Notes on Some Fishes Associated with the Antarctic Krill. II. On *Xenocyttus nemotoi* ABE, and Again on *Neopagetopsis ionah* NYBELIN*

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南極オキアミ漁で混獲された魚類について II.
ツブマトウダイ *Xenocyttus nemotoi* ABE および，ふたたび，
カラスコオリウオ *Neopagetopsis ionah* NYBELINについて*

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要旨: ツブマトウダイ (*Xenocyttus nemotoi* ABE) は，1957年マッコウクジラの胃袋から得られた唯一の標本に基づいて命名発表されたが，その後，ソ連の学者による報告があり，他方最近になって，オキアミ漁に混獲されるものが相当数見られた．それらのうち魚学および食品化学研究用に標本29個体を採集し，他方深海トロールで得られた1尾の写真を入手した．本種の生活史，分布等については不明な点が多いが，上記の資料について記し，また最近の他の研究者による知見を紹介する．

肉の一般成分分析は3個体について実施し，水分 84.2%，粗タンパク質 9.6%，粗脂肪 3.8%，灰分 1.1% (いずれも平均値) の結果を得た．また筋肉と体全体を包むように存在する硬い皮下組織層の熱伝導度を測定，比較したところ，両者には明らかに差は認められたが，その違いは大きいものではなかった．

次に，カラスコオリウオ (*Neopagetopsis ionah* NYBELIN) については，前報作製の際，見落したソ連の文献がいくつかあり，その後出た報告もある．追加標本も日本のオキアミ調査の際にかなり多数得られたし，オキアミ漁と直接関係はないが，ロス海のトロールで6個体 (標準体長 165～435mm) をも入手したので，これらについて簡単に報告する．なおオキアミ漁の際，カラスコオリウオはツブマトウダイより数多く見られることが確かめられた．また，カラスコオリウオの鰓条骨数は8または9であるが，前報で述べたように，9の場合の方がやはり多く，9個ある場合には最下のものが発達不十分で，末端は鰓条膜辺縁に到達しない場合が多いことを知った．

Abstract: Since the description of *Xenocyttus nemotoi* ABE in 1957, there have been but a few records of this oreosomatid fish. Recently it is taken from time to time along with the Antarctic krill, and 29 specimens have been received for study. Their size varies very little, standard length being 113 mm to 180 mm.

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This species is now known to occur off Patagonia as well. They are thought to be the young of a much larger fish. Their diet is copepods.

In the absence of the holotype of its close ally, *Pseudocyttus maculatus* GILCHRIST, it is thought advisable to discuss the relationships of *Xenocyttus* with the other members of the Oreosomatidae and Zeiformes in the future.

The flesh of three specimens of *Xenocyttus nemotoi* measuring some 150 mm in standard length contains water (84.2%), crude protein (9.6%), crude fat (3.8%) and crude ash (1.1%). The subcutaneous tissue is fairly hard, and its heat conductivity is *ca.* 0.60 (kcal/m·h·°C) as against *ca.* 0.65 in the flesh.

Many specimens of *Neopagetopsis ionah* NYBELIN have been collected since the publishing of the previous paper of this series. It is met with oftener than *Xenocyttus nemotoi* at fishing grounds of the Antarctic krill. The number of branchiostegals is oftener 9 on either side. At times it is 8 on either side, or 9 on one side and 8 on the other. The young take the Antarctic krill as food, but one larger specimen trawled at depth in the Ross Sea contained *Pleuragramma antarcticum* BOULENGER in the stomach.

The results of the extensive surveys made by the biologists of U.S.S.R. and observations made by Dr. Keiji NASU (Far Seas Fisheries Research Laboratory) and Mr. Takehiko WATANABE (Tokai Regional Fisheries Research Laboratory) in the austral summer months, 1976–77, on board the fishing boat DAINI BANSHU-MARU (2406 tons), those by Dr. Satoru NAKAMURA (Japan Marine Fishery Resource Research Center, abbreviated to JAMARC hereafter), Mr. Takehiko WATANABE and the junior author in the austral summer months, 1977–78, on board the mother ship ÔTSU-MARU (8000 tons), those by Mr. Nobukazu SHIBATA (Tokai Regional Fisheries Research Laboratory) in the austral summer months, 1978–79, on board the mother ship SHINANO-MARU (8650 tons), those by Mr. Akira HASHIMOTO (JAMARC) in the austral summer months 1978–79 and 1979–80 on board the same ship as just above, and those by Mr. Masanori TAKAHASHI (JAMARC) during the austral summer months, 1979–80, on board the YOSHINO-MARU (3264 tons) have revealed that the zeoid (or oreosomatid) fish *Xenocyttus nemotoi* ABE is to be found among or near the Antarctic krill from time to time and that *Neopagetopsis ionah* NYBELIN is taken along with the krill much oftener than the zeoid (or oreosomatid).

