



(RESEARCH ARTICLE)



A critical eye to breeding potential of the domestic cat (*Felis silvestris catus*) or natural selection vs castration

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Abstract

The article analyze the reproductive potential of uncastrated domestic cats. The notions of the high reproductive capabilities of the species have been refuted, even with provided resources, shelter and human attention. Space and density are not major stressors in a multi-cat indoor group if a high-protein food and inner freedom of individuals are provided. The established natural patterns in its development and the parallel made between other wild felines and human population are evidence of the evolutionary value and genetic potential of the species, which must be assessed and preserved in time. Specific adaptive behavior in female individuals related to indoor life and possibly a way of self-control of reproduction is described

Keywords: Multi-cat household; Uncastrated cats; Cat-cat interactions; Human - cat interactions

1. Introduction

After a thousand years of coexistence with man [1,2] we can safely say that we know in details the morphology, physiology, onto- and phylogeny of the domestic cat. Scientists are unanimous that during this period of time with man, he could never fully tame it [3]. Today, of all companion animals, domestic cats retain the most anatomic, metabolic, and behavioral features of their predecessors. Cats have lived at the periphery of human society, cohabiting with humans but still retaining their independence, with diet options that have included small animals or birds they captured [4]. Unlike farms in rural areas, where food and shelter are easy to find, the highly fragmented urban environment [5] forces the animals that inhabit it, including domestic cat, to become "invisible" [6], replacing daytime activity with nighttime to avoid conflicts with humans.

Unlike its deification in ancient Egypt, overpopulated Europe was reluctant to conform at domestic cat as a species. Public attention focuses pragmatically on the benefits and harms of living with her. Gaining human trust thanks to the rodents it feeds on, it is gradually being replaced by rodenticides, and advances in science and research on the species now bring it the notoriety of a dangerous predator that disturbs the ecological balance [7], spreader of zoonoses [8,9] and even an invasive species [10]. Although it ranks first as a pet, the species is subject to all the "achievements" of the modern urban world - road accidents [11], aggression by humans and other animals, infectious diseases – including induced by man [12].

When it comes to sharing resources, space and even attention, the presence of other species in the human world becomes problematic. The ancient Greeks identified the reasons for this intolerance, based on human superiority and its determining role in the fate of other species such as anthropocentrism. It is one of the main concepts in the field of environmental ethics and philosophy of the environment, originally based on religions - Judaism and Christianity. As a complete platform of thinking it was established in the 19th century and in its most extreme manifestations it is

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associated with chauvinism and speciesism [13]. After humanity has experienced several debilitating pandemics, clearly showing that the human species is as vulnerable as others, modern eco-philosophers are trying to mitigate the effects of its most virulent thread - human hegemony, which usually escalates into the destructive aggression of other species [14, 15]. For example, Hayward [16] gives a detailed interpretation of the concept, noting that when a person is at peace and understanding with himself, he will have the same creative and protective attitude towards other species and nature as a whole. In his essay, Thomas [17] calls for a readjustment of the human psyche and consciousness to all those animals classified as "trash animals" and surviving on the edge in an extremely urban environment.

To what extent do we actually know the only species of *Felidae* without conservation status [18] that has become part of our life? How indoor life affects the species' life strategy?

The study aims to establish the reproductive capabilities of uncastrated cats, bred indoor, as well as the relationships that arise between them and the caretaker

2. Methods

2.1. Duration and study area

The study was conducted in the period 2007-2020. Keeping pets especially indoor is not a cheap activity - the relatively long duration of the study is the reason for the group to go through different financially secure periods, following a one basic principle - the continuous improvement of the caretaker's welfare has had a positive impact on the group life status - primarily by increasing the protein content of the food. Therefore, the period can be conditionally divided into 2 stages: 1st stage - from 2007 to 2017 - of formation and approval of the group, and 2nd stage - after 2017 - of the group's development in conditions of increased quality of life. This clarification is important because, as we will see in the discussion, the quality of the food (protein content = protein index) is crucial for almost all aspects of the group's life.

Four rooms with a total area of 124 m² were used, connected by a 7 m long corridor (private property). In order to avoid accidents, the two balconies with an area of 12 m² are glazed and secured with a net. All possible places that can be used for relaxation - tables, beds, lockers, etc., are lined with duvets, which are replaced with clean ones every day. As the number of individuals increases, the area expands in a vertical direction - through the use of plastic shelves. The rooms are enriched with toys, including interactive. The observations are made 365 days a year - ie. coexistence with them is permanent. People's access is limited to one person - the author. To determine the physical parameters of individuals, standard information is used in veterinary sites, for some there is photographic material with a fixed date.

