Приморская государственная
сельскохозяйственная академия

Общество сохранения
диких животных

Тихоокеанский институт
географии ДВО РАН

Primorskaya State
Academy of Agriculture

Wildlife
Conservation Society

Pacific Geographical
Institute FEB RAS

Болезни и паразиты диких животных Сибири и Дальнего Востока России

Монография

Diseases and parasites of wildlife in Siberia and the Russian Far East

Monograph

Владивосток
Дальнаука
2012

Vladivostok
Dalnauka
2012

УДК 591.2+591.69
ББК 28.6

Болезни и паразиты диких животных Сибири и Дальнего Востока России: монография / под ред. И.В. Серёдкина и Д.Г. Микелла. – Владивосток: Дальнаука, 2012. – 224 с.

Diseases and parasites of wildlife in Siberia and the Russian Far East: monograph / I.V. Seryodkin and D.G. Miquelle, editors. Vladivostok: Dalnauka, 2012. 224 p.

Монография посвящена результатам исследований болезней и паразитов диких животных в разных регионах Сибири и Дальнего Востока России: от Якутии до Камчатки. Большое внимание уделяется проблемам распространения инфекционных и паразитарных заболеваний у хищных млекопитающих. Показаны потенциальное влияние болезней на популяции диких животных и роль домашних животных и человека в распространении инфекций. Обсуждается значение данной темы в вопросах сохранения популяций редких и промысловых видов животных и управления ими. Книга предназначена для широкого круга читателей: ветеринаров, биологов, врачей, охотоведов, экологов, студентов и аспирантов этих специальностей, а также специалистов природоохранных организаций и административных учреждений.

Книга подготовлена и напечатана при финансовой поддержке Общества сохранения диких животных (WCS), являющегося негосударственной природоохранной организацией, деятельность которой базируется на научных исследованиях. Задача общества – сохранение диких животных и экосистем путем разработки и применения новейших научных подходов, основанных на полевых исследованиях, для решения критических экологических проблем.

Табл. 18, ил. 21, библ. 278.

This monograph is devoted to studies focusing on wildlife diseases and parasites in Siberia and Russian Far East, from Yakutia to Kamchatka. Much attention is paid to the spread of infectious and parasitic diseases in carnivores. The potential impact of diseases on wildlife populations and the role of domestic animals and humans in the spread of such infections are discussed, as is the significance of this topic for conservation and management of populations of rare and commercially-valuable animal species. This book is intended for a wide range of readers: veterinarians, biologists, doctors, game biologists, ecologists, students and graduate students of these professions, as well as for professional environmental organizations and government agencies.

This book was prepared and published with financial support from the Wildlife Conservation Society (WCS), a non-governmental science-based conservation organization. WCS's goal is the conservation of wild places and wildlife through the development and application of new scientific approaches based on field studies that address critical environmental problems.

Tabl. 18, ill. 21, bibl. 278.

Утверждено к печати Ученым советом Приморской государственной сельскохозяйственной академии

Approved for publication by the Scientific Council of the Primorskaya State Academy of Agriculture

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Translators: E.I. Nikolaeva, J.C. Slaght

ISBN 978-5-8044-1315-7

CHAPTER 11

Tooth breakage in tigers: cause for conflict?

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Human-tiger conflicts fuel tiger population declines through retaliation killings by local people and government-sanctioned removal of problem individuals (reviewed in Inskip and Zimmerman 2009, Goodrich 2010). Such human-caused mortality may have significant impacts on population persistence (Kenney et al. 1995, Chapron et al. 2008). As part of the Global Tiger Initiative, 13 tiger range states recently pledged to double tiger populations by the next Year of the Tiger (Global Tiger Recovery Program 2010). However, human-tiger conflicts will likely also increase with increasing numbers of tigers (Karanth and Gopal 2005) so proactive plans to manage Human-tiger conflicts will be important for successful recovery. Teams that capture tigers involved in human-tiger conflict situations must assess the condition of tigers, and make an appropriate decision as to the fate of the tiger based largely on its physical condition, i.e., whether or not the animal is fit to survive in the wild (Gurung et al. 2009, Barlow et al. 2010, Goodrich et al. 2011). Accurate assessment of whether a tiger is fit or infirm is critical to avoid unnecessarily removing animals from the wild.

