REVISION OF THE DINOFLAGELLATE SPECIES COMPOSITION OF THE BLACK SEA

Data on the diversity of dinoflagellates of the Black Sea (BS) obtained from all BS countries (Russia, Georgia, Turkey, Bulgaria, Romania and Ukraine) from 1886 to 2018 are critically summarized. The revised list of the BS *Dinoflagellata* includes 420 species (447 including infraspecific taxa) from 92 genera that belong to 47 families, 16 orders and 4 classes. This significantly exceeds the number of dinoflagellate taxa previously cited for the BS. This is mainly due to an increased interest in phytoplankton in recent decades and to international cooperation. Additionally, climate change and intensification of international shipping have contributed to the appearance of invasive species of dinoflagellates in various areas of the sea. The list also includes freshwater species recorded from the less saline areas of the sea. Recent progress in taxonomy has expanded our knowledge about diversity of the BS dinoflagellates; however, the leading orders remained unchanged. *Peridiniales* (124 species/129 including infraspecific taxa), *Gymnodiniales* (96/96), *Gonyaulacales* (73/91), *Dinophysiales* (40/41), *Prorocentrales* (23/25) and *Amphidiniales* (21/22) include 85% of the species found. Genera with the highest species richness are *Protoperidinium* (59/62), *Gymnodinium* (48/48), *Ceratium* (34/52), *Dinophysis* (33/34), *Prorocentrum* (22/24), *Amphidinium* (21/22), *Gyrodinium* (20/20), *Gonyaulax* (19/19) and *Oxytoxum* (14/14). Fifty-two genera are represented in the BS by one species each, 201 species and infraspecific
Revision of the dinoflagellate species

taxa were first cited after 1990. A list of the BS dinoflagellates was compiled with currently accepted taxonomic names and their synonyms cited for the BS. References contain 116 literary and unpublished original data sources. Further efforts to study the species diversity of the BS should be aimed at more accurate identification of species using modern methodologies. Continuing to update the BS phytoplankton database, where complete information on each species is freely available, will also contribute to the progress in studying the biodiversity of the BS.

Key words: *Dinoflagellata*, phytoplankton, species composition, taxonomic structure, Black Sea

Introduction

The Black Sea (BS) is an economically important brackish-water basin on the southeastern border of Eastern Europe surrounded by six countries: Russia, Georgia, Turkey, Bulgaria, Romania and Ukraine (Figure). As part of the Mediterranean Basin, this semi-enclosed inland sea, with a volume of 547 thousand km$^3$, is connected by the Strait of Kerch with the Sea of Azov in the northeast, and through the Bosphorus Strait and the Strait of the Dardanelles with the small Sea of Marmara and the Aegean Sea in the southwest. It has an area of 436,402 km$^2$ and a maximum depth of 2,212–2,245 m (average depth 1,350 m).

![Map of the Black Sea with the borders of the maritime countries](image)

Figure. Map of the Black Sea with the borders of the maritime countries

In the NW part are the mouths of the largest European rivers: the Danube, the Dnieper, the Dniester and the Southern Bug. Their runoff causes a drop in the salinity of the seawater in the narrow coastal area to 10 from nearly 17 in the surface layer of the sea. The salinity difference on the surface (on average 17) and in the lower layers (about 34) of the sea causes a high
density gradient. As a result, there is a blocking layer that prevents water mixing and the penetration of oxygen into the depths. Near the surface the temperature of the water is determined by the air temperature; in the deeper layers it can be 7–8 °C lower. At a depth 150–200 m below, the water lacks oxygen and instead contains dissolved hydrogen sulfide (Sorokin, 1982; Zaitsev, 1998). In terms of biological diversity, the BS is 1.5–2 times poorer than the neighboring Mediterranean Sea, but its productivity is higher.

Dinoflagellates (*Dinoflagellata*) are one of the two most important taxonomic groups of phytoplankton in the study area playing a significant role in food webs. Along with diatoms, they contribute a major part of the primary production in the sea. They remove nutrients purifying the water and serve as indicators of the ecological state of the marine environment. Approximately 80 dinoflagellate species are toxic, causing human health problems and marine animal intoxications and mortalities (Moestrup et al., 2018); about 23 of them have been recorded in the BS.