Individuals are fed twice a day - morning and evening, with 1-2 snacks. To meet the hygienic needs, wood pellets are used, poured into standard trays with dimensions 55/33 cm, which are cleaned twice a day and replaced completely every 3-4 days. The rooms are cleaned before and after each meal with a disinfectant, and if necessary there are intermediate cleanings in any time.

2.2. Subjects

The study began with two stray mixed breed cats - male and female. Cats are dewormed externally and internally, they are neither vaccinated nor castrated. In case of a health problem, a specialized veterinary-medical help is always sought and treatment is carried out (castration is performed only in case of a problematic birth). Subsequently, 4 more cats were assigned to the group: female at 7 months (2009) - with viral disease, male at 8 months - with viral disease (2011), female at 5 months (2012) - with pelvic fracture, male - 3 years old (2014) - with dragging hind legs.

3. Results and discussion

As the topic concerns domestic animals kept as pets, it is mandatory linked to animal welfare and the Framework of Five freedoms [19]. Although the Framework emerged in response to the cruel exploitation of farm animals in England [20], it was the first attempt to establish a minimum standard of care for domestic animals, specifying a number of their physiological and mental needs that should not be neglected. Subsequently, it was successfully applied to zoo and companion animals [21, 22].

The physical parameters of individuals are not only genetically determined, but also a direct result of a balanced diet. Realizing this fact, the caretaker sought to provide varied and fresh food. Freshly cooked chicken and pork mixed with semi-moist or canned food and bread were served as the main dish; at intermediate meals are offered pouches, chicken or pork liver, boiled fish. Nutrition observations show that individuals have difficulty to cope with larger bones, which

calls into question the fact that the domestic cat is an excellent hunter - in the wild it would rather attack small, sick or slowly moving prey on the ground. Given the “+” and “-” of dry food [23], it is given every 2-3 days, supplemented by a mixture of milk and yoghurt, sometimes with raw eggs. Food and water are located away from cat toilets, most often 2-3 cats are fed from a food container. On the other hand, everyone has a reserved place - on a table, refrigerator, chair, in the north room, in the west room, etc. There are water containers in each room. Scientists are unanimous that cats are obligate carnivores and particularly adapted both physiologically and metabolically for high protein intake, but opinions about the protein content of food vary from 20% [24] to 70% [25]. The study refutes this fact - they willingly consume foods of plant origin - potatoes, rice, beans, cabbage - cooked, without spices and added to the main menu or given to snacks (and today a number of well-known companies in the pouches use as impurities in the wet foods rice, carrots, peas and other vegetables). Metric data of individuals are given in Table 1.

Table 1 Metric data of individuals

Name	Sex	Age	Body length (cm)	Breast girth (cm)	Weight (kg)
Orange	male	4	37	33	3,2
Rosen	male	11	35	28	2,6
Nikola	male	6	38	34	3,6
Pipa	female	7	31	30	2,8
Blgy	female	5	36	34	3,1
Kozy	female	6	33	29	2,4
Bessy	male	6	35	32	3,2
Misi	female	3	30	28	2,5

The consequences of good nutrition can easily be seen in the weight and size of individuals. In the internet space data, showing the relationship between age and weight are scarce - mainly for fixed breeds or neutered cats, so the basis for comparison is limited. We can only note that the cats in the study weighed within the acceptable range, with no signs of malnutrition or overweight. The low weight of Rosen - an 11-year-old male cat, is due to the natural aging processes associated with a change in the body - in the case of lack of teeth.

When it comes to domestic cats kept indoors, the emphasis is usually on space as a determining, moreover stress - factor in group relationships [26]. Stress is not always clearly recognizable, but it can be reported in a number of behavioral changes [27], fluctuations in physiological values and impaired immune system, which suggests the development or reactivation of diseases [28]. Behavioral disorders related to stress and pain can be practically detected by the cortisol levels in the urine [29], adrenocorticotropic hormone (ACTH) [30] and glucose, blood plasma, serum and saliva are tested for acute stress [31]. According to other authors, the number of individuals in a multi-cat households is not a cause of stress - cats are highly adaptable and easily create relationships with each other to avoid stress [32].

In the observed group, space has never been a reason for conflict - cats can circulate freely from room to room according to their physical and mental needs. For example, the shelves on racks with an area of 0.2 m² (the smallest possible space) during the warm summer months is used by a cat lying on its entire length, while lower temperatures force this area to be divided by 2 - 3 individuals. The shelves are suitable place for observation, hiding and resting. Entering the other's personal space begins with sniffing and waiting for a response within a few seconds - the lack of an aggressive response is a sign of agreement.

