Contribution to the knowledge on supralittoral macroinvertebrates of the northwestern Black Sea

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Abstract
A checklist of the northwestern Black Sea supralittoral fauna is presented. It includes 18 species: Ophelia bicornis, Namanereis pontica, Cryptorchestia cf. garbinii, Deshayesorchestia deshayesii, Orchestia montagui, Orchestia gammarellus, Orchestia montagui, Armadilloniscus ellipticus, Halophiloscia cf. couchii, Ligia italica, Tylos ponticus, Chthamalus stellatus, Microeuraphia depressa, Thalassomyia frauenfeldi, Donacilla cornea, Myosotella myositis, Truncatella subcylindrica, and Melarhaphe nertoides. This paper provides distribution maps for this species in the northwestern Black Sea, based on field studies. The changes that occurred in species composition are discussed. The regional IUCN categories are proposed.

Key words: biodiversity, distribution, species, IUCN assessment, conservation.

Introduction

The Black Sea differs from most seas or oceans in its nontidal conditions. Its littoral zone (known as the “pseudolittoral” or “midlittoral”) is reduced (Arnoldi, 1948) and formed not by regular tides, but by wave oscillations (Mokievsky, 1949). As a result, the ranges of specialized littoral and supralittoral species are limited by narrow belts of the corresponding biotopes, often no more than tens of centimeters wide.

This makes it vulnerable, especially given the maximum littoral concentration of many human activities: industry, agriculture, hydropower engineering; municipal, fishery and shipping infrastructure, recreational activities, and coast protection works. Such spatial coincidence with strong human impact causes different types of ecological and economic conflicts (Zaitsev 2006).

At the same time, the supralittoral fauna is not covered by official monitoring in any of the Black Sea countries and is usually also relatively little studied in scientific works. Only a few studies in the Black Sea (Mokievsky, 1949; Caspers 1951; Surugiu, Giurgiu, 2006) covered supralittoral species of different taxonomic groups in the complex.
The northwestern Black Sea (from the Cape Kaliakra to the Cape Tarkhankut) has additional specificity, because, firstly, it is desalinated by the largest European rivers (especially, the Danube and the Dnieper) and, secondly, it includes large shallow semi-closed bays, which are absent in other areas of the sea (Zaitsev et al, 2006).

In this paper, we summarize data on the current distribution of marine supralittoral species in the northwestern Black Sea and its changes. Both many taxa of terrestrial origin (beetles, flies, spiders, etc.) and sea crabs distributed in the sublittoral, which spend part of the day on land, were excluded from this analysis. Large Enchytraeidae also are excluded. Recent studies show high cryptic diversity in this group, but materials from the Black Sea basin were not included (Erséus, et al, 2019). The revision of the Black Sea species will also fundamentally change its taxonomy and species composition.

Material and Methods

The paper uses both results of our field research in the region between the Danube Delta and the Cape Tarkhankut (2005-2020) and literature sources (retrospective data and data on the region south on the Danube to the Cape Kaliakra).

It was used both qualitative (manual sampling) and random stratified quantitative (with 10 cm² frame) approach. The specimens were stored in 96% ethanol solution in the Institute of Marine Biology of the National Academy of Science of Ukraine (IMB NASU) collection.

Additionally, several museum collections were studied; among them, usable materials were found at the National Museum of Natural History at the National Academy of Sciences of Ukraine (NMNH). The studied localities are listed in Table 1.

Table 1. The studied localities.

