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CEPHALOPODS IN THE DIET OF KEYSTONE-SPECIES ANIMALS IN THE REGION OF THE ARGENTINE ISLANDS ARCHIPELAGO (WEST ANTARCTICA)

ABSTRACT. Objective. The study of diet of keystone-species vertebrates (*Nothotenia coriiceps*, *Phalacrocorax bransfieldensis*, *Leptonychotes weddellii*) in the ecosystem of the Argentine Islands Archipelago. **Methods.** Biological researches were conducted on Akademik Vernadsky station during wintering in 2006–2007, 2009–2010, 2011–2012, 2019 accordance with tasks of the State Special-Purpose Research Program in Antarctica for 2011–2020. In total, the content of 30 faeces of the *L. weddellii*, 64 pellets and three stomachs of the *Ph. bransfieldensis* and 40 stomachs of the *N. coriiceps* were analyzed. Material was collected at all seasons. **Results.** The *L. weddellii* diet is dominated by three squid species *Galiteuthis glacialis* (39,5%), *Brachiotheutis picta* (21%) and the fishery species *Psychroteuthis glacialis* (15.8%). In the diet of *Ph. bransfieldensis* were found the main four Octopus species such as *Adelieledone polymorpha* – 20%, *Pareledone turqueti* – 20%, and *Graneledone sp.* – 24% and *Benthoctopus sp.* – 16%, who owns the highest proportion of hits. In the nutrition of *N. coriiceps*, cephalopods are rarely recorded. Only one species of Octopus has been registered and has been identified only to the Cirroteuthidae family. **Conclusions.** Found that in the diet of keystone-species vertebrates (*N. coriiceps*, *Ph. bransfieldensis*, *L. weddellii*) in the ecosystem of the Argentine Islands Archipelago there are 13 species of Cephalopods, of which 4 species belong to squid Decapoda and 9 species to octopuses Octopoda (3 species are identified to the genus and one to the family). The findings are important not only to establish the actual status of the Antarctic ecosystem and to conserve biodiversity in the Antarctic region.

Keywords: Cephalopoda, Antarctica, Argentine Islands Archipelago, keystone-species, feeding.

INTRODUCTION

The material was collected during Ukrainian Antarctic expeditions in 2006–2007; 2009–2010, 2011–2012, 2019 in the Argentine Islands Archipelago (West Antarctica). The Argentine Islands Archipelago is located in the Pacific Antarctic in the western part of the Antarctic Peninsula between 65°13'–65°16' S and 64°10'–64°20' W, 142 km north of the Polar Circle, which extends 66°33' S. The island

chain stretches from southeast to northwest 5–7.5 km from the land of Graham Antarctic Peninsula. From the peninsula it is separated by the Penola Strait. The total area of the archipelago is only about 3.5 km². Due to its successful location, the archipelago serves as a kind of refugium for marine invertebrates and vertebrates.

For the comprehensive analysis of the trophic chains of the Antarctic ecosystem, was selected three key species of vertebrates: fish – Yellowbelly rockcod *Nothotenia coriiceps* J. Richardson; bird – Antarctic shag *Phalacrocorax bransfieldensis* King and marine mammal – Weddell seal *Leptonychotes weddellii* (Lesson). The purpose of this work was to study the diet

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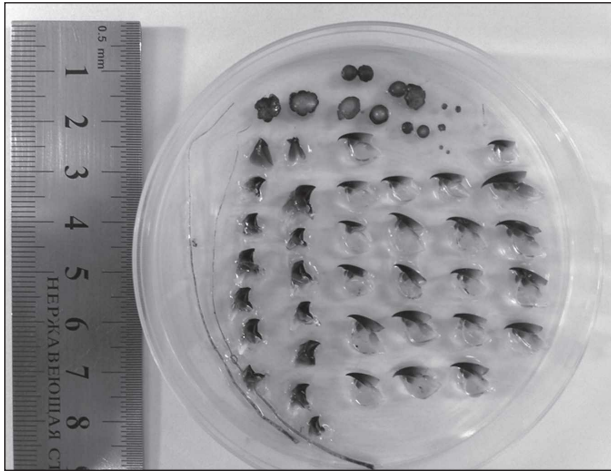


Fig. 1. Cephalopod-beaks from the pellets of Antarctic shag (*Ph. bransfieldensis*)