It is remarkable to see that these fishes taken by the midwater trawl for the krill have swollen belly with full of food in the stomach, and that whereas the diet of *Neopagetopsis ionah* is composed of the krill, the stomach contents of *Xenocyttus nemotoi* are composed mostly of numerous individuals of copepods, *Calanus* spp.*, as first stated by SVETLOV (1978). Further, the distribution range of the latter fish is now known

* In one specimen, the posterior half of the body of an Antarctic krill was found in the mouth. It is not unlikely that in the net the fish gulped the krill.

to extend to the southwest Atlantic (NAKAMURA, 1976). The authors wish to express their sincere thanks to Drs. K. NASU, S. NAKAMURA, Messrs. T. WATANABE, N. SHIBATA, A. HASHIMOTO and M. TAKAHASHI for their kindness and cooperation; to Dr. P. A. HULLEY (South African Museum) for cooperation; to Dr. Tri-Thuc NGUYEN (Ocean Research Institute, University of Tokyo) for drawings, radiographs and counting of the meristic characters; to Mr. Takashi KIDACHI (Tokai Regional Fisheries Research Laboratory) for identification of the stomach contents of *Xenocyttus nemotoi*; to Dr. Kenji MOCHIZUKI (Division of Fisheries, University Museum, University of Tokyo) for radiographs; to Mr. Tetsuo IWAMI (Institute of Biological Sciences, University of Tsukuba) for radiographs, measurements and counting of meristic characters; and to Yamada Science Foundation and Itô Foundation for the Advancement of Ichthyology for help in many ways. It is a pleasing duty of the authors to thank the Department of Marine Biology of the South African Museum for the loan of a specimen of *"Cyttosoma maculatus"* (=*Pseudocyttus maculatus* GILCHRIST).

***Xenocyttus nemotoi* ABE**

Tsubu-matôdai (Japanese name)

Figs. 1, 2 and 3.

Since the description based on the single type specimen of this species in 1957, it was recorded by SVETLOV (1978) (one specimen, 134 mm long) from a depth of 30 m at 64°24′S, 87°57′W, and by NAKAMURA (1976) (one specimen, 120 mm long) under the name of *Pseudocyttus* sp. from off Patagonia at depth of 1121–1158 m.

In the present study, the following specimens have been available:

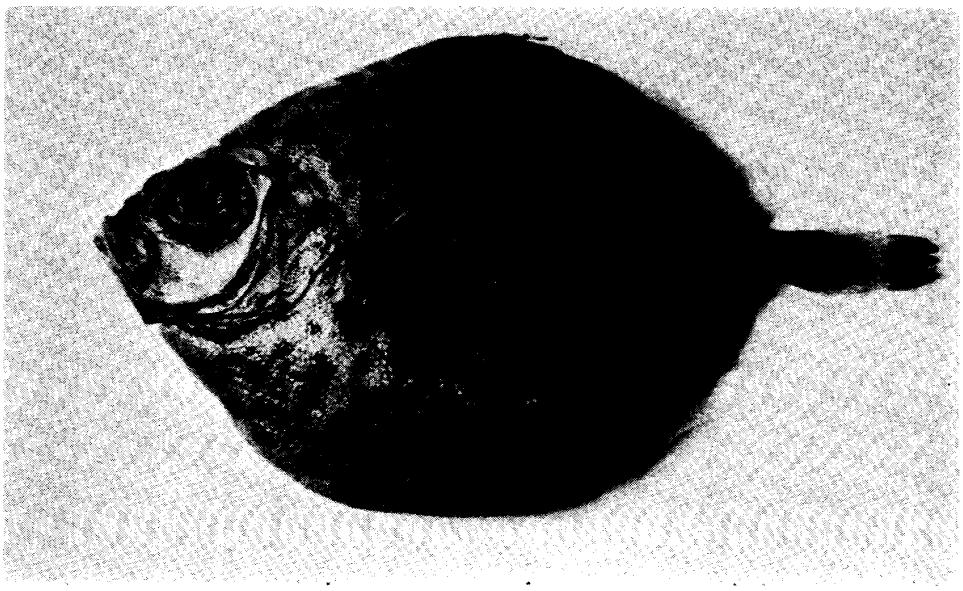

Fig. 1. *Xenocyttus nemotoi* ABE. Total length 155 mm.

