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# Abyssal echinoid and asteroid fauna of the North Pacific

A.N. Mironov, K.V. Minin*, A.B. Dilman

*P.P. Shirshov Institute of Oceanology, Russian Academy of Sciences, Nakhimovsky Pr., 36, Moscow 117997, Russia*

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ABSTRACT

Echinoidea and Asteroidea collected in the Kuril–Kamchatka Trench area by the KuramBio Expedition were examined. Altogether 20 species belonging to 16 genera were found, among them six species and two genera were recorded in the North Pacific for the first time. Morphological variability of *Abyssaster tara* suggests that this species is congeneric with *Styracaster transitivus* and *Styracaster paucispinus*. Complete age series of the echinoid *Echinosigra amphora* and the asteroid *Eremicaster crassus* are described. The juveniles of *E. amphora* ( > 0.5 mm in length) are characterized by unique ophicephalous pedicellaria in the centre of aboral side of the test. The abyssal echinoid and asteroid fauna of the North Pacific (north of 30°N and deeper than 3000 m) comprises 62 species of 36 genera; 22 species (35%) and 3 genera are endemic to this region. Global distribution patterns of genera support the hypothesis that there were two stages of dispersal from the Antarctic to the North Pacific: at earlier stage the dispersal occurred via the East Pacific and at the later stage – via the West Pacific. The genera that had dispersed at earlier stage are represented only in the North and East Pacific and Antarctic. Distribution ranges of these genera in the East Pacific are limited to the narrow zone extending meridionally along the base of the American continental slope. Genera with such distribution pattern are likely adapted to highly eutrophic conditions.



## 1. Introduction

The abyssal fauna of the North Pacific comprises a unique set of species. For this reason the North Pacific was defined as a distinct province in schemes of biogeographic regionalization. This province borders with the West Pacific and East Pacific Provinces (Belyaev, 1989; Kussakin, 1979; Vinogradova, 1959, 1997), or in some schemes with the West Pacific, East Pacific and Central Pacific Provinces (Mironov, 2013; see also Vinogradova, 1997, Fig. 11). According to Watling et al. (2013), the North Pacific Province is adjacent to the broad North Central Pacific Province and narrow near-continental Chile–Peru–Guatemala Basins Province. Depending on the author's opinion, the position of the south border of the North Pacific Province in the western sector varies from 39°N to 29°N. The broad shelves of the Bering and Chukchi Seas separate the North Pacific Province from the Arctic subregion of the Atlantic Deep-Sea Region. The Aleutian, Kuril–Kamchatka, Japan and Izu–Ogasawara Trenches are united by Belyaev (1989) into the Aleutian–Japan Hadal Province.

The isopod fauna of the North Pacific displays high level of species endemism and high proportion of species belonging to genera with the world-wide distribution (Kussakin, 1979). The relationship between faunas of the North Pacific and Southern Ocean has been noted repeatedly. For example, the Antarctic origin was suggested for some North Pacific abyssal genera (Belyaev, 1975, 1985; Gebruk, 1994; George and Menzies, 1968; Kussakin, 1973; Menzies et al., 1973; Mironov, 1976, 1980, 1982). However general patterns in radiation of the Antarctic deep-sea fauna remain uncertain (Gage, 2004).

First deep-sea investigations of the North Pacific fauna (north of 30°N and deeper than 3000 m) were carried out in 1875 by H.M. S *Challenger* (three samples). Two species of Echinoidea and ten species of Asteroidea were found (Agassiz, 1881; Sladen, 1889). Thirteen echinoid and asteroid species new to science or new to the North Pacific abyssal were reported from samples taken by USFC *Albatross* expeditions (Agassiz and Clark, 1907; Fisher, 1905, 1910, 1911, 1917, 1928). As a result of numerous Russian expeditions (Baranova, 1957; Belyaev, 1969, 1985; Belyaev and Mironov, 1993; Belyaev and Moskalev, 1986a, 1986b; Golotsvan, 1998; Korovchinsky, 1976; Korovchinsky and Galkin, 1984; Mironov, 1971, 1973, 1974, 1976, 1995, 1997a, 1997b, and other), the number of species increased from 25 to 54. Among them 27 species were collected by R.V. *Vityaz*. Two more species new for the North Pacific abyssal were described based on samples of R.V. *Melville* (Downey, 1979) and R.V. *Golden Fleece* (Downey, 1986). Thus 56 echinoid and asteroid abyssal species belonging to 34 genera were known from the North Pacific so far.

* Corresponding author. Tel.: +7 499 1292118.
*E-mail address:* kirill.minin569@gmail.com (K.V. Minin).