| Station Number | Locality Name                  | Latitude  | Longitude | Date of record |
|----------------|--------------------------------|-----------|-----------|----------------|
| 1              | Zhebriany Gulf                 | 45,49983  | 29,62325  | 25.06.2018     |
| 2              | Zhebriany Gulf                 | 45,51417  | 29,63492  | 14.04.2012     |
| 3              | The spit of Lake Sasyk          | 45,53608  | 29,65944  | 27.06.2017     |
| 4              | The Danube Delta Edge          | 45,40908  | 29,75981  | 26.06.2009     |
| 5              | The spit of Lake Dhashtejske    | 45,61394  | 29,77553  | 16.09.2012     |
| 6              | The Danube Delta edge          | 45,45853  | 29,77994  | 29.06.2018     |
| 7              | The Tuzly Lagoons              | 45,67514  | 29,87169  | 24-25.04.2016  |
| 8              | The Tuzly Lagoons              | 45,67186  | 29,88422  | 24.04.2016     |
| 9              | The spit of Lake Dhashtejske    | 45,67806  | 29,88694  | 24-27.04.2016  |
| 10             | The Dniester Liman             | 46,41439  | 30,26206  | 08.06.2018     |
| 11             | The Dniester Liman             | 46,47228  | 30,26892  | 30.09.2012     |
| 12             | The Budaki Lagoon              | 45,95272  | 30,31597  | 23-24.07.2010  |
|                |                                |           |           | 11.09.2011     |
| 13             | Snake Island                   | 45,42361  | 30,34258  | 10.09.2016     |
| 14             | The Dniester Estuary           | 46,19814  | 30,34306  | 29.04.2018     |
| 15             | The Budaki Spit                | 45,97861  | 30,34722  | 31.03.2013     |
| 16             | The Budaki Lagoon              | 46,00664  | 30,38078  | 22.04.2011     |
| 17             | The Budaki Spit                | 46,00586  | 30,38094  | 23.04.2011     |
| 18             | V. Kurortne, Odessa region     | 46,00606  | 30,38122  | 24.07.2010     |
| 19             | The Budaki Spit                | 46,02812  | 30,40858  | 04.08.2014     |
| 20             | The Dniester Estuary           | 46,24325  | 30,43542  | 29.09.2013     |
| 21             | The Khadzhibej Estuary         | 46,83747  | 30,46281  | 23.04.2014     |