1 (160 mm TL.*, 135 mm SL.**)	Dec. 10, 1977	63°34′S, 129°41′E
1 (155 mm SL.)	Dec. 17, 1977	64°10′S, 117°50′E
1 (145 mm TL., 123 mm SL.)	Jan. 6, 1978	64°36′S, 123°14′E
1 (142 mm SL.)	Jan. 8, 1978	64°36′S, 115°45′E
1 (128 mm SL.)	Jan. 10, 1978	64°37′S, 115°13′E
1 (147 mm SL.)	Jan. 12, 1978	64°29′–64°38′S, 114°22′–115°14′E
1 (*ca.* 160 mm TL., 135 mm SL.)	Jan. 18, 1978	64°14′S, 113°30′E
1 (*ca.* 165 mm TL., 138 mm SL.)	Jan. 20, 1978	64°22′S, 113°47′E
1 (180 mm TL., 153 mm SL.)	Jan. 22, 1978	64°26′S, 112°52′E
2 (135 , 150 mm SL.)	Jan. 25, 1978	64°37′S, 112°47′E
1 (143 mm SL.)	Jan. 27, 1978	64°26′S, 112°38′E
3 (153–175 mm TL., 132–148 mm SL.)	Jan. 28, 1978	64°27′S, 112°31′E
3 (148–162 mm TL., 125–138 mm SL.)	Jan. 1978	64°05′S, 114°34′E
1 (149 mm TL., 128 mm SL.)	Dec. 1977–Jan. 1978	63°40′S, 121°31′E–64°10′S, 114°10′E
1 (*ca.* 170 mm TL., 138 mm SL.)	Feb. 1, 1978	64°23′S, 111°55′E
1 (128 mm SL.)	Feb. 2, 1978	64°37′S, 112°47′E
1 (173 mm TL., 148 mm SL.)	Dec. 10, 1978	64°10′S, 125°20′E
1 (138 mm SL.)	Dec. 23, 1978	64°01′S, 126°34′E
1 (131 mm SL.)	Dec. 24, 1978	64°08′S, 125°47′E
2 (125, 138 mm SL.)	Dec. 25, 1978	64°08′S, 125°48′E
1 (182 mm TL., 155 mm SL.)	Jan. 7, 1980	63°42′S, 91°11′E
1 (175 mm TL., 153 mm SL.)	Jan. 12, 1980	63°10′S, 90°30′E
1 (182 mm TL., 156 mm SL.)	Jan. 13, 1980	63°09′S, 90°07′E
1 (133 mm TL., 113 mm SL.)	Feb. 26, 1980	67°50′S, 85°14′W

Though not taken along with the Antarctic krill, a specimen of this species measuring 220 mm in TL. and weighing 250 g was photographed on board the fishing vessel DAISHIN-MARU on December 12, 1976. The photograph has been received from the Kyokuyô Fishing Co. for identification. The fish was caught at 48°58′S, 71°08′E at depth of 672–652 m.

In view of the remarkable change with advancing age in body shape, squamation, etc. in some groups of teleosts, and in view of the absence (destroyed, after PENRICH,

* Total length.