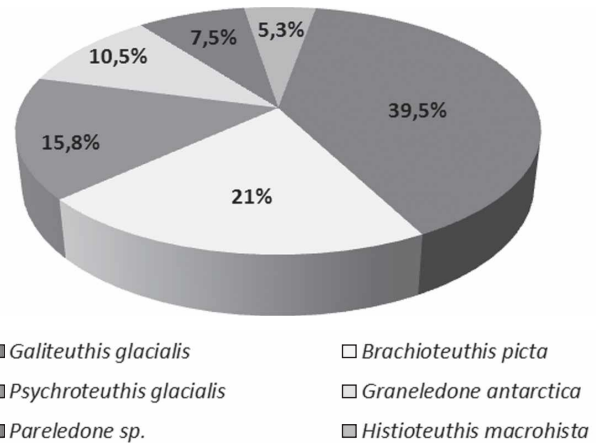


Fig. 2. Frequency of occurrence of different species of cephalopods in Weddell seal (*L. weddelli*) feces from the Argentine Islands Archipelago

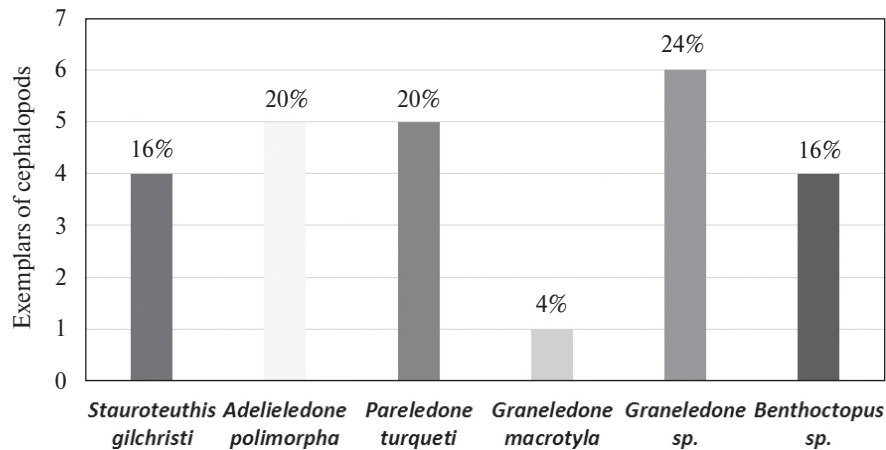


Fig. 3. The number of exemplars of cephalopods in the pellets Antarctic shag (*Ph. bransfieldensis*) from the Argentine Islands Archipelago

of keystone-species vertebrates (*N. coriiceps*, *Ph. bransfieldensis*, *L. weddellii*) in the ecosystem of the Argentine Islands Archipelago. To identify the species composition and estimate the percentage of cephalopods in their diet was the task. Results of this study will be used in the program for monitoring and forecasting the density of the Cephalopoda population (CCAMLR Ecosystem Monitoring Program CEMP) of the Commission on Conservation Marine Living Resources (CCAMLR). The provision of research results in the CCAMLR allows us to really assess the species composition and presence of Cephalopoda

species in this CCAMLR Subarea 48.1. and use the results to develop a strategy for the management and rational use of the natural resources. The studies were conducted in accordance with the objectives of the State Special-Purpose Research Program in Antarctica for 2011–2020.

METHODS

In total, the content of 30 faeces of the *L. weddellii*, 64 pellets and three stomachs of the *Ph. bransfieldensis* and 40 stomachs of the *N. coriiceps* were analyzed.

Material was collected at all seasons. The samples were washed separately with a sieve (minimum mesh 0.54 mm) (Casaux et al. 2005; Daneri et al., 1999). Cephalopods were identified using chitins cephalopod-beaks (upper and lower jaws) (Fig. 1) according to the Cephalopod Beak Guide for the Southern Ocean (Xavier, Cherel, 2009) and Identification key and species description for Antarctic squids (Okutani T., Clarke M., 1985; www.antarctica.ac.uk/about_antarctica/wildlife/index.php; www.marinespecies.org/photogallery.php?album=668).

