

The index of the hearts squad Carnivora, as an indicator of predator ecology

Roman Chikachev^{1,*}

¹Far Eastern State Agrarian University, Blagoveshchensk, Russia

Abstract. The article presents the results of calculating the heart index of representatives of the order of carnivores, as one of the main morphophysiological indicators of predator activity. Based on the results of the study, the criteria for specific environmental characteristics of predators used for food production and determining the degree of load on the body were determined. To determine these indicators in some representatives of predatory animals obtained in the Amur region weight measurements of the hearts of sexually Mature individuals were performed: *Martes zibellina*, *Meles leucurus*, *Canis lupus*, *Lynx lynx*, *Vulpes vulpes*. Weight indicators of the index were carried out by measuring the ratio of the total mass of the organ to the body weight of the animal (organ mass x 100/ total mass of the animal =%). Conditionally dividing the studied predatory species into: small, medium and large, we determined: active predators intensively tracking their prey and leading high physical activity. Specialized predators that get food by sneaking up and chasing for short distances, not able to run for a long time. Predator-gatherers. In which this feature was an adaptive reaction in the course of evolution for the survival of the species in adverse conditions, food competition and settlement of new territories.

1 Introductory part

The study of heart morphology was paid attention to by researchers of various directions. The body constantly needs the normal functioning of the heart, adapting to the influence of the environment and lifestyle, which forces to transform all the organs in the course of historical development.

The heart of a living organism performs the functions assigned to it during the entire period of the animal's life. While coping with many stressful situations, including the overall load on the body. The heart mass, as an absolute value, depends on the size of the animal, and within the species can vary from gender and age. But the relative index or so-called heart index does not directly depend on the total body weight, but depends on the body's oxygen demand, the frequency of organ work, metabolism, and energy expenditure. Nutrition and feeding activities of any animal are the main environmental characteristics that affect many other vital functions of the body. The method of morphophysiological indicators is used to study the correlation of morphological properties of a species with

*Corresponding author: chikachev1980@mail.ru

environmental factors. Thanks to them, there is an idea of the ecological conditionality of the physiological characteristics of animals, which in some cases creates prerequisites for the biological decoding of the actual ecology of the species, establishing the biological specificity of the population [1].

In the study of Elena Chirkova [2-4] the description of the morphology of predator hearts is given as an organ with a high index necessary for greater endurance, feeding intensity, respiration during the period of pursuit and foraging, and sharp maximum loads on the body.

2 Material and methods of research

To determine these indicators in some representatives of predatory animals obtained in the Amur region weight measurements of the hearts of sexually Mature individuals were performed: *Martes zibellina*, *Meles leucurus*, *Canis lupus*, *Lynx lynx*, *Vulpes vulpes*. Weight indicators of the index were carried out by measuring the ratio of the total mass of the organ to the body weight of the animal (organ mass x 100/ total mass of the animal =%). In the future the obtained results were supplemented with research data from other authors who studied the predators of the Far East [5-10].

3 Results

The results of the study and calculation of the heart index of some representatives of the order of carnivores are presented in table 1.

Table 1. Indicators of the heart index in some representatives of the Carnivora order (%)

The sight of a predator	Males			Females			Average index value for the view
	Limit		Average	Limit		Average	
	min	max		min	max		
<i>Ursus arctos</i>	-	-	0.70	-	-	0.50	0.60
<i>Pantera tigris</i>	-	-	-	-	-	-	0.42
<i>Lynx lynx</i>	0.50	0.73	0.62	0.57	0.69	0.64	0.63
<i>Canis lupus</i>	0.90	1.06	1.00	1.11	1.29	1.16	1.18
<i>Vulpes vulpes</i>	1.11	1.18	1.14	1.12	1.21	1.16	1.15
<i>Prionailurus euptilura</i>	-	-	-	-	-	-	0.53
<i>Meles leucurus</i> (with subcutaneous fat weight)	0.35	0.54	0.44	0.36	0.54	0.46	0.45
<i>Meles leucurus</i> (without subcutaneous fat)	0.50	0.73	0.62	0.49	0.79	0.61	0.62
<i>Martes zibellina</i>	1.14	1.60	1.34	1.11	1.46	1.27	1.53

In most cases (with the exception of the brown bear), the indicator is higher in females, which is due to the additional load on the body as a result of gestation and caring for the young. The difference between the minimum and maximum indicators refers to the individual characteristics of this animal.