** Standard length.

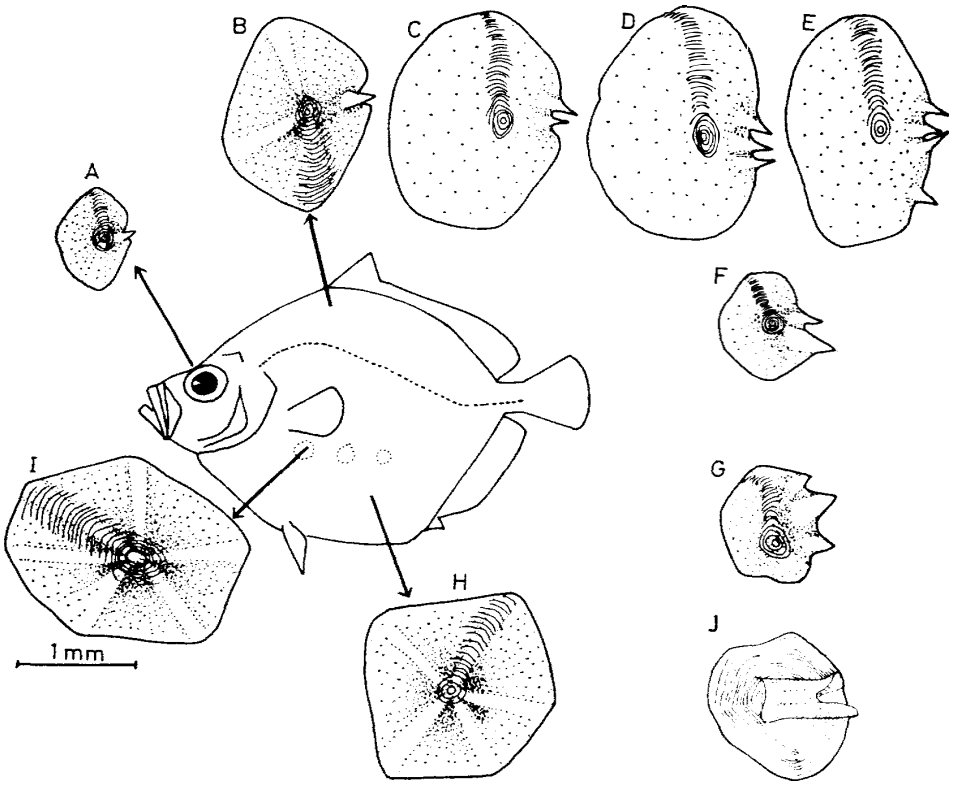

Fig. 2. Scales of *Xenocyttus nemotoi* ABE. A, B, H, I: from a specimen measuring 140 mm in SL.; C-G: from a specimen measuring 155 mm in SL.; J: from middle part of lateral line of a specimen measuring 149 mm in SL.

Fig. 3. Left and right sagitta (inner side) of a specimen measuring 149 mm in SL. The scales in the figure measure 1 mm.

1969) of the holotype of *Pseudocyttus maculatus* GILCHRIST, it is thought advisable to wait for opportunities of getting specimens of various sizes before discussing the relationships of the present species with the others of the family Oreosomatidae or Zeiformes. The type specimen of *Xenocyttus nemotoi* has long been at the hand of Dr. George S. MYERS and his team who are far in advance in the study of Zeiformes.

The specimens listed above will be sent to proper persons on request.

It may be worth mentioning that the counting of vertebrae (43) is somewhat difficult because of the unusual shape of the atlas and that the shape of the scales varies considerably even in specimens measuring 130–150 mm in SL. as seen from Fig. 2.

Distribution. Eastern and Western Antarctic; off Patagonia.

Food chemical and biophysical notes. The muscle of this fish is what is called "white muscle" and well developed from dorsal to caudal part except for abdominal part where the viscera are packed. The abdominal cavity is formed and protected by the elastic, hard and collagenous subcutaneous layer. The subcutaneous layer wraps up the whole body with variable thickness.

Three specimens measuring 140–154 mm in standard length and weighing 164–258 g have been used for chemical and physical studies. They were stored at −25°–−30°C for several months on board etc., and thawed before subjected to general chemical analysis and measurement for heat conductivity. The analysis was done on the flesh from the dorsal part and on the subcutaneous layer from the abdominal part. Moisture was determined by drying method. Crude protein, crude fat and crude ash were analyzed by Kjeldahl method, Soxhlet's method and AOAC method, respectively. The heat conductivity was measured by Box-probe method* (QTM-MD Meter, Showa-denkô Co. Ltd.). The results of three experiments are presented, by mean value, in Tables 1 and 2.

Table 1 shows that the moisture, crude protein and crude fat of the flesh were 84.2%, 9.6% and 3.8%, respectively. Macroscopical and microscopical observations suggest that the subcutaneous layer of this fish is not made of an adipose tissue, and that it is rather composed of a connective tissue. This was also supported by the results of general analysis, *i.e.*, the subcutaneous tissue contained less fat (about 10%) than the subcutaneous adipose layer in the other fish, for example, sardine whose skin with

Table 1. Chemical composition of flesh and subcutaneous tissue of *Xenocyttus nemotoi* ABE (weight % on wet basis).

Substance	Flesh	Subcutaneous tissue
Moisture	84.2	80.2
Crude protein	9.6	8.0
Crude fat	3.8	9.5
Crude ash	1.1	1.2

* It is ideal that the thickness of sample is infinite on measuring heat conductivity by Box-probe method. But, in the present work, it was confirmed that the thickness of the sample (6.5–7.0 mm) had no effect on measuring by Schmidt's analysis (MCADAMS, 1954).

subcutaneous adipose tissue contains 64% fat (YAMADA, 1979). But general composition of the subcutaneous layer was the same as that of the flesh except for fat content.