In fact, it turns out that it is not the density but the nutritional resources and their quality that are crucial for the physical and mental health of the group members - the high protein intake makes cats calm, dulls their instincts, guarantees strong immunity, and provokes affiliative behavior [33]. Providing food, water and shelter eliminates the insecurities of everyday life - a major factor that triggers the stress and aggression underlying survival. A similar determining role of food resources has been found in the wild felines - cougar, leopard, lion [34].

As a result of the study, the indoor group numbered 54 individuals, with 3 females castrated. The distribution of individuals by sex is almost 1:1 (28 males : 26 females)(without manipulation) (Figure 1).

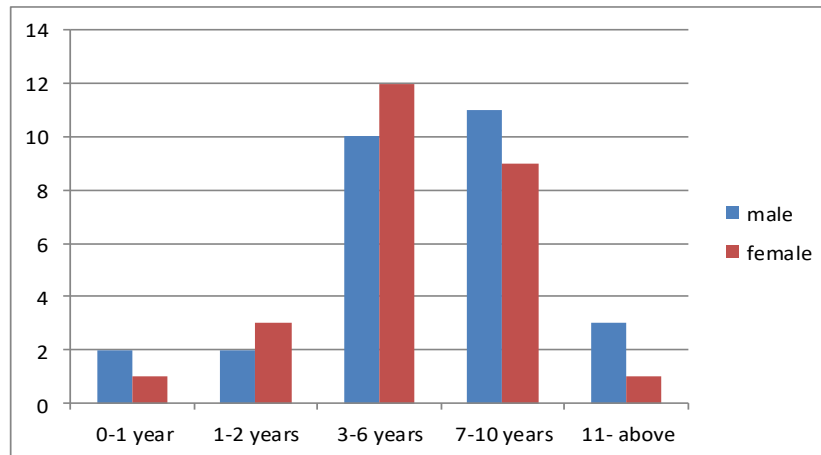


Figure 1 Distribution of individuals by sex and age

This distribution surprisingly coincides with the established ratio between the sexes of human offspring - Fisher's Principle [35] and leads us to think, that the development rules of human population refer in full force to the feline species. The relationship between gender and age has long been the subject of analysis by evolutionary biologists, mathematicians - demographers and modern sociologists. Determining the age structure allows better forecasting of population growth, plus the ability to link this growth to the level of economic development, respectively with the quality of life in the region [36]. In this sense, the age structure of the group shows similarity to that of developing countries - with high birth and death rates, low to medium life expectancy, the reasons for which are low-protein intake at the stage of group formation or inbreeding depression, reducing immunity to generations [37]. Two of the oldest cats, females, died in the summer of 2020 at the age of 12. Although aggressive behavior between individuals is rare, the group still does not have a stable structure within the Lotka meaning [38]: individuals in kittens and junior groups are few, young and sexually mature cats predominate, but there is no geriatric group. The consequences of improved animal welfare can only be analyzed over the next 10 years.

Research has established the required number of toilets in the laboratory [39] - in this case this can not be done so each has its place in the tray, some use different trays for urine and feces. It is known that the hygiene of uncastrated cats is more difficult to maintain - the most sexually active tomcats mark corners and walls, after cleaning the place they choose another place. All cats are demanding on the cleanliness of the beds in which they sleep - if they are dirty, the bedding is lowered to the ground or the place is avoided. Since most cats grow up in a crowded environment, the constant movement and sounds around them is not annoying. Usually in the morning and evening while some sleep, the younger ones play with toys or with each other. Sick cats or mothers usually need solitude before or after birth, but in reality they find the right place for themselves. Inhibited activity, characteristic of stressed cats [40] is extremely rare - for the study period, only 3 individuals showed a tendency to hide under covers for no apparent reason.

Cats are very sensitive to manipulation, environment and disruption of routine [41]. To minimize stress, contacts are minimized - in practice, even a number of basic medical procedures deal with the caretaker: deworming, first aid for viral diseases - vomiting, disorder, runny nose, inflamed eyes, fever, of course, after consultation with vet doctor. Gathering in one place of many animals, including sheltering sick ones, even for humanitarian reasons, enriches the "cocktail" of viruses. After a discussion with a veterinarian, the presence of the most common viruses was established - feline calicivirus (FCV), feline herpesvirus (FHV), and feline immunodeficiency virus (FIV), which reduce the number of individuals in the group at different age levels. In general, even the slightest health discomfort is detrimental to the psyche and physique of the cat at any age.