The index of weight of the heart in (*Ursus arctos*) according to Boris Shevchenko [5] in males approximately 0.70%, in females 0.50%; for the type of average heart index – 0.60%. The brown bear is an omnivorous representative of the order of predators that include animal and plant food in their diet (Fig. 1).



Fig. 1. Brown bears on the feeding ground for ungulates. Photo By Viktor Grigoriev.

Animal feeds are represented by insects and their larvae, small vertebrates, folds of ground-nesting birds, carrion. The bear is able to produce large animals. Such hunts occur from ambush, the attack is lightning fast, and in case of failure of the attack - a short chase. This method is effective in case of attacks on small or weak animals and their young. Plant food in the diet of the brown bear is represented by berries, juicy parts of herbaceous plants, nuts and acorns, and agricultural crops.

These types of food are high-calorie and nutritious, which allows a large predator not only to fill the necessary energy needs, but also to accumulate a large enough supply of nutrients for winter hibernation. In General, the bear's diet has the character of a predator gatherer, adapted for a long gradual search and collection of food, and active hunting is characterized by short high physical loads.

Two indicators were used to calculate the heart index in Asian badger (*Meles leucurus*). Since it is a winter sleeping animal and before laying for a short period (1-2 months) accumulates subcutaneous fat up to 30 % from the total weight, the index was calculated from the total body weight of the animal and without the weight of the accumulated fat stock [11]. Thus the index of males from the total body weight Lim 0.35-0.54%, average 0.44%, without the accumulated reserves of fat Lim 0.50-0.73%, average 0.62%, in females, the heart index of total body weight Lim 0.36-0.54%, average 0.46%, without subcutaneous fat Lim 0.49-0.79%, average 0.61% respectively.

The badger is the only member of the marten family that spends an unfavorable cold period of the year in its sleep. Preparing the burrow for this (Fig. 2). At the same time, not making reserves, but building up a large amount of subcutaneous and internal fat. The appearance and lifestyle of the animal indicates its sluggish, but energetic lifestyle. Work on the removal of residential burrows, constant care for it, reconstruction, construction of additional temporary burrows. All this requires a huge expenditure of energy.

In nutrition, the badger, like the brown bear, is omnivorous. Occupying the ecological niche of the myophage-gatherer, it prefers animal feed, it is a predator not capable of pursuit. Its diet consists of insects and their larvae, invertebrates, amphibians, mouse-like, destroys the nests of ground-nesting birds, is able to hunt Chicks that have fallen out of the nest up to the stork, willingly eats carrion, in preparation for winter sleep, goes to feed on

acorns, nuts, visits agricultural fields with corn and soy. Thus, accumulating enough fat reserves for winter sleep.

In nutrition, the badger, like the brown bear, is omnivorous. Occupying the ecological niche of the myophage-gatherer, it prefers animal feed, it is a predator not capable of pursuit. Its diet consists of insects and their larvae, invertebrates, amphibians, mouse-like, destroys the nests of ground-nesting birds, is able to hunt Chicks that have fallen out of the nest up to the stork, willingly eats carrion, in preparation for winter sleep, goes to feed on acorns, nuts, visits agricultural fields with corn and soy. Thus, accumulating enough fat reserves for winter sleep.



Fig. 2. A lot of ground and procured a litter, the result of the preparation of the Asian badger burrows for the winter sleep. Photo of the author.