Table 2 shows the heat conductivity of the flesh and the subcutaneous layer was about 0.65 and 0.60 (kcal/m·h·°C), respectively. As to the heat conduction, the result indicates that the subcutaneous layer of this fish is not an unique tissue and that the heat is conducted at nearly the same speed as that of the flesh.

Table 2. Heat conductivity of flesh and subcutaneous tissue of *Xenocyttus nemotoi* ABE.

Sample	k* (kcal/m·h·°C) mean±SD
Flesh	$0.65_4 \pm 0.02_3$
Subcutaneous tissue	$0.59_8 \pm 0.01_6$

* Significant difference at 5% level.

Again on *Neopagetopsis ionah* NYBELIN

In the previous paper of this series (ABE and SUZUKI, 1978), the following works were not referred to: PERMITIN, 1966 (16 specimens: southern Scotia Sea; northern Weddell Sea at 69°18′S, 118°50′W, over great depth), PERMITIN, 1969 (58°58′S, 42°30′W; 58°30′S, 26°23′W; 60°11′S, 35°10′W, over great depths in northern Weddell Sea), DEWITT, 1970 (1 adult specimen 381 mm TL.; Ross Sea), PERMITIN, 1970 (Scotia Sea off South Orkney and South Sandwich Islands), PERMITIN and TARVERDIEVA, 1978 (South Orkney Islands).

After the publishing of the previous paper of this series, the following additional specimens of this species have been received:

1* (*ca.* 128 mm SL.)	Nov. 23, 1976	64°17.2′S, 134°08.0′E
2* (*ca.* 150, 150 mm SL.)	Nov. 27, 1976	63°59.6′S, 129°22.2′E
2 (175, 200 mm SL.)	Jan. 12, 1978	64°29′S–64°38′S, 115°14′E–114°22′E
1 (*ca.* 355 mm TL., 310 mm SL.)	Feb. 10, 1978	66°02′S, 139°42′E
23 (81–197 mm SL.)	Austral summer months, 1977–78	63°40′S, 121°33′E ~ 64°10′S, 114°10′E
2 (68, 197 mm TL., 60, 168 mm SL.)	Dec. 9, 1978	64°13′S, 125°21′E
7 (*ca.* 200–250 mm TL.)	Austral summer months, 1978–79	63°18′S, 115°52′E ~ 65°47′S, 141°50′E

* In poor condition. Branchiostegals not counted.

6 (*ca.* 150–180 mm SL.)	Austral summer months, 1978–79	63°48′S 125°48′E	~ 64°08′S 128°26′E
5 (192–213 mm TL.)	Dec. 13, 1979– Jan. 6, 1980	63°42′S 79°35′E	~ 64°55′S 91°11′E

Though trawled in the Ross Sea, the following specimens have also been examined:

2 (*ca.* 165 mm, *ca.* 295 mm SL.)	Feb. 22, 1979	75°30.0′S 169°55.3′E	~ 75°33.0′S 169°50.5′E
3 (193 mm, 270 mm, 420 mm SL.)	Feb. 23, 1979	72°29.5′S 172°56.0′E	~ 72°30.4′S 172°56.6′E
1 (*ca.* 480 mm TL., 435 mm SL.)	Feb. 23, 1979	73°27.7′S 173°52.0′E	~ 73°30.5′S 173°46.9′E

The number of branchiostegals is 9(2+7) or 8(2+6); 9 (left) and 9 (right) in 27 specimens, 9 (left) and 8 (right) in 7 specimens, 8 (left) and 9 (right) in 4 specimens, 8 (left) and 8 (right) in 7 specimens, 9 (left) and (?) (right, damaged) in 1 specimen, 8 (left) and 8 or 9 (right) in 1 specimen. The 9th (the lowermost) branchiostegal is often incomplete; the distal end and sometimes distal and proximal ends do not reach the margin of the branchiostegal membrane.

While thawing the specimens and while putting labels in a warm room, autolysis proceeded rapidly making the counting of branchiostegals difficult. The numbers of the branchiostegals given above are those correctly counted.

In one of the larger specimens trawled in the Ross Sea, three fairly large individuals of *Pleuragramma antarcticum* BOULENGER were found in the stomach. In smaller specimens taken with krill net the stomach contents consist mostly of the Antarctic krill.

References

ABE, T. and KAJI, S. (1972): A record of *Oreosoma atlanticum* (Oreosomatidae, Zeiformes, Teleostei) from Tasman Sea. Uo, **8**, 5–7.