Playing, vocalizing, purring, kneading are just a few of the characteristics of normal behavior at home cat. But when veterinarians study in detail the biology of species they treat, they seem to forget one essential feature - reproduction. On other hand, the public consciousness skillfully manipulates with the call: "Castrate your pet!". The so-called reproductive (chart) pyramids are widely circulated, proclaiming the high reproductive potential of pets - a copy of the long-forgotten theory of Malthus on the reproduction of the human population [42]. Fortunately, the media does not fully quote Malthus's idea: if reproduction is not controlled, the human population, growing exponentially, will quickly deplete food resources and reach the so-called Malthusian Catastrophe. The domestication of animal species makes them completely dependent on humans [43] and it is very convenient to speculate on their inability to self-regulate

reproduction, giving humans the full right to control their reproduction, in this case by routine sterilization [44]. Control over the reproduction of primates and non-human animals has long been carried out in zoos, kennels, farms, etc.

The domestic cat (*Felis silvestris catus*), like all other members of the *Felidae* family, has a specific tomcat - induced ovulation. It is a surprising fact that animals, like plants, are dependent in their reproductive cycle on the day's length and the seasons [45]. The main biological functions in mammals - growth, reproduction, metabolism and stress adaptation are controlled by specific hormonal axes [46]. Physiological and psychological stress signals cause the hypothalamus to induce ACTH secretion by the pituitary gland, which instructs the renal cortex to secrete effector hormones - mainly cortisol, which in turn activate various hormones, including sex hormones. For temperate latitudes with four seasons, the role of stress factor is assumed by low temperatures and lack of food - in winter individuals report high levels of testosterone in males and estradiol - in females - a fact established for wild family members and domestic cat, which determines the peak of heat in February - March and weaker - in September. In fact, the terms "heat " and " anthem of survival" can easily be equated.

Testosterone in wild males play another important role - it is associated with aggression, so necessary for to establish their territory, to provide better food resources, to find female in heat and create a generation, etc. [47]. It is true that in a closed indoor community with provided resources, aggression is rather a stress factor and an obstacle in communication, but its extreme forms are rarely reached - usually the quarrel ends with a voice match with curved backs. In fact, more active behavior helps the indoor individuals to provide more daily protein intake, a more comfortable place to sleep, to observe, and so on.

Removal of the gonads at an early age leads to neoteny (delayed maturation) - a phenomenon more common in animals (incl. modern man) and less common in plants [48, 49]. Observations of castrated females in the group show that they are more gentle and timid than others, avoid contact with others, some even repel the young, and if feeding is not controlled by householder, they may fall asleep hungry. Both in indoor and outdoor conditions, this would doom them to death - such a lack of initiative in everyday life has been found in neutered feral cats and this is one of the reasons for the " vacuum effect" in their colonies [50]. As a rule, they are more capricious about food and their appetite should be stimulated with more treats and more often than others.

As the number of cats increases, so does the number of sexually mature males and females too. Although not all mature males and females participate in the reproductive process - usually the role of tomcats is taken over by 3-5 individuals, who chase another hot female as a pack. Thus, for a period of about 1-2 weeks, 4-5 queens are mated and give birth to about 15-20 kittens (period - 2007 - 2017). For females, childbirth is stressful and mothers line up like spoons next to each other in the first few days after birth. As they licking and calm each other, they make "kindergartens" by gathering all the newborn kittens in one place, or stealing their babies if they have chosen different places for the litter. During this period another interesting phenomenon in the reproductive strategy of the group is observed - synchronization of female reproductive cycles (in the human population this effect is defined as the McClintock phenomenon [51]). Similar synchronization of cycles, births and general rearing of young has been found in free-living lions [52, 53].

The cats in the study have two very important characteristics - intact physiological integrity (uncastrated, unvaccinated) and limited freedom of choice, insofar as they live in a confined space. According to Regan [54], it is the respect for the personal freedom (and dignity) of the animal that is considered as one of the moral components of welfare. In this sense, the ideas of modern guardians of animal rights and animal welfare - Nussbaum [55], Singer [56], Francione [57], Palmer [58] do a great job, but Darwin was the first [59]. Despite the closed and static environment, which hardly resembles the natural one, with wood pellets instead of soil, with curtains and furniture instead of trees and artificial prey, natural selection works .

