of trichinelloscopy and the peptic digestion technique (Moretti *et al*., 2001). Infestation prevalences for each parasite species infesting animals by age and sex were compared by chi-squared analysis with Bonferoni adjustment. Prevalence is the percent of nutria infested, and mean intensity is the mean number of parasites per infested host following Bush *et al*. (1997).

Results

Nineteen species of parasites were found in 39 (36 %) of the 108 accessions examined, and sixty-nine individuals (64 %) were found without parasites ($P = 0.04$, odds ratio 0.57). Prevalence and worm burden intensities of the respective parasites in nutria are shown in Table 1. The mean physical condition ratings of nutria were mostly good. The bulk of the infested nutria (79 %) harbored ≤ 3 species of parasites, but 21 % harbored four to six species. Identified parasite species included Nematoda (in 82.0 %), Cestoda (12.8 %), Trematoda (33.3 %) and Sporozoa (24.0 %). Almost all specimens obtained were dead, and some nematodes, cestodes and trematodes were unidentifiable because of the poor condition of the specimens.

Out of the 39 infested nutria, 14 were males and 25 females ($p = 0.2$, odds ratio = 0.56), meanwhile 12 were immature against 27 mature ($P = 0.08$, odds ratio = 0.44). Juveniles appeared to be only significantly affected by Nematoda than adults. There were no other statistically significant differences between parasite infestation and age or sex.

Eight species of nematodes were demonstrated. Most worms were found in the small intestine, although some were recovered from the colon and cecum. The most abundant and prevalent parasites were *Strongyloides myopotami* and *Trichuris myocastoris*, collected from 29 and 15 hosts, respectively. Nine species of *Tricostrongylus* were found, but the material was poorly preserved in three cases and further classification must be based on new material. *Heligmosomum* sp., was represented by mostly immature specimens in the small intestine of adult nutria. All four animals infested with *Capillaria hepatica* had many such worms in the bile duct. Some decomposed specimens found in the bladder and trachea were considered to be *Capillaria* spp. (probably *Capillaria aerophila*) on account of body size, shape and morphology. In addition, *Capillaria aerophila* eggs were also identified in the feces of these accessions.

Four species of cestodes were found, but the hosts had only one or two species each. Half of these specimens were not identified at the species level because of their advanced state of decomposition. This was the case of a duodenum and jejunum obstruction due to *Taenia* spp. observed in an adult male which was emaciated and in generally poor condition. The intestine section was impacted by a large tangle of worms. In another cases, cestodes were either too difficult to disentangle or were macerated and had fallen into pieces.

Among Trematoda, *Fasciola hepatica* accounted for the bulk of the identified specimens. Identification of members of the Dicrocoeliidae family was based on their body size, location of two suckers, and egg sizes. They were represented by three mature specimens from the liver and bile duct, and another specimen occasionally recovered from the pancreas of a 5-year-old female.

No evidence of Acantocephala and *Trichinella* specimens was seen.

Eimeria myopotami and *E. nutriae* were the predominant species throughout the trial. Some oocysts were in poor condition and could not be identified. Only two animals out of the eighteen infested by coccidia, developed severe coccidial infections, with up to circa 20,000 oocysts/g of feces, but no signs of diarrhea were observed.

Five nutria were found to be infected with *Cryptosporidium* spp. Microscopically, up to four round, densely stained *Cryptosporidium* cysts (4 to 4.5 by 4.0 μm) were seen in the fecal samples from colon to rectum. Finally, fecal sample examination for *Giardia* spp. resulted in only two adult female nutria testing positive.