Heart index in Amur tiger (*Pantera tigris*) 0.42% [6]. One of the largest representatives of the group in the diet prefers to get medium and large ungulates, is able to get young bears, possible attacks on domestic animals. Being an antagonist of the wolf in nature, it hunts and eats it at every opportunity. The same applies to dogs (Fig. 3).



Fig. 3. The Amur tiger uses logging roads to make it noiseless and easier to find food during the snow-covered period. Photo Valeri Romania.

The index of the heart in lynx (*Lynx lynx*): males Lim 0.50 – 0.73%, average 0.62%, females Lim 0.57-0.69%, average 0.64%; for the type of average heart index – 0.63%. The

main food items for it are: medium-sized ungulates and their young, hares, teterevinny, in the conditions of forest – steppe agricultural landscapes-pheasants. Mathematical data processing shows a direct relationship between heart mass and body weight (Fig. 4).

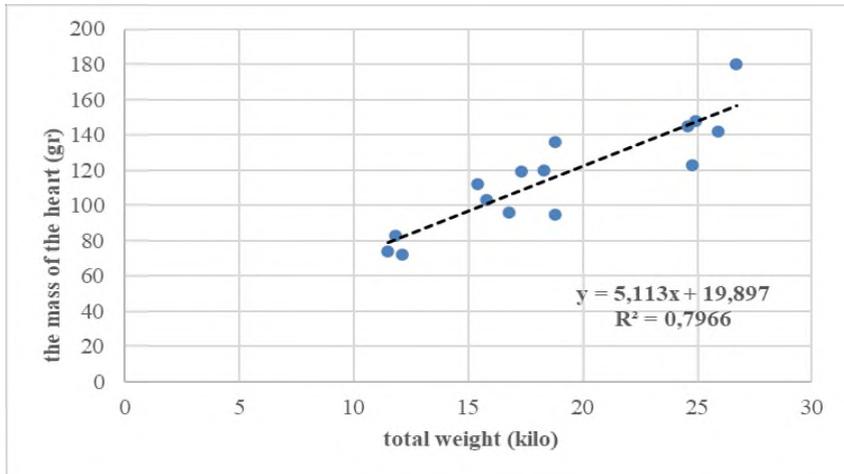


Fig. 4. Dependence of heart weight on body size in adult lynx.

Far Eastern forest cat has a heart index 0.53% [6]. Due to the unpretentious choice of food items, its potential victims can be all small animals from insects to frogs, fish, rodents, birds to such large animals as muskrats, pheasants, hares. Cat eats and carrion of wild and domestic animals [8].

All the family *Felidae* the way of life and methods of obtaining food are similar. When searching for food, cats can move around the grounds for a long time, at the time of detection of prey, the main hunting tactic is to hide, ambush and lightning attack at a short distance. The pursuit lasts only a few jumps. What does it say about the inability of cats to long maximum loads on the body [7].

In turn, the inability to run for a long time says the manner of defense of animals from the enemy. A far Eastern cat and a lynx climb a tree, while a young tiger defends itself by pressing its back against a tree. An adult tiger usually attacks the enemy itself, since it has no natural enemies in nature.

Wolf (*Canis lupus*) have a heart index-male Lim 0.90-1.06%, average 1.00%, females Lim 1.11-1.29%, average 1.16%; for the type of average heart index – 1.18%. Wolf eurytopic predator able to adapt to changing habitat conditions. Capable of hunting in a pack, a family group in which each has its own role often the pursuit of the victim can continue for a long time. The object of food for the wolf are all ungulate species, able to extract mouse-like, hares, birds, eat the corpses of fallen animals. The list of wolf food items can only be determined by their availability and availability in a given territory [9]. Wolves, due to a refined backbone and not much developed body weight, are able to develop high speed, move for a long time, but unlike dogs with a strong backbone and a stronger developed body weight, they are not able to maneuver more quickly when attacking a defending victim, so the probability of injury to wolves from a large victim is much higher. Therefore, the wolves need to exhaust and weaken the victim by prolonged pursuit. Mathematical data processing shows a direct relationship between the heart mass and the animal's body weight (Fig. 5).