Broken teeth, particularly canines, are often cited as infirmities that lead to depredations by large felids on domestic animals and humans (e.g. Rabinowitz 1986, Marker 2003, Gurung et al. 2009, Kashkarov 2009, Surmach 2011) and hence, broken canines may be considered a reason to remove large felids from the wild. Within Russia, there are unsubstantiated claims that tigers commonly break canines when captured in snares for research purposes, resulting in a large number of research tigers later becoming problem animals due to their inability to hunt effectively (Kashkarov 2009, Zhuralev 2010, Surmach 2011).

The idea that broken canines represent a significant infirmity resulting in conflict probably stems in part from popular literature that reports broken canines in man-eating lions (Corbett 1955, 1957), and peer-reviewed literature regarding damaged dentitions of the legendary man-eating lions of Tsavo (Neiburger and Patterson 2000, 2002). Broken canines are common in wild felids with 20–40% of skulls examined in various studies having damaged dentition (Van Valkenburg 1988, 2009, Patterson et al. 2003). However, the occurrence of broken teeth was not correlated with conflict in a study of lion dental condition (Patterson et al. 2003). No such studies have been conducted for tigers, yet despite evidence to the contrary for lions, broken canines are often assumed to be a significant cause of tiger depredations on humans and domestic animals (Gurung et al. 2009, Yudin and Yudina 2009) with calls to halt research activities that require capture of tigers because of purported negative impacts (Salkina, in Zhuralev 2010). Despite the absence of concrete data to support such claims, this general sentiment may pressure managers to view capture operations in a negative light and may influence managers responsible for resolving conflicts to remove animals from the wild because of damaged teeth.

We used data on breakage of canine teeth in wild Amur tigers in the Russian Far East to address three questions: 1) To what extent were capture operations responsible for tooth breakage? 2) What was the relationship between human-tiger conflict and tooth breakage? 3) To what extent did tooth breakage negatively impact tigers? We analyzed data on tooth breakage in tigers captured as part of a long-term research project (hereafter referred to as "research tigers") in the Russian Far East (Miquelle et al. 2010) to establish a baseline for frequency of canine breakage in wild tigers and to estimate the impacts of tooth breakage on tiger health. We were able to record instances of recent tooth breakage that could have occurred during capture to assess how frequently capture efforts resulted in tooth breakage. We compared canine breakage between research tigers and tigers captured in human-tiger conflict situations (hereafter referred to as "conflict tigers") to determine if tooth breakage could be implicated as a cause of human-tiger conflict. Finally, we looked at survival and reproductive rates of tigers with and without tooth breakage to assess whether tooth breakage might negatively impact these aspects of life history.

Study Area & Methods

Research tigers were captured from 1992–2010 on and near the Sikhote-Alin Biosphere Zapovednik, which is centrally located in the north-south gradient of the geographic range of tigers in the Russian Far East (Miquelle et al. 2010). We collected data on conflict tigers from 1999–2010 (Seryodkin et al. 2010, Goodrich et al. 2011) throughout the range of Amur tigers in Russia in Primorskii and Khabarovskii Krais (Miquelle et al. 1999). Research tigers were captured in Aldrich foot snares or darted from helicopters (Goodrich et al. 2001) and conflict tigers were captured or killed by a variety of means from 1992–2010 (Goodrich et al. 2011). Canine teeth were examined and usually photographed to assess breakage. We estimated tiger age based on known birth dates of cubs born to radio-collared tigers (Kerley et al. 2003), degree of tooth eruption, and/or degree of tooth wear, gum recession, and staining (Goodrich et al. 2001), and placed adults in one of four age classes: < 4 years, 4–7 years, 7–10 years, and > 10 years. Our analysis included only broken canines with pulp exposure and did not consider breakage of other teeth. However, for live tigers, it was not always possible to examine all teeth before tigers recovered from anesthesia and for dead tigers, frozen carcasses or limited access to some carcasses hindered detailed examinations.

To establish a baseline for canine breakage in wild Amur tigers not involved in conflict, we calculated the percent of tigers with one or more broken canines from our "research" population. Animals that appeared to have broken canines during the capture process (freshly broken) were categorized separately. To determine if canine breakage was related to sex or age, we compared the percent of animals with broken teeth between sexes and among the four adult age classes. For individual tigers captured multiple times over several years, data were used from only one capture per tiger selected at random. We examined the potential impact of broken canines on survival of research tigers by comparing annual survival (Van der Toorn 1997) and the mean age at death between resident adult research tigers with broken canines and those without. Non-resident subadult (i.e. dispersing) animals were not included because dispersal-related mortality was nearly 100% (Goodrich et al. 2008). None of these tigers had broken canines, so including these animals with their low survival rates would have biased the test, reducing the chance of detecting a difference in survival associated with canine breakage. Some tigers were initially captured without any broken canines, but had broken canines in subsequent captures. For survival analysis, we estimated the date on which a canine was broken as the mean date between captures. Further, these animals were included in both groups and survival rates assumed to be independent. Thus, while 24 tigers were included in the survival analysis, the overall sample size was 27. Date of death was determined based on radio-tracking data as described by Goodrich et al. (2008).