ABE, T. and SUZUKI, M. (1978): Notes on some fishes associated with the Antarctic krill. I. *Neopagetopsis ionah* NYBELIN. Nankyoku Shiryô (Antarct. Rec.), **62**, 23–28.

DEWITT, H. H. (1970): The character of the midwater fish fauna of the Ross Sea, Antarctica. Antarctic Ecology, Vol. 1, ed. by M. W. HOLDGATE. London, Academic Press, 305–314.

HEEMSTRA, P. C. (1980): A revision of the zeid fishes (Zeiformes: Zeidae) of South Africa. Ichthyol. Bull. J.L.B. Smith Inst. Ichtyol., **41**, 3+18.

HOTTA, H. (1961): Nihon-san Kôkotsu Gyorui no Chujiku Kokkaku no Hikaku Kenkyu (Comparative Study of the Axial Skeleton of Japanese Teleostei.), Tokyo, Norin-Suisan-Gijutsu-Kaigi-Jimukyoku, 4+155+10 p (69 pls.).

KARRER, C. (1973): Uber Fische aus dem Sudostatlantik. Mitt. Zool. Mus. Berlin, **49** (1), 191–257.

McADAMS, W. H. (1954): Heat Transmission. 3rd ed. New York, McGraw-Hill, 31–54.

McALLISTER, D. E. (1968): Evolution of branchiostegals and classification of teleostome fishes. Natl Mus. Can., Bull., **221**, 239 p (2 page-less figs).

MYERS, G. S. (1960): A new zeomorph fish of the family Oreosomatidae from the coast of California, with notes on the family. Stanford Ichthyol. Bull., **7** (4), 89–98.

NAKAMURA, I. (1976): Karâ Enyô Gyojô no Sokouo-rui, Vol. II. Tokyo, Nihon-Torôru-Sokouo-Kyôkai, 57, 69 (Figs. S. Afr.-41 and Patagonia-12).

NAUMOV, A. G. and PERMITIN, Yu. E. (1973): O troficheskikh vzpimootnosheniyakh *Euphausia superba* dana i ryb Yuzhnogo Okeana (na primere Morya Skotiya) (On trophic relations between *Euphausia superba* and fish in the Southern Ocean with special reference to the Sea of Scotia.). Tr. VNIRO, **113**, 216–229.

PERMITIN, Yu. E. (1966): Novye dannye o vidovom sostave i rasprostranenii ryb Morya Skotiya (Skosha) (Antarktika) (Some new data on specific composition of fish in the Sea of Scotia). Vopr. Ikhtiol., **6** (3), 424–531.

PERMITIN, Yu. E. (1969): Novye dannye o vidovom sostave i rasprostranenii ryb Morya Skotiya (Skosha) v Antarktike (New data on specific composition of fish in the Scotia Sea). Vopr. Ikhtiol., **9** (2), 221–239.

PERMITIN, Yu. E. (1970): The consumption of krill by Antarctic fishes. Antarctic Ecology, Vol. 1, ed. by M. W. HOLDGATE. London, Academic Press, 177–183.

PERMITIN, Yu. E. (1977): Vidovoy sostav i zoogeograficheskii analiz fauny donnykh ryb Morya Skotiya (Species composition and zoological analysis of bottom fish fauna of the Scotia Sea). Vopr. Ikhtiol., **17**, 843–861.

PERMITIN, Yu. E. and TARVERDIEVA (1978): Pitaniye ryb semeystv nototenievykh i belokrovnykh u Yufnykh Orkneyskikh Ostrovov (Feeding of Antarctic cods (Nototheniidae) and ice-fishes (Chaenichthyidae) near the South Orkney Islands). Biol. Morya, **2**, 75–81.

SMITH, J. L. B. (1960) 1961: *Oreosoma atlanticum Cuvier*, 1829, in South Africa, with notes on other zeid fishes. Ann. Mag. Nat. Hist., Ser. 13, **3**, 565–569, 1 pl.

SVETLOV, M. F. (1978): Sluchay poimki *Xenocyttus nemotoi* ABE v Yugo-vostochnoy Chsti Tikhogo Okeana (A record of *Xenocyttus nemotoi* ABE from the Southeast Pacific). Vopr. Ikhtiol., **18** (3), 544.

YAMADA, J. (1979): Lipid oxidation in various tissues of sardine, *Sardinos melanosticta*. Bull. Tokai Reg. Fish. Res. Lab., **99**, 21–27.

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