The "first sieve" of the selection is made by the mothers themselves - guided by their primary instinct, they lie down and suffocate seemingly normal, but in fact sick and crippled babies (regardless of the number of newborns and the efforts of caretaker to keep them all). In the first week, 30-40% of the young are crushed or do not reach the mammary glands of any mother. For the observed period, two cases of cannibalism were observed by mothers - one at the beginning of the study period - 2008, when the cats were 5-6, and the other - in 2020 (with a full group), which shows that the causes of cannibalism are not stress from overcrowding or protein starvation. Males are attentive and caring to the young, rarely irritated by their presence. A total of 1-3 offsprings of all litters survive for up to 6 months. Presumed factors for high infant mortality are viral diseases ("second sieve"), a consequence of reduced immunity from inbreeding or weak breast milk. Individuals who have passed through the sieve of viruses indulge in a "happy" life - the food provided ensures early maturation. The static environment does not provide many opportunities for individuals to choose and they indulge in instincts - males do not miss a hot female, and females - a period of heat. This triggers the "third sieve" - exhausting the body from too much sex - in males and frequent births - in females. Active sexual life,

started at an early age, takes its victims - attacked by various viral diseases, some individuals barely live to 7-8 years. A similar relationship between longevity and annual reproductive success leading to early death has been found in female cheetahs [60]. The study showed that females who gave birth to more litters early in their life often died younger, indicating a trade-off between longevity and yearly reproductive success. Over the years, the number of young and mature females and males gradually decreases, respectively the number of litters. The ever-increasing protein index of food leads to fewer pregnant females giving birth less frequently and less, but healthier and disease-resistant kittens (period 2017 - 2020) - i.e. the group shows signs of control over its reproductive potential. In fact, behind the self-control of reproduction stands natural selection acting again, sifting out the individuals and genome they carry in order to better adapt them to indoor life, in a group [61]. Reproductive synchronization between females is de-centered and because their behavior is decisive in relationships, the first adaptive changes associated with indoor life are observed in them - skipping one or more mating periods until the body recovers from birth, change of the position of the body during mating (with a slight twist the normal position for mating at the last moment is disturbed, at which the females turn out to be lateral or with the abdomen to the tomcat), use of duvets, boxes, furniture and bags for hiding - the queen falls asleep surrounded by tomcats - a strategy maintained throughout the all period of mating.

4. Human - cat interactions

The formed group does not have a hierarchical structure, family ties are not respected, but the caretaker is a part of the group. As stated by Rochlitz [62], "the caretaker is the most important determinant of a cat's welfare, and group-housing in enriched environments cannot substitute for individual human care and attention". She is rarely awakened for breakfast, but the care and nutrition of the young are regularly transferred to her, she takes on the "complaints" of health problems and the consequences of their treatment - bites, scratches. Not all cats in the group allow her close to themselves - about 20% keep their distance and do not allow contact with her, and 5% even have the behavior of feral cat - hiss and run when approaching. 20% of individuals have names and respond to the moment when naming - either to an invitation for food, play or to end a conflict. Contacts with individuals are short, usually on their own initiative [63], morning cuddling is mandatory. Rare periods of free time in the evening are usually filled with joint games. In general, females are more distant, males show a strong attachment to the caretaker. Like all small mammals, small cats strictly obey to their circadian rhythms - the domestic cat is expected to have nocturnal activity genetically encoded by the prey it feeds on [64]. The strong connection between caretaker and individuals changes this activity to a daily one - with two main peaks: in the morning, especially before sunrise and morning meal, and in the evening, before sunset and evening meal [65]. The highest level of interaction between a cat and a caretaker is copying his behavior - it rarely happens in the group at the moment and requires more mutual activities.

5. Conclusion

The title of one of the Keulartz articles [66] - Captivity for Conservation!? can safely treat the domestic cat - only indoor life can provide the necessary security and tranquility of the species, especially in urban environment. In theory, domestic cat can be mated all year round - in practice, this high reproductive potential is never realized, even in indoor conditions. Raising more individuals is not a problem if food with a high protein content and inner freedom of the individuals are provided - aggressive behavior is rare, especially if there is a closeness in the relationship between cats and caretaker. The first adaptive changes associated with self-control of reproduction in indoor conditions were observed in the behavior of female individuals. The established similarity in a number of characteristics of the multicat household, the wild representatives of the family and the human population are evidence of natural processes taking place in it. This gives the species *Felis catus* a specific evolutionary value that should not be overlooked, regardless of the sins attributed to it. And while we are counting the closest ones who have trusted us - dogs and cats, and inventing more and more "humane" ways to reduce their populations, let's not forget about other, far more dangerous species living in our shadow - rodents and the plague epidemic, that still exists today [67]. With the advancement of genetics, many similarities have been established between the human and feline genomes, which makes cats invaluable helpers in the fight against hereditary and infectious diseases in humans [68, 69, 70].

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

No conflict of interest is being reported.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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