Discussion

Very little information is present in the literature on diseases of coypus in the wild. In fact, to our knowledge, there is no previous systematic report of parasites in free-range nutria from the south hemisphere, the indigenous region of this species. Coypus are susceptible to a number of parasitic diseases which have been well previously documented (Davis & Shillito, 1963; Scaramella & Motti, 1988; Scheuring, 1990). As the mean body condition of the animals studied herein was generally good, it is suggested that the population was not experiencing nutritional deprivation, nor a debilitating nature due to a heavy worm infestation. Moreover, the prevalence of nutria without signs of the presence of parasites was significantly higher than that of infested animals in our survey. Unfortunately, this low incidence of parasite infestation cannot be matched with other surveys because of the lack of baseline data based on large field samples. Perhaps, gastrointestinal tract investigation was sometimes hindered by post-mortem autolysis, and the impact of the real number of parasites in the affected nutria could not be assessed completely. The burden of parasites is influenced by many factors such as the host specificity, the presence of intermediate hosts or the proximity to other animals with which they could exchange helminth species (Williams & Thorne, 1996). Thus, the diversity of the parasitic fauna in nutria caught from this region seems lower than, for example, that previously reported from Babero and Lee (1961) in Louisiana a long time ago. Nevertheless, all parasites found here have been previously recorded in farm-bred nutria (Scaramella & Motti, 1988; Scheuring, 1990). *Strongyloides myopotami* and *Trichuris myocastoris* were the most prevalent Nematoda in this survey. Both can cause severe losses on farms, especially where the diet is inadequate (Pridham, 1966; Körner, 1985). *S. myopotami* is stated to be very difficult to detect at necropsy because it is very small (5 to 6 mm), is buried in the intestinal mucosa, and is coloured red with the host's blood (Davis & Shillito, 1963; Wenzel, 1982). Therefore, it might easily have been overlooked. *Heligmosomum* sp. was also observed here in the gastrointestinal tract, although in few numbers. Scarce information concerning the pathogenicity of this ascarid for the nutria is available (Babero & Lee 1963; Scaramella & Motti, 1988).

Herein, other nematodes have been found almost only incidentally in apparently healthy animals. Our efforts to demonstrate *Trichinella* spp, based only on trichinelloscopy and peptic digestion, were unsuccessful. Wild nutria may serve as host for *Trichinella* spp. and can infect humans, as infestations has been reported in several countries since the first description in Suisse (Rübli, 1936; Bessonov *et al*., 1980). The normal mode of transmission, via contaminated feed, is unlikely to occur in captivity on farms as long as uncontaminated or appropriately-treated diets are fed to these rodents. But nutria in the wild, although essentially herbivorous, has an alimentary spectrum fairly broad and certain conditions, like a deficiency in vitamins and proteins, induces it to eat garbage meat, fish, mollusca and become infected with *Trichinella* spp. (Moretti *et al*., 2001). Although it is recommended to perform the trichinelloscopy

examination of nutria meat for public consumption, a more sensitive immunological test, like the monoclonal blocking ELISA, perhaps should be implemented in future studies (Moretti *et al*., 2001).

Most cestode parasites of wild nutria are innocuous, with a few exceptions (Davis & Shillito, 1963; Wenzel, 1982). The trematodes and most of the cestodes found require marine or freshwater invertebrates, shellfish or fish as intermediate hosts, which can be easily incorporated by the nutria in their diet. In Britain and North America, where they have been more intensively studied than in their native South America, nutria feeds on sedges, reeds and other aquatic herbs (Conder, 1982). *Fasciola hepatica* was the most prevalent Trematoda here. Fascioliasis was known to occur in nutria from a number of countries including both American and European countries to which this rodent has been introduced (Pridham, 1966; Pascal *et al*., 2003; Pelloté *et al*., 2008). In fact, because of its eco-ethologic characteristic, the nutria could be a potential wild reservoir of *F. hepatica* in Brazil (Santos, 1992) and in France (Menard *et al*., 2001) where a prevalence of 36%, the triple of our figures, was reported.

Examinations of faecal samples have also revealed the presence of Sporozoa, being coccidia (*Eimeria myopotami* and *E. nutriae)* the most prevalent. Nutria can carry protozoans that probably cause ill health or death (Vietmeyer, 1991). *Eimeria* spp. (i.e. *E. steidae*, *E. nutriae*, *E. myopotami*, *E. pellucida*), are natural parasites of nutria, and coccidiosis is a major problem primarily in young kits from farms (Wenzel, 1982; Körner, 1985; Scheuring, 1990). In addition, coccidiosis by mostly *E. nutriae*, *E. myocastori* and *E. myopotami* was reported from trapped nutria from Italy, with significant intestinal and hepatic lesions (Bollo *et al*., 2003).

Cryptosporidium and *Giardia* were also demonstrated in this survey, but in small number of accessions. Nevertheless, these finding are of epidemiological importance, as both are common parasites that occur in many mammal species, including the nutria and humans, and some animal isolates are of zoonotic potential (Acha & Szyfres, 1986; Sulaiman *et al*., 2003). In previous studies, no evidence of the presence of *Giardia* spp. cysts and trophozoites was detected from wild nutria from Louisiana (Howerth *et al*., 1993), meanwhile Dunlap & Thies (2002) revealed a 73 % of the prevalence of *Giardia* spp. infection in nutria from east Texas combining trichrome staining and an immunoassay test.