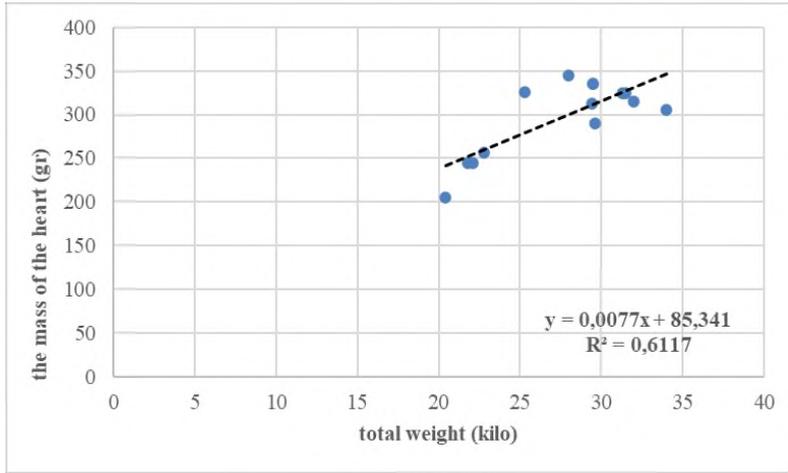


Fig. 5. The dependence of the heart weight from body measurements in adult specimens of the wolf.

Sable (*Martes zibellina*) has a heart index – males Lim1.14-1.60%, average 1.34 and females Lim 1.11-1.46%, average 1.27%; for the type of average heart index – 1.53%. The animal can be attributed to a multi-animal (aurifera). Using a wide variety of animal and plant feeds in their diet. Animal feeds include: insects, shellfish, fish, birds, and mammals, including such large prey as musk deer, hares, and capercaillie. The need for each of these groups of food for the seasons is determined by the physiological state of the animal's body, so in certain periods, regardless of the abundance of animal food in nature, this predator switches almost completely to eating plant food - berries, fruits of forest plants, nuts [12]. At the same time, in various environmental conditions, the sable has developed a variety of behavioral traits. Mathematical data processing shows a direct relationship between the heart mass and the animal's body weight (Fig. 6).

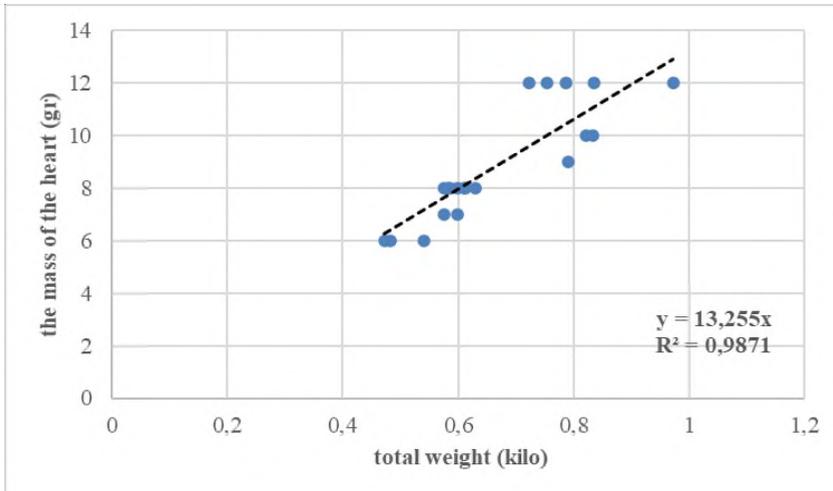


Fig. 6. Dependence of heart weight on body size in adult sable individuals.