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|   | Location                                      | Latitude  | Longitude | Collection Date(s)                  |
|---|----------------------------------------------|-----------|-----------|-------------------------------------|
| 22| The spit of the Dniester Estuary             | 46,08047  | 30,48006  | 31.03.2013                          |
| 23| The spit of the Dniester Estuary             | 46,11056  | 30,50356  | 31.03.2013                          |
| 24| The Dniester Estuary                         | 46,13011  | 30,50864  | 19-20.10.2009                       |
|   |                                              |           |           | 02.06.2018                          |
| 25| The Dnieper-Bug Estuary                      | 46,61292  | 30,55814  | 17.06.2011                          |
| 26| V. Sanjiyka, Odessa region                   | 46,21829  | 30,60318  | 06.09.2019                          |
| 27| V. Sanjiyka, Odessa region                   | 46,23540  | 30,61944  | 13.07.2011                          |
| 28| V. Sanjiyka, Odessa region                   | 46,24333  | 30,62664  | 03.08.2013                          |
| 29| V. Sanjiyka, Odessa region                   | 46,24456  | 30,62692  | 03.08.2013                          |
|   |                                              |           |           | 19.05.2015                          |
| 30| V. Sanjiyka, Odessa region                   | 46,25161  | 30,63197  | 19.06.2019                          |
| 31| The Sukhyi Estuary                           | 46,35058  | 30,64319  | 17.05.2009                          |
| 32| The Sukhyi Estuary                           | 46,33294  | 30,66156  | 05.04.2015                          |
|   |                                              |           |           | 09.05.2015                          |
| 33| City of Chornomorsk, Odessa region           | 46,30166  | 30,66675  | 08.09.2019                          |
| 34| The Sukhyi Estuary                           | 46,32111  | 30,67888  | 29.06.2019                          |
| 35| The Khadzhibej Estuary                       | 46,55644  | 30,69886  | 23.04.2014                          |
| 36| Odessa Bay                                   | 46,37055  | 30,73277  | 25.06.2019                          |
| 37| Odessa Bay                                   | 46,38222  | 30,75028  | 15.03.2011                          |
|   |                                              |           |           | 23.04.2012                          |
| 38| Odessa Bay                                   | 46,40097  | 30,75550  | 20.08.2019                          |
| 39| Odessa Bay                                   | 46,47917  | 30,76361  | 16.03.2011                          |
| 40| Odessa Bay                                   | 46,47589  | 30,76608  | 08.04.2009                          |
|   |                                              |           |           | 18.06.2010                          |
|   |                                              |           |           | 16.03.2011                          |
| 41| Odessa Bay                                   | 46,45744  | 30,76720  | 07.06.2019                          |
| 42| Odessa Bay                                   | 46,45672  | 30,76803  | 10.06.2010                          |
| 43| Odessa Bay                                   | 46,45372  | 30,76866  | 07.06.2019                          |
| 44| Odessa Bay                                   | 46,43402  | 30,77050  | 08.08.2019                          |
|   |                                              |           |           | 17.05.2020                          |
| 45| Odessa Bay                                   | 46,44375  | 30,77206  | 23.04.2012                          |
| 46| V. Kryjanivka, Odessa region                 | 46,55778  | 30,79125  | 18.06.2013                          |
| 47| V. Kryjanivka, Odessa region                 | 46,55814  | 30,79656  | 18.06.2013                          |
| 48| V. Dofinivka, Odessa region                  | 46,57044  | 30,89322  | 27.05.2009                          |
|   |                                              |           |           | 24.06.2012                          |
| 49| V. Chabanka, Odessa region                   | 46,58478  | 30,96503  | 03.08.2011                          |
| 50| V. Chabanka, Odessa region                   | 46,58964  | 30,98794  | 03.08.2011                          |
| 51| V. Hryhorovka, Odessa region                 | 46,59000  | 30,98972  | 27.05.2009                          |
|   |                                              |           |           | 17.07.2010                          |
|   |                                              |           |           | 04.08.2011                          |
|   |                                              |           |           | 07.10.2011                          |
|   |                                              |           |           | 22.05.2012                          |
|   |                                              |           |           | 07.06.2014                          |
|   |                                              |           |           | 25.06.2015                          |
|   |                                              |           |           | 26.08.2019                          |
| 52| The Small Adzalyk Estuary                    | 46,60211  | 31,01081  | 17.07.2010                          |
| 53| The Cape Adzhyyask                           | 46,61089  | 31,30628  | 10.05.2018                          |
| 54| V. Rybakivka, Mykolaiv region                | 46,62242  | 31,39664  | 06.05.2018                          |
| 55| The Kinburn Spit (inland marches)            | 46,47100  | 31,65908  | 18.06.2011                          |