In last decades several reports summarizing the species composition of microalgae, including dinoflagellates, have been published for selected regions of the BS (Zaitsev, Alexandrov, 1998; Krakhmalnyi, Panina, 2000; Polikarpov et al., 2003; Gynnez, Boicenco, 2004; Terenko, 2005a, b; Krakhmalnyi et al., 2006, 2012; Nesterova et al., 2006; Senicheva, 2008; Krakhmalnyi, 2011; Cărăuş, 2012; Feyzioğlu, Şahin, 2017). In our previous work (Krakhmalnyi et al., 2012) we presented a historic review of the dinoflagellates studied in the BS and analyzed their diversity, but without publication of a species list. Since the mentioned article provides a detailed review of the dinoflagellate studies from the past, here we briefly discuss only the main periods of research.

Research on dinoflagellates of the BS was begun by Pereyaslavtseva (1886), who identified 19 dinoflagellate species in samples collected near Sevastopol (Crimea). Twenty years later Reinhard (1909) compiled both literary and unpublished original data on BS phytoplankton, presenting a list of 44 species and infraspecific taxa (i.s.t.) of dinoflagellates. Research on the BS phytoplankton continued between World War I and World War II. Studies were summarized by Morozova-Vodyanitskaya (1948, 1954) who reported 100 species and i.s.t. that belong to 22 genera and 13 families. The next two decades were marked by a high activity of phytoplankton research in various areas of the sea. As a result, from 1950 to 1969, 177 species and i.s.t. of dinoflagellates from 25 genera and 17 families were identified (Kiselev, 1950; Pitsyk, 1954; Petrova, 1957, 1963 1964, 1965; Valkanov, 1957; Ivanov, 1960, 1964, 1965, 1967; Skolka, 1960, 1963; Georgieva, 1961, 1969; Kuzmenko, 1966; Kovaleva, 1969; Makarova, 1969). In the 1970s–1990s the BS dinoflagellates were mentioned in publications of many authors (Roukhlyajnen, 1975; Gomoiu, 1977; Ivanov, 1977; Bodeanu, Usurelu, 1979; Nesterova, 1979, 1985, 1987; Nezlin, Zernova, 1983; Senicheva, 1983; Senichkina, 1983; Ilyash, 1984; Petrova-Karadjova, 1984, 1990; Ilyash, Fedorov, 1985; Sukhanova et al., 1987, 1991; Bityukov et al., 1993; Bodeanu, 1993). Pitsyk (1979) cited 205 taxa of the BS dinoflagellates but did not list them. In total, 48 taxa new to the BS were published during this period.
In the last decades, the study of the BS plankton, including dinoflagellates, has been intensified, largely due to international support and cooperation. Information appeared about dinoflagellates of the BS coast of Georgia (Gvarishvili, 1998a, b; Komakhidze, Mazmanidi, 1998) and Turkey (Eker, 1998; Öztürk, 1999; Türkoğlu, Koray, 2002; Eker-Develi, Velikova, 2009; Baytut et al., 2010; Özdemir et al., 2012; Feyzioğlu, Şahin, 2017). Phytoplankton research continued off the coast of Ukraine (Sukhanova, Cheban, 1990; Vinogradova, Velikova, 1992; Krakhmalnyi, 1994а, b, 2001, 2002, 2005, 2014; Bryantseva et al., 1996, 2003, 2008; Bryantseva, 2000, 2008; Senichkina et al., 2001, 2004; Terenko L., 2001, 2002, 2005а, b, 2007, 2010, 2011; Krakhmalnyi, Terenko, 2002а, b; Senicheva, 2002, 2004; Terenko G., 2004; Derezyuk, 2008; Terenko L., Terenko G., 2009; Terenko G. et al., 2011), Bulgaria (Moncheva, Krastev, 1997; Konsulov, 1998; Velikova, 1998; Velikova, Larsen, 1999; Velikova et al., 1999; Moncheva et al., 2001; Moncheva, Kamburska, 2002; Moncheva, Parr, 2010), Romania (Petranu, 1997; Bodeanu, 2002; Cărăuş, 2002; Bodeanu et al., 2004; Boicenco, 2010, 2011) and Russia (Mikaelyan, 1997, 2008; Vershinin, Moruchkov, 2003; Vershinin, Morton, 2005; Vershinin et al., 2005; Vershinin, Orlova, 2008; Vershinin, Velikova, 2008; Yasakova, 2010).

Recently, considerable achievements have been made in the study of dinoflagellates due to the development of new technologies (scanning electron microscopy and molecular methods), resulting in significant changes in taxonomic structure and species number of the BS dinoflagellates. Furthermore, some previously known dinoflagellate species of the BS have been re-described, new records have been reported and revisions of the species composition have been published.