To determine if tooth breakage influenced predation, we compared size of prey killed by tigers with broken canines to that of tigers without broken canines. We hypothesized that if broken canines influence prey selection, tigers with broken canines are compromised in their ability to hunt, tigers with broken canines should kill smaller prey. To test for differences in prey size between tigers with broken canines and those without, we compared estimated weight of tiger kills found during our research on Sikhote-Alin Biosphere Zapovednik (Miquelle et al. 2005). Tiger kills were located by telemetry and snowtracking as described by Miquelle et al. (2005). For each animal killed, age was estimated as ≤ 1 year, 2 years, subadult, or adult. Weights were estimated only for prey animals for which an age estimate was available (Table 1). Where sex of prey was unknown, the median of male and female weights was used. Where data were not available for specific prey age classes, weights were estimated based on weight ratios derived from data on sika deer (Danilkin 1999). While these estimates may not be precise, the error will be consistent for tigers with and without broken canines, and will not influence the comparison between tiger groups. Mean weight of prey species killed was compared between tigers with broken canines and those without using a t-test.

Table 1. Estimated weight of Amur tiger prey species

Prey species	Weight (kg) per age category			Source
	1 year	2 years	Adult	
Roe deer female	28	35	35	Danilkin 1999
Roe deer male	28	35	40	Danilkin 1999
Sika deer female	52	63[1]	74	Danilkin 1999
Sika deer male	63	84[1]	106	Danilkin 1999
Red deer female	104[2]	127[2]	149	Bromlei and Kucherenko 1983
Red deer male	133[2]	178[2]	224	Bromlei and Kucherenko 1983
Wild boar female	65[2]	78[2]	92	Bromlei and Kucherenko 1983
Wild boar male	115[2]	153[2]	193	Bromlei and Kucherenko 1983
Amur goral female	–	27[2]	32	
Brown bear female[3]	30	101	145	Authors, unpublished data
Brown bear male[3]	32	169	270	Authors, unpublished data
Asiatic black bear female[3]	33	–	82	Authors, unpublished data
Asiatic black bear male[3]	40	88	133	Authors, unpublished data
Eurasian badger[4]	–	–	6.6	M.S. Goncharuk, unpublished data

[1] estimated as midpoint between 1 year and adult weights;
[2] data not available, so weights were estimated based on weight ratios derived from sika deer (Danilkin 1999);
[3] data from Sikhote-Alin Biosphere Zapovednik;
[4] data from Lazovskii District, all age and sex classes combined

To determine if broken canines influenced reproductive rates, we compared number of cubs produced per year (Kerley et al. 2003, Goodrich et al. 2010) between tigers with broken canines and those without. In cases where litter size was unknown, but radio-collared tigresses were known to be with cubs, litter sizes were estimated as the mean number of cubs per litter (2.5, Kerley et al. 2003). Means were compared using t-tests and frequency of tooth breakage using chi-square tests (Ambrose and Ambrose 1981).

To examine the relationship between canine breakage and conflict, we assessed whether the proportion of tigers with broken canines varied between research tigers and conflict tigers. We also compared mean age of research tigers with that of conflict tigers because degree of tooth breakage likely increases with age.

Results

We captured or handled 71 tigers a total of 102 times. Of these, 46 tigers were captured 54 times in snares for which data on canine breakage were available. Of these 54 captures, canine breakage associated with capture (fresh breaks) was observed in two cases (3.7%) and in a third case (a conflict tiger) it was not clear whether the breakage was related to capture, but if included, this would represent 5.6% of captures that resulted in canine breakage. Despite the low breakage rate associated with capture, 25% of 68 tigers for which data exists (both research and conflict) had broken canines.