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| No. | Location                                      | Latitude | Longitude | Date       |
|-----|-----------------------------------------------|----------|-----------|------------|
| 56  | The Kinburn Spit                              | 46.46914 | 31.66208  | 11.05.2005 |
| 57  | The Kinburn Spit                              | 46.46567 | 31.66394  | 17.06.2011 |
| 58  | The Kinburn Spit                              | 46.44767 | 31.68936  | 10.07.2005 |
| 59  | Yahorlyk Bay                                  | 46.44867 | 31.69539  | 12.05.2005 |
| 60  | Yahorlyk Bay                                  | 46.47019 | 31.70156  | 22.06.2012 |
| 61  | The Dnieper-Bug Estuary                       | 46.74614 | 31.87231  | 14.08.2013 |
| 62  | The Dnieper-Bug Estuary                       | 46.99267 | 31.99047  | 12.05.2019 |
| 63  | The Dnieper-Bug Estuary                       | 46.57722 | 32.20761  | 19.08.2017 |
| 64  | The Dnieper-Bug Estuary                       | 46.60072 | 32.20761  | 19.08.2017 |
| 65  | The Gulf of Tendra                            | 46.16639 | 32.23083  | 10.08.2017 |
| 66  | The town of Zaliznyi Port, Kherson region      | 46.12392 | 32.26117  | 22.07.2011 |
| 67  | The Tarkhankut Peninsula, Karadjinska Bay      | 45.38025 | 32.51336  | 30.04.2013 |
| 68  | The Tarkhankut Peninsula, Karadjinska Bay      | 45.36236 | 32.51389  | 01.05.2013 |
| 69  | The Tarkhankut Peninsula                       | 45.37317 | 32.51411  | 01.05.2013 |
| 70  | The Tarkhankut Peninsula, Karadjinska Bay      | 45.51589 | 32.71094  | 30.04.2013 |
| 71  | The Tarkhankut Peninsula                       | 45.53125 | 32.72342  | 27-28.04.2013 |
| 72  | The Tarkhankut Peninsula                       | 45.53714 | 32.73225  | 28.04.2013 |
| 73  | The Tarkhankut Peninsula                       | 45.54419 | 32.74336  | 28.04.2013 |
| 74  | The Tarkhankut Peninsula                       | 45.54125 | 32.74517  | 28.04.2013 |
| 75  | The Tarkhankut Peninsula, Yarylgachska Bay     | 45.57258 | 32.84564  | 30.04.2013 |
| 76  | The Tarkhankut Peninsula, Yarylgachska Bay     | 45.57525 | 32.84564  | 30.04.2013 |
| 77  | Dzharylgach Island, Karkinit Bay               | 46.01147 | 32.92619  | 20.07.2015 |
| 78  | Dzharylgach Island, Dzharylgach Bay            | 46.03603 | 32.92644  | 17.08.2015 |
| 79  | Dzharylgach Island (inland marshes)            | 46.04081 | 32.93636  | 17.08.2015 |
| 80  | Dzharylgach Island, Dzharylgach Bay            | 46.04594 | 32.94291  | 17.08.2015 |
| 81  | Dzharylgach Island, Karkinit Bay               | 46.01208 | 32.94297  | 20-21.08.2012 |
| 82  | Karkinit Bay, the Bakalska spit                | 45.75883 | 33.20519  | 18.05.2013 |
| 83  | Yahorlyk Bay                                  | 46.15736 | 33.59292  | 02-04.05.2011 |

The main geographic names used in this work are pointed in fig. 1.

We do not use the EUNIS names of habitats, because a significant part of the specific habitats in this region remains uncodified (prepared by us as a separate publication). Therefore, we use informal names of habitats, the main of which are shown in fig. 2.

The IUCN categories of conservation status were assessed for the studied species on a regional level for the region of our field study: Least Concern (LC), Near Threatened (NT), Vulnerable (VU), Endangered (EN), Critically Endangered (CR). This regional assessment of conservation status was carried out in a two-step process. The global IUCN approaches were used in the first step for the regional populations and, in the second step, this initial assessment was supported by specific elements of regional level assessments (Gärdenfors et al, 2001). In these cases, it includes analyses of the «rescue effect» (the process by which immigrating propagules result in lower extinction risk for the target population) (Gärdenfors et al, 2001). It was taken into account for species with pelagic larvae that could be carried by currents from other regions of the Black Sea as a downgrading of the conservation category.
Results

Seventeen species were analyzed in our study. For each, the numbers of the stations where it was found during our research are given, as well as literature data on other locations. The regional conservation status covers the coast between the Danube Delta and the Cape Tarkhankut.

Annelida

**Ophelia bicornis** Savigny, 1822  
Habitat: this species is mostly known as littoral, but in our studies, it penetrated from the surf zone to the supralittoral, where it was buried deep in the sand.  
Distribution: Karadjinska Bay at the Tarkhankut Peninsula (stations 67, 70) (Fig. 3); the Northern and Southern Dobruja (Konsulov, 1998; Surugiu, 2005); was previously widespread along Tarkhankut Peninsula (Mokievsky, 1949).  
Regional conservation status: CR B1ab(i,ii,iii)+2ab(i,ii,iii).