RESULTS

Leptonychotes weddellii. Previously, Xavier J.C., Cherel Y. (2009) examined the feeding of Weddell seals by four species of cephalopods in the western Antarctic region, and in particular in the South Shetland Islands and near the Antarctic Peninsula. In particular, the diet of the seal included such cephalopods as *Gonatus antarcticus* Lönnberg, *Kondakovia longimana* Filippova, *Moroteuthis knipovitchi* Filippova and *Psychroteuthis glacialis* Thiele (Clarke, Mac-Leod, 1982; Lipinski, Woyciechowski, 1981). A scatological analysis of *L. weddellii* showed that cephalopods predominate in the seal feeding area of the Argentine Islands Archipelago after the fish (Dykyy, 2009; 2012). Among the cephalopods in *L. weddellii* diet are four squid species, three of which have been identified. In particular, *Brachioteuthis picta* Chun, whose chitinous beaks often occur in its excrement (Fig. 2). Also in the excrement of several individuals of the Weddell seal from Cruls Islands and Forge Islands (near French Strait) found large squid beaks of *P. glacialis*, measuring up to 44 cm in size. The squid habitat captures the Antarctic Peninsula, and the species favors depths of 200 to 700 m and according to literary data is included in the diet, sperm whale, Weddell and elephant seals (Fisher, Hureau, 1985; Clarke, 1980).

Two new squid species, such as *Histioteuthis macrorhista* Voss and *Galiteuthis glacialis* Chun, have also been identified (Fig. 2). The excrement analysis also revealed two antarctic Octopus species – *Graneledone antarctica* Voss and *Pareledone sp.*, which were

first identified in the diet of this species in the Argentine Islands Archipelago.

Phalacrocorax bransfieldensis. Analysis of pellets *Ph. bransfieldensis* showed that fish predominate in bird diet (54%), including the remains of 407 exemplars of fish of 19 species (734 otoliths) (Zahorodnyi, Dykyy, 2017). Found that in second place in diet *Ph. bransfieldensis*, after fish, is dominated by Cephalopods (36%). The pellets revealed 25 upper and 10 lower cephalopod-beaks belonging to 25 individuals of Cephalopods. In particular, it was found that the diet of *Ph. bransfieldensis* includes six species of Cephalopods, namely Octopus representatives. Four of them were identified. In particular, *Adelieledone polimorpha* Robson – 20% and *Pareledone turqueti* Joubin – 20%, whose chitins-beaks are most commonly found in *Ph. bransfieldensis*. Also isolated from the pellets of octopus beaks *Stauroteuthis gilchristi* Robson – 16% and *Graneledone macrotyla* Voss – 4%, which occur less frequently. The largest proportion of Cephalopods is from the genera *Graneledone* – 24% and *Benthoctopus* – 16% which we were not able to identify to the species level (Fig. 3).

Nothotenia coriiceps. An analysis of 40 stomachs of *N. coriiceps* shows that sometimes Cephalopods also become prey to large fish specimens. Only in one stomach were registered three fragments of the mandible of one octopus, species from the family Cirroteuthidae.

CONCLUSIONS

The diet of keystone-species vertebrates (*N. coriiceps*, *Ph. bransfieldensis*, *L. weddellii*) in the ecosystem of the archipelago of the Argentine Islands Archipelago includes 13 species of Cephalopods, of which 4 species belong to squid Decapoda and 9 species to octopuses Octopoda (3 species are identified to the genus and one to the family). The *L. weddellii* diet is dominated by three squid species *G. glacialis* (39.5%), *Brachiotheutis picta* (21%) and the fishery species *P. glacialis* (15.8%). The diet of *Ph. bransfieldensis* is dominated by the main four Octopus species such as *A. polimorpha* – 20%, *P. turqueti* – 20%, and *Granele-*

done sp. — 24% and *Benthoctopus* sp. — 16%. In the diet of *N. coriiceps*, Cephalopods are rarely recorded. Only one species of octopus has been registered by belongin to the Cirroteuthidae family. The findings are important not only to establish the actual status of the Antarctic ecosystem and to conserve biodiversity in the Antarctic region.