We detected no difference in proportion of research and conflict tigers with broken canines ($\chi^2 = 0.09$, df = 1, $P = 0.76$); 24% of research tigers ($n = 46$) and 27% of conflict tigers ($n = 22$) had broken canines (Table 2). We detected no difference in age between research tigers ($\bar{x} = 4.9 \pm 3.5$) and conflict tigers ($\bar{x} = 5.3 \pm 3.5$; $t = 0.43$, df = 61, $P = 0.67$) (Table 2). For both samples combined, we detected no difference between sexes in proportion of animals with broken teeth ($\chi^2 = 0.81$, df = 1, $P = 0.84$), but the proportion of animals with broken canines increased with age class ($\chi^2 = 33.8$, df = 3, $P < 0.001$; Fig. 1).

Table 2. Percent canine breakage in research tigers versus conflict tigers and reproductive and survival rates of research tigers with and without broken canines, 1992–2010, Russian Far East

	Research tigers			**Conflict tigers**		
	n	**mean**	**SD**	***n***	**mean**	**SD**
Age	45	5	3.5	22	5.3	3.5
Canine breakage	46	24%		22	27%	

Mean weight of prey killed by tigers with broken canines (131 kg, $n = 7$ tigers and 81 kills) was greater than that for tigers without broken canines (111 kg, $n = 20$ tigers and 206 kills; $t = 1.71$, df = 25, $P = 0.011$). Because some of the tigers without broken canines were juveniles (< 3 yrs old) which may kill smaller prey due to smaller body size, we tested for a difference using data only from adults. Mean prey size was still larger for tigers with broken canines than for those without (114 vs 111 kg), but the difference was marginally significant ($t = 1.72$, df = 20, $P = 0.061$). Thus, we conclude that canine breakage did not force tigers to kill smaller prey.

We detected no difference between estimated annual survival for tigers without broken canines (0.82 ± 0.06) and those with broken canines (0.73 ± 0.11; $z = 0.13$, $P = 0.89$) (Table 3). The mean age at death was greater for tigers with broken canines ($\bar{x} = 10.8 \pm 3.0$, $n = 10$) than for those without ($\bar{x} = 7.6 \pm 2.6$, $n = 10$; $t = -2.77$, df = 22, $P = 0.01$) (Table 3). We detected no difference in mean number of cubs born per year between research tigresses with ($\bar{x} = 1.2 \pm 1.2$, $n = 9$) and without ($\bar{x} = 1.3 \pm 0.6$, $n = 4$) broken canines (Table 3). Four research tigresses produced 1–3 litters each, despite 1–3 broken canines.

Table 3. Survival and reproductive data of Amur tigers with and without canine breakage, 1992–2010, Russian Far East

	Tigers with broken canines			**Tigers without broken canines**		
	n	**mean**	**SD**	***n***	**mean**	**SD**
Survival rate	8	0.82	0.06	19	0.73	0.11
Reproduction rate of females (cubs/year)	9	1.2	1.2	4	1.3	0.6
Age of death	10	10.8	3.0	10	7.6	2.6

We found evidence suggesting that a broken canine was a serious health issue in 2 cases. The first was a conflict tiger who had 3 broken canines not related to capture, but was also missing several other teeth, including all of the premolars and the molar on the upper left side of her mouth. This tigress was emaciated when captured and had killed several domestic animals in a town. The second was a research tiger that had broken an upper canine at the gum line prior to capture. Part of the break extended 3 cm into the skull, resulting in a hole packed with debris and prey remains, resulting in infection. Despite being a large (200 kg) adult male (7 yrs old), this animal's home range was only 159 km^2; whereas mean adult male home range size was 1,385 ± 539 km^2 (Goodrich et al. 2010). We suspect that the tiger's limited movements were due to health issues associated with the broken tooth; however, 3 months after his capture, we lost radio-contact with the tiger, likely because he was poached and his collar destroyed (Goodrich et al. 2008).

Discussion

Only 3.7–5.6% of tigers captured in snares broke canines. None of these tigers suffered any apparent ill effects as a result of their broken teeth, nor did they become conflict animals as a result of their broken canines. One of these animals did attack a human, but only after that person shot the tiger from about 90 meters away, near an adult wild boar the tiger had recently killed. The shot hit the tiger in the chest, provoking the tiger to attack, and the person sustained minor injuries. Thus, the data did not support published opinion that tigers frequently break canines during capture in Aldrich foot snares (Kashkarov 2009, Zhuravlev 2010, Surmach 2011). Nonetheless, we continue to take precautions to minimize tooth breakage or other injuries, such as by setting snares in areas where there are no trees (other than that to which the snare is attached) or other hard objects that a tiger may bite and subsequently break teeth.