In the present study we aimed to: 1) analyze and review the available literature and original data on the species composition of *Dinoflagellata* of the BS and 2) present a list of the BS dinoflagellates that takes into account the latest taxonomic changes.

**Materials and methods**

This revision of the dinoflagellate species composition of the BS was based both on an analysis of literature published from 1886 through 2018 and on unpublished original data of the authors of the present study. The original materials were collected in the Ukrainian sector of the BS from 1992 to 2018. They include the results of studies of the coastal and open BS waters (1992–1993), the Strait of Kerch (2003, 2006–2009), the Sevastopol coast (1991, 2008–2016), the Odessa coast (1986, 1998–2002, 20089–2018) and the Zmiinyi Island coast (2003–2018).

Here we present the *Dinoflagellata sensu* Fensome & al. (1993), as revised by Fensome & al. (1998) and updated by Okolodkov (2011). The genera *Tovellia* Moestrup & al. and *Opisthoaulax* Calado (Calado, 2011) have been included in the family *Tovelliaceae* Moestrup & al. (Lindberg et al., 2005). The genera *Nusuttodinium* Takano & Horiguchi and *Karenia* Hansen & Moestrup have been placed in the order *Gymnodiniales* (Takano et al., 2014);
the genus *Akashiwo* Hansen & Moestrup (Daugbjerg et al., 2000) was separated from *Gymnodinium* Stein; the genus *Margalefidinium* Gyme, Richlen & D.M. Anderson was erected for some species of *Cochlodinium* F. Schütt (Gyme et al., 2017); the genus *Prosoaulax* Calado & Moestrup (Calado, Moestrup, 2005) was added to the order Suessiales; the genera *Glochidinium* Boltovskoy (Boltovskoy, 1999), *Palatinus* Craveiro & al. (Craveiro et al., 2009), *Parvodinium* Carty (Carty, 2008), *Bysmatrum* Faust & Steidinger (Faust, Steidinger, 1998), *Lessardia* Saldarriaga & al. (Saldarriaga et al., 2003), *Apocalathium* Craveiro, Daugbjerg, Moestrup & Calado (Craveiro et al., 2016) and Huia H. Gu, K.N. Mertens & T. Liu (H. Gu et al., 2016) were added to the order *Peridiniales*; the genera *Blixaea* Gottschling and *Unruhdinium* Gottschling were added to the reestablished family *Kryptooperidiinaeae* (Gottschling et al., 2017); the family *Amphidomataceae* Tillmann and the genus *Azadinium* Elbrächter & Tillmann (Elbrächter et al., 2009) were ascribed to *incerti ordinis*. *Chimonodinium* gen. nov. was added to the order *Toracosphaerales* Tangen, the family *Toracosphaeraceae* Schiller (Craveiro et al., 2011). Recently, the new order *Torodinales* Boutrup, Moestrup & Daugbjerg, with the new family *Kapelodiniaceae* Boutrup, Moestrup & Daugbjerg and a new genus *Kapelodinium* Boutrup, Moestrup & Daugbjerg were described (Boutrup et al., 2016). The order *Amphidiales* was erected (Moestrup, Calado, 2018). AlgaeBase (Guiry, Guiry, 2018) was consulted to verify currently accepted taxonomic names (with some exceptions, e.g., *Ceratium/Tripos, Oxytoxum/Corythodinium* and some others). The summary list presented here was compiled using the BSPC database developed under the EU Sixth Framework Programme (2002–2006, project BS SCENE). BSPC was located on the server housed by the Institute of Biology of the Southern Seas, NAS of Ukraine (IBSS). Experts from all BS countries, including the authors of this article, took part in the BSPC updating, contributing both published and unpublished data on the records of microalgal species in the BS. The BS phytoplankton database first appeared online in 2008. In 2014, updating and support of the BSPC on the server of the IBSS was discontinued. Since 2018 it is available at http://phyto.bss.plankton.kiev.ua. The checklist published here* is tied to the list of BSPC references and follows their numbering as it given on the site http://phyto.bss.plankton.kiev.ua/wiki/References.

**Results and Discussion**

According to generalized literary and unpublished original data, 420 species (447 including i.s.t.) from 92 genera of *Dinoflagellata* are cited for the BS. These significantly exceed the annotated checklist published by Gómez and Boicenko (2004) and Terenko (2007), where 267 and 345 species names are listed respectively. They belong to 47 families, 16 orders and 4 classes (Table).