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REFERENCES

1. Casaux, R., Baroni, A., Ramo, A. 2005. The diet of the Weddell Seal *Leptonychotes weddellii* at the Danco Coast, Antarctic Peninsula. *Polar Biol.*, 25, 1–6.
2. Clarke, M. 1980. Cephalopoda in the diet of sperm whales of the Southern Hemisphere and their bearing on sperm whale biology. *Discov Rep.*, 37, 1–324.
3. Clarke, M., MacLeod, N. 1982. Cephalopod remains in the stomachs of eight Weddell seals. *Br. Antarc. Surv. Bull.*, 57, 33–40.
4. Daneri, G.A., Piatkowski, U., Coria, N.R., Carlini, A.R. 1999. Predation on cephalopods by Antarctic fur seals, *Arctocephalus gazella*, at two localities of the Scotia Arc, Antarctica. *Polar Biol.*, 21, 59–63.
5. Dykyy, I. 2012. The feeding peculiarities of the Antarctic seals in the region of the archipelago of Argentina Islands. *Document CCAMLR № WG-EMM-12/PI*. 1–9.
6. Dykyy, I. 2009. The feeding peculiarities of the Antarctic seals in the region of the archipelago of Argentina Islands. *Ukrainian Antarctic Journal*, 8, 215–223.
7. Fisher, W., Hureau, J.C. 1985. FAO species identification sheets for fishery purposes. *Southern Ocean (Fishing Areas 48, 58 and 88)*. FAO, 1, 232.
8. Lipinski, M., Woyciechowski, M. 1981. Cephalopods in the food of Weddell seals from the Admiralty Bay (King George Island, South Shetland Islands). *Pol Polar Res.*, 2(3–4), 163–167.
9. Okutani, T., Clarke, M. 1985. Identification key and species description for Antarctic squids. *BIOMASS Handbook*, 21, 57.
10. Xavier, J.C., Cherel, Y. 2009. Cephalopod Beak Guide for The Southern Ocean. *British Antarctic Survey*. Cambridge, UK. 129.
11. Zahorodnyi, I., Dykyy, I. 2017. The feeding of the Antarctic shag (*Phalacrocorax (atriceps) bransfieldensis*) in the region of the archipelago of Argentina Islands (Western Antarctica). *VIII International Antarctic Conference Dedicated to the 25th anniversary of Ukraine's accession to the Antarctic Treaty (Kyiv, Ukraine, May 16–18, 2017)*. Kyiv, 54–55.

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ГОЛОВОНОГІ МОЛЮСКИ В ЖИВЛЕННІ КЛЮЧОВИХ ВИДІВ ТВАРИН АРХІПЕЛАГУ АРГЕНТИНСЬКІ ОСТРОВИ (ЗАХІДНА АНТАРКТИКА)

Мета. Дослідження трофічних зв'язків ключових видів хребетних тварин (*Nothotenia coriiceps*, *Phalacrocorax bransfieldensis*, *Leptonychotes weddellii*) екосистеми Аргентинських островів. Завданням було з'ясувати, видовий склад і який відсоток становлять головоногі молюски в їхньому живленні. **Методи.** Дослідження проводилися на Українській антарктичній станції «Академік Вернадський» (регіон архіпелагу Аргентинські острови) впродовж зимівок (2006–2007; 2009–2010, 2011–2012, 2019) у відповідності до завдань Державної програми досліджень України в Антарктиці на 2011–2020 рр. Загалом проаналізовано вміст 30 екскрементів тюленя Уеддела *Leptonychotes weddellii*, 64 пелеток та трьох шлунків блакитноокого баклана *Ph. bransfieldensis* та 40 шлунків гололобої нототенії *Nothotenia coriiceps*. Збір матеріалу був проведений включаючи усі пори року. Відібрані зразки окремо промивалися за допомогою сита. Визначення головоногих молюсків проводилося за хітиновими дзьобиками (верхніми і нижніми щелепами). **Результати.** В раціоні *L. weddellii* домінує три види кальмарів *Galiteuthis glacialis* (39,5%), *Brachiotheuti spicta* (21%) та

промисловий вид *Psychroteuthis glacialis* (15,8%). В раціоні *Ph. bransfieldensis* домінують основні чотири види восьминогів такі як *Adelieledone polymorpha* – 20%, *Pareledone turqueti* – 20%, та *Graneledone sp.* – 24% і *Benthooctopus sp.* – 16 %, яким належить найбільша частка трапляння. В живленні *N. coriiceps* головоногі молюски трапляються досить рідко. Зареєстровано лише один вид восьминога, який вдалося ідентифікували лише до родини Cigroteuthidae. **Висновки.** З'ясовано, що до спектра живлення ключових видів хребетних тварин екосистеми Аргентинські острови входить 13 видів головоногих молюсків, з яких 4 види належать до кальмарів Decapoda і 9 видів (три види ідентифіковано лише до роду і один до родини) належать до восьминогів Ostopoda. Отримані результати мають важливе значення не лише для встановлення фактичного стану антарктичної екосистеми та збереження біорізноманіття в регіоні Антарктики.

Ключові слова: Cephalopoda, Антарктика, Аргентинські острови, ключові види, живлення.