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**Table 1**
List of stations of the KuramBio Expedition with Echinoidea and Asteroidea

| Station | Date | Latitude (start–end) | Longitude (start–end) | Depth [m] | Gear |
|---|---|---|---|---|---|
| SO223/001-10 | 30.07.2012 | 43°58.35′N–43°58.33′N | 157°18.23′E–157°17.97′E | 5423–5429 | EBS |
| SO223/001-11 | 30.07.2012 | 43°58.44′N–43°58.61′N | 157°18.29′E–157°18.13′E | 5418–5419 | EBS |
| SO223/001-12 | 31.07.2012 | 43°58.19′N–43°57.81′N | 157°19.11′E–157°21.58′E | 5379–5421 | AGT |
| SO223/001-13 | 31.07.2012 | 43°58.36′N–43°58.26′N | 157°15.70′E–157°14.60′E | 5425–5427 | AGT |
| SO223/002-10 | 03.08.2012 | 46°14.77′N–46°14.99′N | 155°32.79′E–155°32.62′E | 4859–4865 | EBS |
| SO223/002-11 | 03.08.2012 | 46°13.69′N–46°14.87′N | 155°33.29′E–155°32.49′E | 4861–4869 | AGT |
| SO223/003-10 | 05.08.2012 | 47°14.27′N–47°14.94′N | 154°42.17′E–154°43.18′E | 4977–4986 | AGT |
| SO223/004-3 | 06.08.2012 | 46°58.34′N–46°58.46′N | 154°33.03′E–154°33.39′E | 5681–5780 | EBS |
| SO223/004-4 | 07.08.2012 | 46°58.00′N | 154°32.37′E | 5766 | GKG |
| SO223/004-5 | 07.08.2012 | 46°57.97′N | 154°32.49′E | 5766 | GKG |
| SO223/005-11 | 12.08.2012 | 43°35.67′N–43°34.75′N | 153°57.93′E–153°58.12′E | 5378–5379 | AGT |
| SO223/005-12 | 12.08.2012 | 43°35.91′N–43°34.72′N | 153°57.94′E–153°58.28′E | 5379 | AGT |
| SO223/006-9 | 14.08.2012 | 42°29.25′N–42°28.32′N | 154°0.05′E–153°59.73′E | 5293–5307 | AGT |
| SO223/006-10 | 14.08.2012 | 42°29.00′N–42°27.88′N | 154°0.09′E–154°0.32′E | 5295–5299 | AGT |
| SO223/006-12 | 15.08.2012 | 42°28.49′N–42°28.22′N | 153°59.54′E–153°59.71′E | 5304–5307 | EBS |
| SO223/007-4 | 16.08.2012 | 43°2.31′N | 152°59.16′E | 5222 | GKG |
| SO223/007-10 | 17.08.2012 | 43°01.82′N–43°01.66′N | 152°58.55′E–152°58.45′E | 5223–5221 | EBS |
| SO223/007-11 | 18.08.2012 | 43°2.66′N–43°1.57′N | 152°59.46′E–152°58.59′E | 5218–5222 | AGT |
| SO223/007-12 | 18.08.2012 | 43°2.56′N–43°1.46′N | 152°59.48′E–152°58.62′E | 5222 | AGT |
| SO223/008-9 | 20.08.2012 | 42°14.32′N–42°14.27′N | 151°42.68′E–151°42.49′E | 5125–5126 | EBS |
| SO223/008-10 | 21.08.2012 | 42°14.76′N–42°14.46′N | 151°43.85′E–151°42.76′E | 5124–5125 | AGT |
| SO223/008-11 | 21.08.2012 | 42°14.74′N–42°14.40′N | 151°43.53′E–151°42.32′E | 5121–5126 | AGT |
| SO223/008-12 | 21.08.2012 | 42°14.38′N–42°14.32′N | 151°43.12′E–151°42.94′E | 5127–5124 | EBS |
| SO223/009-4 | 22.08.2012 | 40°35.03′N | 151°0.06′E | 5404 | GKG |
| SO223/009-9 | 23.08.2012 | 40°34.51′N–40°34.25′N | 150°59.92′E–150°59.91′E | 5399–5421 | EBS |
| SO223/009-10 | 24.08.2012 | 40°36.13′N–40°35.31′N | 151°0.07′E–151°0.12′E | 5404–5406 | AGT |
| SO223/009-11 | 24.08.2012 | 40°35.12′N–40°34.44′N | 151°0.15′E | 5401–5404 | AGT |
| SO223/009-12 | 25.08.2012 | 40°34.49′N–40°34.28′N | 150°59.85′E–150°59.18′E | 5399–5392 | EBS |
| SO223/010-5 | 26.08.2012 | 41°11.99′N | 150°5.75′E | 5251 | GKG |
| SO223/010-9 | 26.08.2012 | 41°11.37′N–41°11.17′N | 150°05.63′E–150°05.60′E | 5264–5266 | EBS |
| SO223/010-10 | 27.08.2012 | 41°12.82′N–41°11.75′N | 150°5.76′E–150°5.81′E | 5249–5258 | AGT |
| SO223/010-11 | 27.08.2012 | 41°12.04′N–41°10.78′N | 150°5.87′E–150°6.34′E | 5236–5257 | AGT |
| SO223/010-12 | 27.08.2012 | 41°12.802′N–41°13.011′N | 150°6.162′E–150°05.652′E | 5245–5262 | EBS |
| SO223/011-5 | 29.08.2012 | 40°12.86′N | 148°6.02′E | 5350 | GKG |
| SO223/011-9 | 29.08.2012 | 40°12.49′N–40°12.37′N | 148°05.40′E–148°05.43′E | 5263–5362 | EBS |
| SO223/011-10 | 30.08.2012 | 40°13,3.′N–40°12.53′N | 148°6.48′E–148°5.76′E | 5347–5348 | AGT |
| SO223/011-11 | 30.08.2012 | 40°13.55′N–40°12.90′N | 148°6.77′E–148°6.20′E | 5349–5352 | AGT |
| SO223/011-12 | 31.08.2012 | 40°12.328′N–40°12.106′N | 148°5.738′E–148°5.538′E | 5350–5348 | EBS |
| SO223/012-2 | 31.08.2012 | 39°43.43′N | 147°9.98′E | 5243 | GKG |
| SO223/012-4 | 31.08.2012 | 39°42.78°N–39°42.49′N | 147°09.55′E–147°09.37′E | 5224–5215 | EBS |
| SO223/012-5 | 01.09.2012 | 39°43.47′N–39°42.54′N | 147°10.11′E–147°9.51′E | 5217–5229 | AGT |