There are few reports of parasitic diseases in the literature, suggesting either that nutria is unusually resistant to the variety of pathogens which affect the other rodent families or, more probably, that it has not been studied in such great detail. Because of the relatively low parasite intensities for the bulk of the accessions in this survey, parasitic disease did not appear to be a major factor or is probably of little consequence in this wild population.

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References

ACHA, P. N., SZYFRES, B. (2001): *Zoonoses and Communicable Diseases Common to man and animals*. 2nd Edition, Pan Americam Health Organization Publishing, Washington, 410 pp.

ALLEN, A. V., RIDLEY, D. S. (1970): Further observations on the formol-ether concentration technique for faecal parasites. *J. Clin. Path.,* 23: 545 – 546

BABERO, B. B., LEE, J. W. (1961): Studies on the helminths of nutria, *Myocastor coypus* (Molina), in Louisiana with check-list of other worm parasites from this host. *J. Parasitol*., 47 (6): 378 – 390

BESSONOV, A. S., PENKOVA, R. A., USPENSKY, A. V., SHEKHOTSOV, N. V. (1980): Veterinary-sanitary examination of nutria (*Myocastor coypus*) carcasses for Trichinellosis. In: *Proceedings of the 5th. International Conference on Trichinellosis*, *September 1 – 5*. Windsor, U.K., Redbooks Ltd., pp. 423 – 425

BOLLO, E., PREGEL, P., GENNERO, S., PIZZONI, S., ROSATI, S., NEBBIA, P., BIOLATTI, B. (2003): Health status of a population of nutria (*Myocastor coypus*) living in a protected area in Italy. *Res. Vet. Sci*., 78 (8): 21 – 25. DOI: 10.1016/S0034-5288(3)000035-3

BUSH, O., LAFFERTY, K. D., LOTZ, J. M., SHOSTACK, A. W. (1997): Parasitology meets ecology in its own terms. *J. Parasitol*. 83: 575 – 583

CATZEFLIS, F. M., HANNI, C., SOURROUILLE, P., DOUZERY, E. (1995): Molecular systematics of histricograph rodents: evidence from the mitochondrial 12 SrRNA gene. *Mol. Phylogenet. Evol*., 3: 206 – 220

CONDER, G. B. (1982): Coypus. In: DE BEER, G., BOURLIÈRE, F. (Eds) *Encyclopedia of the animal world*. Volume 6. Published by Bay Books Pty Ltd., Sydney, pp. 482 – 484

DAVIS, R. A., SHILLITO, E. (1963): The coypu or nutria (*Myocastor coypus* Molina). In: *UFAW Handbook: Universities Federation For Animal Welfare*. Wiley and Blackwell, Oxford, United Kingdom. Chapter 27, pp. 457 – 467

DAWES, B. (1968): *The Trematoda*. Cambridge University Press, Cambridge, United Kingdom, 644 pp.

DUNLAP, B. G., THIES, M. L. (2002): Giardia in beaver (*Castor canadensis*) and nutria (*Myocastor coypus*) from east Texas. *J. Parasitol*., 88: 1254 – 1258. DOI: 10.1645/0022-339(2002)088[1254:GIBC CA]2.0.CO;2

GEORGI, J. R. (1974): *Parasitology for veterinarians*. W.B. Saunders Company, Philadelphia, Pennsylvania, 386 pp.

GOSLING, L. M., BAKER, S. J., CLARKE, C. N. (1988): An attempt to remove coypus (*Myocastor coypus*) from a wetland habitat in East Anglia. *J. Appl. Ecol.*, 25 (4): 49 – 62

HOWERTH, E. W., REEVES, A. J., MCELVEEN, M., AUSTIN, F. W. (1994): Survey for selected diseases in nutria (*Myocastor coypus*) from Louisiana. *J. Wildlife Dis*., 30 (3): 450 – 453

IUCN (2009): *Red List of threatened species*. International Union for the Conservation of Nature. Gland, Switzerland

& Cambridge, UK. Retrieved March 13, 2010 from http://www.iucnredlist.org. DOI: 10.111/j.1472-4642.2009.00633.x

JOKIPII, L. S., POHJOLA, S., JOKIPII, M. M. (1983): Cryptosporidium: a frequent finding in patients with gastrointestinal symptoms. *Lancet*, 2: 358 – 361

KINLER, N. W., LINSCOMBE, G., RAMSEY, P. R. (1987): Nutria. In: NOVAK, M., BAKER, J., OBBARD, M. E., MALLOCH, B. (Eds) *Wild furbearer management and conservation in North America*. Ministry of Natural Resources, Ontario, Canada, pp. 327 – 343