* See the electronic supplement in the online version of the article:
  https://algologia.co.ua/archive/28/4/428

432
The taxonomic structure of dinoflagellates has been substantially expanded in recent years (Table). The increase in the number of taxonomic ranks has been due to the progress in taxonomy of the group in the last decade. A number of new taxa were introduced, including new classes, orders and families; new genera were described using both light and scanning electron microscopy and molecular identification. A number of species were assigned to new taxa of different ranks. At the same time, the leading orders remained unchanged: Peridiniales (124 species/129 including i.s.t.), Gymnodiniales (96/96), Gonyaulacales (73/91), Dinophysiales (40/41) Prorocentrales (23/25) and Amphidiniales (21/22) incorporate 85% of the species found. The Peridiniales ranked first in species diversity of the BS dinoflagellates at all stages of the study. The exception is late 1990s-2013, when the Gymnodiniales contribution to the taxonomic structure increased due to the studies on the naked Gymnodiniales species identified in vivo. Recent taxonomic changes dropped their number; in 2018, the Gymnodiniales ranks second again.

Table

| Taxon | Number of species (including infraspecific taxa) |
|-------|--------------------------------------------------|
|       | 1886-1949 | 1950-1969 | 1970-1990 | Late 1990s-2013 | 1886-2018 |
| Class DIOPHYCEAE Pascher 1914 |
| Order AMPHIDINIALES Moestrup & Calado 2018 |
| na¹ na na na 21(22) |
| Family Amphidiniales Moestrup & Calado 2018 |
| 13 20 11 36 40 |
| (13) (20) (11) (36) (41) |
| Order DINOPHYSIALES Kof. 1926 |
| 33(34) |
| (33) |
| Family Amphisoleniaceae Er. Lindem. 1928 |
| Amphisolenia F. Stein 1883 |
| 1(1) 1(1) |
| Family Dinophysiae F. Stein 1883 |
| Dinophysis Ehrenb. 1839 |
| 13(13) 19(19) 11(11) 32(32) 33(34) |
| (13) (19) (11) (32) (33) |
| Family Oxyphysiaceae Sournia 1984 |
| Phalacroma F. Stein 1883 |
| - 1(1) - 2(2) 6(6) |
| Oxyphysis Kof. 1926 |
| - - - 1(1) s |
| Order GONYAULACALES Taylor 1980 |
| 21 40 28 87 73 |
| (21) (42) (31) (107) (91) |
| Family Ceratiaceae Wiley & Hickson 1909 |
| Ceratium Schrank 1793 |
| 6(6) 17(19) 11(14) 34(54) 34(52) |
| Monaster F. Schütt 1895 |
| - - - 1(1) |
| Family Cladopyxidaceae F. Stein 1883 |
| [Amphidoma] F. Stein 1883 |
| - - - 1(1) t |
| Cladopyxis F. Stein 1883 |
| - 1(1) - 1(1) 1(1) |
| Micracanthodinium Deflandre 1937 |
| - - - 2(2) 2(2) |
| Palaeophalacroma Schiller 1928 |
| - - - 1(1) 1(1) |

433
| Family          | Genus                        | Species                      |
|----------------|------------------------------|------------------------------|
| **Goniomaceae** | *Alexandrium* Halim 1960     | 1(1)                         |
|                | *Gonioma* F. Stein 1883      | 1(1)                         |
| **Heterodiniaceae** | *Heterodinium* Kof. 1907   | -                            |
| **Ostreopsidaceae** | *Alexandrium* Halim 1960   | t                            |
| **Protoceratiaceae** | *Proteroceratium* Bergh 1881 | -                            |
| **Pyrophacaceae** | *Pyrophacus* F. Stein 1883   | 1(1)                         |
| **Gymnodinales** | *Gymnodiniales* Apstein 1909 | 15                           |
| **Amphitholaceae** | *Achradina* Lochmann 1903    | -                            |
| **Brachydiniaceae** | *Karenia* G. Hansen & Moestrup 2000 | -                            |
| **Ceratoperidiniaceae** | *Ceratoperidinium* Margalef ex A.R. Loebli. 1980 | -                            |
| **Gymnodiniaceae** (Bergh) Lankester 1885 | *Akashiwo* G. Hansen & Moestrup 2000 | -                            |
| **Amphidiniaceae** | *Amphidinium* Clap. & Lachm. 1859 | 3(3)                         |
| **Cochlodiniaceae** | *Cochlodinium* F. Schütt 1896 | 3(3)                         |
| **Gymnodiniaceae** (Bergh) Lankester 1885 | *Gymnodinium* F. Stein 1878 | 15                           |
| **Katodiniaceae** | *Katodinium* Fott 1957       | -                            |
| **Gymnodiniales** | *Margarodinium* F. Gyme, Richlen & D.M. Anderson 2017 | -                            |
| **Nisutodiniaceae** | *Nisutodinium* Takano, Yamaguchi, Inouye, Moestrup & Horiguchi 2014 | -                            |
| **Paulsenellina** | *Paulsenella* Chatton 1920   | -                            |
| **Pleodiniaceae** | *Pleodinium* Chatton 1933    | -                            |
| **Spiniferodiniaceae** | *Spiniferodinium* T. Horiguchi & M. Chinara 1987 | -                            |
| **Polykrikos** | *Polykrikos* Bützlchi 1873   | -                            |
| **Gyrodiniaceae** | *Gyrodinium* Kof. & Swezy 1921 | 11(11)                    |
| **Tovelliaceae** | *Opisthoaulax* Calado 2011   | 1(1)                         |
| **Warnowiaceae** | *Warnowiaceae* Er. Lindem. 1928 | -                            |
### Revision of the dinoflagellate species