**Namanereis pontica** (Bobretzky, 1872)  
Habitat: under shelters (stones, algal deposits, and Zostera mats)  
Distribution: widespread in the studied region (stations 31, 37, 40, 41, 45, 48, 49, 51, 73, 81, 84) (Fig. 3); the Northern and Southern Dobruja, the Gulf of Tendra (Vinogradov, Losovskaya, 1968; Surugiu, 2000).  
Regional conservation status: LC

Arthropoda

**Cryptorchestia cf. garbinii** Ruffo, Taroerro et Latella, 2014 (formerly identified as **Cryptorchestia cavimana** (Heller, 1865) or **Orchestia bottae** Milne-Edwards, 1840)  
Habitat: under shelters (stones, algal deposits, and Zostera mats), in small watercourses, salt marshes
Figure 2. Northwestern Black Sea habitats: A – burrowed sand; B – Zostera mats; C – exposed rocks; D – shelters (stones and algal deposits).

Distribution: widespread from the Danube Delta to the Kinburn Spit (stations 4, 6, 8, 9, 10, 14, 16, 20, 21, 24, 25, 26, 31, 32, 33, 34, 35, 41, 46, 47, 48, 49, 50, 51, 61, 62, 63) (Fig 4.); the Northern Dobruja (Petrescu, 1998)
Regional conservation status: LC

Deshayesorchestia deshayesii (Audouin, 1826)
Habitat: burrowing in the sand; occasionally under algal deposits and big stones.
Distribution: widespread in the studied region (stations 1, 2, 3, 5, 9, 17, 18, 22, 27, 29, 30, 51, 52, 53, 54, 57, 60, 66, 67, 68, 69, 70, 76, 77, 78, 82) (Fig. 4); the Northern Dobruja (Petrescu, 1998)
Regional conservation status: EN B2ab(ii,iii)

Orchestia gammarellus (Pallas, 1766)
Habitat: Sandy shores and under shelters (algal deposits, and Zostera mats)
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Distribution: Karkinit Bay, the Budaki Lagoon, the Dnieper-Bug Estuary, Zhebrian Gulf (stations 12, 16, 61, 72, 73, 75, 77, 83, 84) (Fig. 4); the Northern Dobruja (Petrescu, 1998; Surugiu, Giurgiu, 2006)
Regional conservation status: VU B1ab(ii,iii,iv)+2ab(ii,iii,iv)

**Figure 3.** Distribution of supralitoral Annelida, Mollusca, Cirripedia and Insecta species in the studied sector of the northwestern Black Sea.

*Orchestia montagui* Audoun, 1826
Habitat: under shelters (stones, algal deposits, and *Zostera* mats), salt marshes.
Distribution: Snake Island, the Great Adzhalyk Estuary, Yahorlyk and Karkinit bays (stations 13, 55, 65, 72, 79, 80, 81) (Fig. 4); the Northern Dobruja (Petrescu, 1998; Surugiu, Giurgiu, 2006)
Regional conservation status: NT

*Armadilloniscus ellipticus* (Harger, 1878)
Habitat: under shelters (stones, algal deposits, and *Zostera* mats)
Distribution: from Odessa Bay to the Dnieper-Bug Estuary, Karkinit Bay (stations 11, 12, 16, 31, 48, 51, 55, 72, 73, 75, 84) (Fig. 5); the Northern Dobruja (Giurginca et Ćurčić, 2003).
Regional conservation status: NT

*Halophiloscia couchii* (Kinahan, 1858)
Habitat: under shelters (stones, algal deposits, and *Zostera* mats)
Distribution: from Odessa Bay to the Dnieper-Bug Estuary, Karkinit Bay (stations 44, 51, 69, 72, 73, 75, 84) (Fig. 5); the Northern Dobruja (Kusakin, 1969)
Regional conservation status: NT

*Ligia italica* Fabricius, 1798
Habitat: exposed rocks and boulders
Distribution: the Tarkhankut Peninsula (stations 72, 73, 74, 75) (Fig. 5); Odessa Bay (Pauli, 1954) (now extirpated), the Northern Dobruja, Cape Kaliakra (Caspers, 1951),
Regional conservation status: VU D2

*Tylos ponticus* Grebnitzky, 1874
Habitat: burrowing in the sand, occasionally under algal deposits and big stones.
Distribution: between the Danube Delta and the Dniester Estuary, the Kinburn and Tendra spits, Dzharylgach Island, the Tarkhankut Peninsula (stations 8, 18, 57, 66, 80, 81) (Fig. 5); Odessa bay (Pauli, 1954) (now extirpated).
Regional conservation status: CR B2ab(ii,iii,iv)