Fox (*Vulpes vulpes*) has a heart index: males Lim1.11-1.18%, average 1.14 and females Lim 1.12-1.21%, average 1.16%, for the type of average heart index – 1.15%. The Fox consumes quite a large amount of animal feed, which includes: insects, rodents including hare and muskrat, birds, carrion. Forage of plant origin, as a rule, is additional food

resources of the Fox, which are used by it most often passively. Fox eats berries, nuts, soy beans. Includes leaves of cereals and sedges in the diet.

4 Discussion

The analysis of determining the activity of a predator species takes into account not only the diversity of the species composition of feed, but also their number, as well as the availability of food items. The increase in the biomass of potential victims increases with the disappearance of snow cover in the summer, which makes it possible for predators to be more selective in choosing food items, being determined in the direction of easy access and safety of extraction. To a certain extent the gender and age of the predator play a role which are to a different extent.

They have the skills and methods of obtaining food. Consequently, the size and hunting skills of predators of the same species, as do their victims, often correlated within the framework of proportionality - matching the physical parameters of the predator the physical parameters of the object of attack, and this is reflected in the individuality of individuals or groups of predators of the same species, not the species as a whole.

The so-called internal social organization that allows you to hunt together to get a larger victim and meet the need for food for all members of the group. Completely satiated in one meal.

5 Conclusions

Thus, conditionally dividing the studied predatory species into: small, medium and large, taking into account the similarity of spatial and trophic environmental conditions of the studied individuals, methods of foraging and seasonal rhythms, we can distinguish: A-active predators - intensively tracking their prey and leading high physical activity. They are small Martens (sable), foxes and wolves. In terms of cardiac index greater than 1 (Fig. 7).

A-high index of the heart index characterizes this group as actively hunting predators, leading an intraspecific and interspecific struggle with competitors for areas with high protective nesting and feeding conditions. Which require the constant presence of the host. This group also reflects the so-called biological meaning of the dependence of heart mass on total weight, which results in a difference in the ratio of body mass and its surface (the area of heat output). This also affects the increase in this indicator.

B-specialized predators. These include cats (lynx, tiger, cat) that have this indicator within the range of 0.42% before 0.64%, this is also explained by their methods of obtaining food by sneaking up and chasing at short distances.

C. predator gatherers. This Asian badger and brown bear in the process of evolution have become omnivorous representatives of the family of carnivorous predators-gatherers, this is due to the need to accumulate a large supply of subcutaneous fat in a short time to lie down in winter sleep. This feature was an adaptive reaction in the course of evolution for the survival of the species in adverse conditions, food competition and settlement of new territories. Omnivory is due to the peculiarities of ecological adaptation, and plant-based feed with a high content of proteins, fats and carbohydrates can be partially digested in the digestive tract of the predator accumulating reserves of adipose tissue up to 30% of the body weight. What makes it possible to lie down in winter sleep and use nutrients [11].

Understanding the physiological characteristics of wild predators as an adaptive ecological response is based on their physical activities related to the arrangement of burrows, long and long journeys in search of food for themselves and their offspring, and a

large consumption of food rich in protein and carbohydrates, which is very important for the period of preparation of the animal for winter sleep. In addition, the structure of the muscle tissue of badgers has a different microstructure in contrast to the similar way of life in the wild burrowing animals. The skeletal musculature of the badger has larger muscle fibers, while the connective tissue is less developed and has a less developed vascular network, respectively, poor blood supply [13].