Van Valkenburg (2009) reported only 9% canine breakage in museum skulls of tigers, which is considerably lower than 24–27% that we found. This may be due to differences in mean age of specimens, i.e., tooth-wear data presented by Van Valkenburg (2009) suggests a preponderance of young animals and very few old animals. Patterson et al. (2003) found 40% of lion skulls examined had damaged teeth, but did not report canine breakage specifically, and included unbroken teeth with pulp cavities exposed as "damaged". The proportion of tigers with broken teeth in our sample increased markedly with age, as was found by Patterson et al. (2003) for lions. We believe that tooth damage resulted in significant health issues in only two cases and resulted in depredation on domestic animals in only one case. Otherwise, research tigers with broken canines did not appear to have difficulty securing sufficient prey to survive and reproduce. Indeed, tigers with broken canines killed larger prey than those without, probably because these tigers were older and more experienced and hence more capable at capturing larger prey. Further, there was no difference in survival or reproduction between tigers with broken canines and those without, and tigresses with 1–3 broken canines successfully raised cubs. We believe that, like lions, tigers have mechanisms to retard or prevent infection of broken teeth with pulp exposures (Patterson et al. 2003). We may have failed to detect differences due to small samples in some cases, particularly for difference in survival between tigers with and without broken canines which was 9% higher for those with broken canines (Table 2). This difference was likely due to the higher mean age of tigers with broken canines; however, sample sizes were too small to calculate age-specific survival rates.

There was no significant difference in proportion of tigers with broken canines between research and conflict tigers, and tooth damage was linked to conflict in only one case. Patterson et al. (2003) found similar results for African lions and the pattern may hold true for most large felids, which have similarly high tooth breakage rates (Van Valkenburg 1988, 2009). However, Rabinowitz (1986) found that 5 of 13 conflict jaguars had broken canines, while all canines of 17 non-conflict animals were intact, but insufficient data were presented to determine cause and effect.

Our data support the premises that 1) contrary to the opinion of some (Kashkarov 2009, Zhuravlev 2010, Surmach 2011), canine breakage in captures that use snares is rare; 2) that broken canines in wild tigers are not usually an impairment that significantly reduces an animal's reproduction, survival, or ability to kill wild prey; and 3) in most cases broken canines have no influence on whether a tiger becomes a conflict animal by killing domestic animals or humans. These results provide strong evidence that managers should not remove conflict tigers from the wild based on the presence of broken canines alone. Further, in analyzing data on tiger dentition relative to conflict, researchers should not assume that broken canines represent a serious health problem. For example, broken canines are often listed as an infirmity causing depredation on humans and domestic animals, but with no detail about the injury, suggesting that the authors assumed that a broken canine is sufficient injury to force an animal to prey on humans or livestock (e.g. Rabinowitz 1986, Marker 2003, Gurung et al. 2009). Our data suggest that such an assumption is not valid and researchers should describe dental damage more carefully and the reasons they believe it resulted in conflict (e.g. severe infection associated with the break). Otherwise, managers are mislead into believing broken canines are a serious issue leading to reduced body condition and eventual attacks on domestic animals or humans, and may unnecessarily remove tigers and other large carnivores from the wild, thereby hampering conservation efforts.

Acknowledgements

Funding was provided by the Wildlife Conservation Society, National Fish and Wildlife Foundation's Save the Tiger Fund, 21st Century Tiger, U.S. Fish and Wildlife Service Rhino and Tiger Conservation Fund, the Homeland Foundation, The Columbus Zoo and Aquarium Conservation Fund, National Geographic Society, Exxon Corporation, the Charles Engelhard Foundation, Disney Wildlife Fund, Turner Foundation, Richard King Mellon, Avocet Charitable Lead Unitrust, Robertson Foundation, Starr Foundation, Goldman Environmental Foundation, Denver Zoo, and numerous private donors. A.N. Khobotnev, E.V. Tsarapkin, B.O. Schleyer, N.N. Rybin, A.N. Rybin, A.V. Kostirya, V.V. Melnikov, V.G. Schukin, and E.N. Gizhko assisted with data collection. A.A. Astafiev, M.N. Gromyko, E.V. Potikha, and E.A. Pimenova of Sikhote-Alin Biosphere Zapovednik, S.A. Zubtsov of Inspection Tiger, and T.S. Aramileva of the Primorye Wildlife Management Department provided logistical and administrative support. The Russian Ministry of Natural Resources provided permits for capture.

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