**Figure 4.** Distribution of supralittoral Talitridae species in the studied sector of the northwestern Black Sea.

**Chthamalus stellatus** (Poli, 1791)
Habitat: exposed rocks
Distribution: Karkinit Bay (Arnoldi, 1948); in the Northern Dobruja probably extirpated after extremely reduced temperatures occurred in winter 1995/1996 (Surugiu, Giurgiu 2006).
Regional conservation status: EN (rescue effect correction; CR (“Possibly Extinct” tag) in the initial assessment).

**Microeuraphia depressa** (Poli, 1791)
Habitat: exposed rocks
Distribution: the Tarkhankut peninsula (stations 75) (Fig. 3).
IUCN: regional: NT (rescue effect correction; VU D2 IUCN in the initial assessment)

**Thalassomyiafrauenfeldi** Schiner, 1856
Habitat (imago): exposed rocks and boulders; occasionally on wet algal deposits
Distribution: From the Dniester Estuary to the Tarkhankut Peninsula (stations 15, 19, 28, 29, 32, 33, 34, 36, 37, 38, 40, 41, 42, 43, 44, 46, 47, 50, 51, 72, 75) (Fig. 3).
Regional conservation status: LC

**Mollusca**

**Donacilla cornea** (Poli, 1791)
Habitat: this species is mostly known as littoral, but it can penetrate from the surf zone to the supralittoral, where it was buried deep in the sand (Mokievsky, 1949) and gravel (Son, Koshelev, 2014)
Distribution: Dzharylgach Island, the Budaki spit, coast near the Small Adzhalyk Estuary (stations 17, 51, 78) (Fig. 3); widespread between the Danube Delta and the Cape Tarkhankut before the 1960s (Mokievsky, 1949; Zakutsky, 1967), but now, in addition to our findings, it is found here only at the Tarhankut Peninsula (Kopii, 2012); Eforie Bay (Micu and Micu, 2006).
Regional conservation status: CR B2ab(ii,iii,iv)
**Melarhaphe neritoides** (Linnaeus, 1758)
Habitat: exposed rocks
Distribution: the Tarkhankut Peninsula (stations 75) (Fig. 3).
Regional conservation status: NT (rescue effect correction; VU D2 in the initial assessment).

**Myosotella myosotis** (Draparnaud, 1801)
Habitat: under shelters (stones, algal deposits, and Zostera mats)
Distribution: between the Danube Delta and the Dniester Estuary, the Kinburn and Tendra spits, Dzharylgach Island, Karkinit Bay (stations 7, 8, 16, 55, 56, 58, 59, 72, 75, 79, 80, 84) (Fig. 3); Odessa Bay (collections of NMNH) (now extirpated); the Northern Dobruja (Grossu, 1993);
Regional conservation status: NT

**Truncatella subcylindrica** (Linnaeus, 1767)
Habitat: under shelters (stones, algal deposits, and Zostera mats)
Distribution: Karkinit, Dzharylgach, and Yahorlyk bays, the Kinburn Spit (stations 58, 59, 72, 79) (Fig. 3); the Gulf of Tendra (Kornushin, 1980, Anistratenko, Stadnichenko, 1994), the Northern Dobruja (Grossu, 1993).
Regional conservation status: NT

![Figure 5](image-url) Distribution of supralitoral Isopoda species in the studied sector of the northwestern Black Sea.

**Discussion**

Regarding habitat distribution, most species are highly specialized and colonize mobile substrates (Fig. 6, A-F) (burrowing species), exposed rocks, or shelters (Fig. 6, G-L) (lower surfaces of stones, algal deposits, or Zostera mats). In separate locations with mosaic habitats, species populate a wider range of habitats, for example, *D. deshayesii* and *T. ponticus* not only burrow in the sand but can also be present under shelters.

The species that burrows in the sand or lives under shelters were colonized the most of estuaries in the studied region. This fact was almost not observed before our studies (Zakutsky, 1967).