KÖRNER, E. (1985): Krankheiten bei sumpfbibern und deren behandlungsmöglichkeiten. *Tierärztl. Prax*., 13: 235 – 240

LAKKONEN, J., SOVERI, T., HENTTONEN, H. (1994): Prevalence of *Cryptosporidium* sp. in peak density *Microtus agrestis*, *Microtus oeconomus* and *Clethrionomys glareolus* populations. *J. Wildlife Dis*., 30 (1): 110 – 111

MARTINO, P. E., STANCHI, N. O. (1998): Causes of death in captive nutria (*Myocastor coypus*) in Argentina. *Isr. J. Vet. Med.*, 53: 83 – 88

MARTINO, P. E., SASSAROLI, J. C., CALVO, J., ZAPATA, J., GIMENO, E. (2008): A mortality survey of free range nutria (*Myocastor coypus*). *Eur. J. Wildl. Res*., 54: 293 – 297. http://dx.doi.org/10.1051/vetres:20011141

MENARD, A., AGOULON, A., L'HOSTIS, M., RONDELAUD, D., COLLARD, S., CHAUVIN, A. (2001): *Myocastor coypus* as a reservoir host of Fasciola hepatica in France. *Vet. Res.* 32(5): 499 – 508

MORETTI, A., PIERGILI FIORETTI, D., GRELLONI, V., MARINI, C., LEONARDI, L., VELATTA, F. (2001): Susceptibility of nutria (*Myocastor coypus*) to Trichinella infection: biological aspects. *Parasite*, 8 (2) : 206 – 208

PASCAL, M., LORVELEC, O., VIGNE, J.D., KEITH, P., CLERGEAU, P. (2003): *Évolution holocène de la faundes vertébrés de France: invasions et disparitions*. Publiée par l'Institut National de la Recherche Agronomique (INRA) et le Centre National de la Recherche Scientifique, París, France, 381 pp.

PELLOTÉ, F., PASCAL, M., LORVELEC, O., CLERGEAU, P. (2008): *Les espèces invasives en Bretagne: le Ragondin (Myocastor coypus)*. Retrieved April 29, 2009 from http://www.bretagne-environnement.org/especes-invasives. DOI: 10.1890/080083

PRIDHAM, T. J., BUDD, J., KARSTAD, H. A. (1966): Common diseases of fur bearing animals. II. Diseases of chinchillas, nutria, and rabbit. *Can. Vet. Jour*., 7, (4): 84 – 87

RÜBLI, H. (1936): Trichinose beim sumpfbiber, *Myocastor coypus* Mol. Schweizer. *Arch. Tierheilk.*, 78: 420 – 421

SANTOS, I. C. (1992): *Myocastor coypus* as a wild reservoir of *Fasciola hepatica. Rev. Brasileira Parasit. Vet*., 1 (1): 27 – 30

SCARAMELLA, D., MOTTI, G. (1988): *Allevamento del castorino*. 1st Edition, Edagricole Pub., Bologna, Italia, 133 pp.

SCHEURING, W. (1990): *The examination of intestinal parasitofauna in coypu (Myocastor coypus, Molina 1782) from closed husbandries with particular regard to coccidia.* Edited by Akademii Rolcniczej, Wroclaw, Polska, 41 pp.

SOULSBY, E. J. (1965): *Textbook of veterinary clinical parasitology. Vol. I. Helminths*. Blackwell Scientific Publications, Oxford, England, 1120 pp.

SULAIMAN, I. M., FAYER, R., BERN, C., GILMAN, R. H., TROUT, J. M., SCHANTZ, P. M., DAS, P., LAL, A. A., XIAO, L. (2003): Triosephosphate isomerase gene characterization and potential zoonotic transmission of *Giardia duodenalis*. *Emerg. Inf. Dis.,* 9 (11): 1444 – 1452. DOI: 10.3201/eid0911.030084

VERSTER, A. (1969): A taxonomic revision of the genus *Taenia* Linnaeus, 1758 st. *Onderstepoort J. Vet. Res*., 38: 3 – 58.

VIETMEYER, N. D. (1991): *Microlivestock: Little-known small animals with a promising economic future*. National Academy Press, Washington D.C., 449 pp.

WENZEL, U. (1982): *Pelztiergesundheitsdienst*. Tierärztliche Praxis, VEB Gustav Fischer Verlag, Jena, Germany, 254 pp.

WILLIAMS, E. S, THORNE, E. T. (1996): Infectious and parasitic diseases of captive carnivores, with special emphasis on the black-footed ferret (*Mustela nigripes*). *Rev. sci. tech. Off. int. Epiz*., 15 (1): 91 – 114

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