The joint German–Russian expedition KuramBio (Kurile Kamchatka Biodiversity Study) on board of the R.V. *Sonne* (cruise SO 223) sampled the abyssal plain adjacent to the Kuril–Kamchatka Trench from 21st July to 7th September 2012. A total of 20 species of Echinoidea and Asteroidea from 16 genera were found, six species and two genera are recorded in the North Pacific for the first time. The present paper reports the results of examination of the KuramBio collection. This work also summarizes knowledge on global distribution patterns of echinoid and asteroid genera known from the North Pacific abyssal.

## 2. Material and methods

The study area of the KuramBio expedition extends from 39°42′N to 47°18′N and from 147°4′E to 157°27′E. The depth ranges from 4830 to 5780 m. The echinoids and asteroids were taken at 19 Agassiz trawl (AGT) stations, 15 modified epibenthic sledge (EBS; see Brandt et al., 2013) stations and 7 box-corer (GKG) stations (Table 1). In the AGT samples, irregular echinoids were mostly represented only by fragments of tests. Identification of fragmentary specimens is based mainly on features of pedicellariae that were removed from fragments and placed in approximately 5% sodium hypochlorite (household bleach, such as Clorox®). The sutures of plastron plates were indistinct externally but easily observed internally in the adult *Ceratophysa ceratopyga*. For this reason plate patterns were drawn from inside. The echinoid and asteroid juveniles were found in the EBS samples. Available complete age series made it possible identifying with certainty juveniles of the two species, the echinoid *Echinosigra* (*Echinogutta*) *amphora* and the asteroid *Eremicaster crassus*. The following traditional abbreviations were used: TL – length of test, TW – width of test, TH – height of the test (for echinoids), *R* – radius, *r* – interradius (for asteroids).

In addition, the KuramBio material on Crinoidea was examined. Only fragments of stalks were found in five samples.

All maps were created using GeoMapApp software (version 3.3.9; Ryan et al., 2009).

## 3. Results and discussion

### 3.1. Systematics

**Class Echinoidea**
**Order Echinothurioida**
**Family Kamptosomatidae**
***Kamptosoma abyssale* Mironov, 1971**
Fig. 1A–C, E–L

*Kamptosoma abyssale* Mironov, 1971: 321–323, Figs. 2–4; 1997b: 75.

*Holotype*. Institute of Oceanology, Moscow, No. XV-69-1, R.V. *Vityaz*, St. 5609, test 55 mm in diameter.