The exception is *C. cf. garbinii*, which alternatively, associated with fresh and brackish waters, set apart from the typically marine, supralittoral Talitridae such as *Orchestia* spp. (Rewicz et al., 2020). In the first half of the XX century, it was not recorded from open coasts of the northwestern Black Sea, where *Orchestia* spp. were reported, but now is widespread not only in the estuaries but also in the marine supralittoral zone.
Figure 6. Key species of the different supralittoral habitats. Mobile substrates (burrowing): A – Tylos ponticus; B – Deshayesorchestia deshayesii; C – Ophelia bicornis; D – Donacilla cornea. Exposed rocks: E – Ligia italica; F – Microeuraphia depressa; G – Melarhaphe neritoides; H – Thalassomyia frauenfeldi. Shelters: I – Namanereis pontica; J – Myosotella myosotis; K – Orchestia spp.; L – Armadillomiscus ellipticus.
For the two districts within the study region we can compare distributional data with retrospective information: Karkinit Bay (Arnoldi, 1948; Mokievsky, 1949) and Odessa Bay (Zagorovsky, Rubinstein, 1916; Pauli, 1954; Kaminskaya et al, 1977). The first is relatively kept in the natural conditions, except for sandy stretches, which are places of concentrations of recreation activities. As a result, in our studies, we do not see significant changes in species composition and distribution along the Tarchankut Peninsula. Only on several small stretches of public beaches, the supralittoral ecosystem was destroyed. The only species that has sharply declined in this district, is D. cornea.

Alternatively, the ecosystem of Odessa Bay is completely transformed. Natural rocky coast in 1950-1960s was turned to the mosaic of hard-substrate infrastructure and artificial sandy beaches. As a result, most of the locations are barren habitat without shelters for invertebrates, where among supralittoral species only Th. frauenfeldi are abundant. Interesting, that this species has appeared in Odessa Bay after the construction of numerous seawalls, inhabiting the smooth surfaces, which became the optimal biotope for this species. Probably, at the same time, the turnover of Talitridae species (key components of supralittoral ecosystems) took place. O. gammarellus, which, in the Odessa Bay, occupied the habitat of algal deposits (Zagorovsky, Rubinstein, 1916), disappeared from this area, and the more eurytopic C. cf. garbinii began to be recorded in its vicinity (Kaminskaya et al, 1977).

Also, several other species were extirpated: isopods, T. ponticus, and L. italicus, which have been present there in the XIX – early XX centuries (Pauli, 1954) and gastropod M. myosotis, which was sampled in Odessa Bay last time in 1986 (collections of NMNH).

In general, the assessment results show a sharp difference in conservation status between species confined to different types of coasts and habitats.

Species that are buried in the sand (O. bicornis, D. cornea, T. ponticus, D. deshayesii) belong to the “problem” categories CR, EN, and VU.

This is since the expansion of recreational activity on the sandy beaches leads to the trampling of the supralittoral species. As a result, they tend to completely disappear on city beaches and resort areas. Alternatively, species confined to rocky shores or living under shelters are predominantly in low risk NT and LC.

However, for such species in this region, there is a specific threat that is not related to human impact. Strong desalination in the area makes it possible for severe icing and freezing of rocky shores. This is critical for species inhabiting exposed rocks. This is directly proved for the disappearance of Ch. stellatus in Romania (Surugiu, Giurgiu 2006) and it is quite possible regarding the disappearance of some species in the Odessa Bay.

The regional IUCN status of CR A1abc; B1a(i, ii, iii, iv)+2ab(i, ii, iii, iv) was proposed for D. cornea in the Romanian Black Sea (Micu and Micu, 2006), which is consistent with our data and the status of CR can be attributed to the entire Black Sea.

Apparently, for the species of O. bicornis, M. neritoides, Th. frauenfeldi, M. depressa, Ch. stellatus, C. cf. garbinii, D. deshayesii, O. gammarellus, and Orchestia spp. our estimates will coincide with the general situation for the entire northwestern Black Sea. For other species, more research is needed.

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