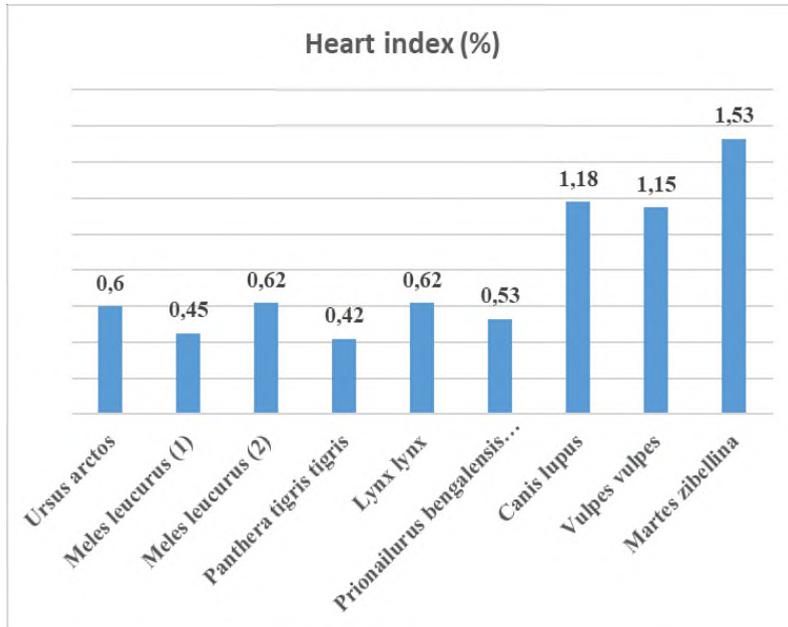


Fig. 7. Index the hearts of the members of the order of Carnivora (%).

According to physical data, the species has not lost the ability to high short-term and long-term uniform loads, which allows these predators to get food by active hunting, and with an increase in the total weight to switch to more affordable food (carrion, invertebrates, amphibians, weak and sick animals, plant food).

References

1. S. S. Shvartz, V. S. Smirnov, L. N. Dobrinsky *Method of morphophysiological indicators in the ecology of terrestrial vertebrates* **58**. 387 (1968)
2. E. N. Chirkova, Morphology of the heart and its internal structures of mammals of different ecological groups. *Biol*, 18 (2009)
3. E. N. Chirkova, S. M. Zavaleeva Architectonics of internal structures of the heart of the wolf as a representative of the terrestrial ecological group Ecology in the modern world: the view of scientific youth, *Materials of the all-Russian conference of young scientists*, 32-36. (2007)
4. E. N. Chirkov, S. M. Savelieva The morphology of internal heart structures the red Fox, *Bulletin of Orenburg state University. Orenburg* **6** (70), 104 108. (2007)
5. B. Shevchenko. *Anatomy of a brown bear*, 454 (2003)
6. A. Zhilin Morphological parameters of the heart of wild cats of the Primorye territory Dissertation of the candidate of veterinary Sciences-Ussuriysk, 147 (2017)

7. Zhilin, A. I. Korotkova Some aspects in the structure of the heart of the far Eastern lynx, *Young scientists-agro-industrial complex of the Far East: materials of the XV interuniversity scientific and practical conference of young scientists, postgraduates and specialists*, 14-20. (2015)
8. V. G. Yudin far Eastern forest cat. 443 (2015)
9. V. G. Yudin *The Wolf Of The Far East Of Russia*, **2** 412 (2013)
10. V. G. Yudin. the Fox of The far East of the USSR Vladivostok: DVNTs of the USSR Academy of Sciences. 282 (1986)
11. R. A. Chikachev Anatomy of the intestines of the Asian badger of the Amur subspecies as an ecological adaptive feature of an omnivorous predator Ecological and biological well-being of plants and animals, *Materials of the international scientific and practical conference*, 237-239. (2017)
12. N. N. Bakeev, G. I. Monakhov, A. A. Sinitsyn *Vyatka*, **2**, 336 (2003)
13. R. A. Chikachev, S. L. Sandakova, I. A. Berseneva blood Indicators of the Amur subspecies of the Asian badger (*Meles leucurus amurensis*) in the autumn period far Eastern agrarian Bulletin. Blagoveshchensk, **2** (46), 108-113. (2018)