| Family | Gymnodiniales familia incertae sedis |
|--------|--------------------------------------|
| Warnowia | Er. Lindem. 1928 |

| Order | PERIDINIALES |
|-------|--------------|
| Haeckel 1894 |

| Family | Diplopsalidaceae |
|--------|-----------------|
| Matsuka 1988 |

| Family | Gymnodiniales |
|--------|--------------|
| Warnowia | Er. Lindem. 1928 |

| Family | Lebouridinium |
|--------|--------------|
| Lebouridinium | G. Gu, Takayama, Moreira & Lopey-Garcia 2016 |

| Family | Preperidinium |
|--------|--------------|
| Mangin 1913 |

| Family | Glenodiniales |
|--------|--------------|
| Glenodiniales | Wiley & Hickson 1909 (na) |

| Family | Lebouridinium |
|--------|--------------|
| Glenodiniales | Warnowia |

| Family | Glenodiniaceae |
|--------|--------------|
| Glenodiniaceae | Luebroidinium |

| Family | Glenodiniopsidaceae |
|--------|---------------------|
| Glendeninopsidaceae | J. Schiller 1935 |

| Family | Glenodiniaceae |
|--------|--------------|
| Glenodiniaceae | Glenodiniales |

| Family | Heterocapsaceae |
|--------|----------------|
| Heterocapsaceae | Glenodiniaceae |

| Family | Heterodiniaceae |
|--------|-----------------|
| Heterodiniaceae | Glenodiniaceae |

| Family | Kolkwitziellaceae |
|--------|-----------------|
| Kolkwitziellaceae | Glenodiniaceae |

| Family | Peridiniaceae |
|--------|--------------|
| Peridiniaceae | Peridiniaceae |

| Family | Peridiniopsidaceae |
|--------|-------------------|
| Peridiniopsidaceae | Glenodiniaceae |

| Family | Podolampaceae |
|--------|--------------|
| Podolampaceae | Peridiniaceae |

| Family | Protoperidiniaceae |
|--------|-------------------|
| Protoperidiniaceae | Peridiniaceae |

435
| Family | Genus | Species | | |
|--------|-------|---------|---|---|---|---|---|---|---|---|---|
| Preperiadinum | Mangin 1913 | - | I(1) | - | 2(2) | t | |
| Properiadinum | Bergh 1881 | 23 | 33 | 22 | 59 | (60) | 59 | (62) | |
| Thecadiniaceae | Balech 1956 | - | - | - | - | 1(1) | |
| Peridiiniellae familia incertae sedis | Bysmatrum Faust & Steidinger 1998 | - | - | - | t | 1(1) | |
| Thecadiniaceae | Balech 1956 | - | - | - | - | 1(1) | |
| Peridiiniellae familia incertae sedis | Glenodinium Ehrenb. 1836 | t | t | t | t | 6(6) | |
| Thecadiniaceae | Balech 1956 | - | - | - | 1(1) | |
| Peridiiniellae familia incertae sedis | Peridiiniellae | - | - | - | 3(3) | 3(3) | |
| Order PHYTODINIALES | T. Christensen 1962 | 2(2) | 2(2) | 1(1) | 2(2) | 2(2) | |
| Prorocentrales | Lemmerm. 1910 | 8(8) | 14(14) | 8(8) | 22(23) | 23(25) | |
| Order PHYTODINIALES | T. Christensen 1962 | 2(2) | 3(3) | 3(3) | 3(3) | 3(3) | |
| Parodiaceae | F. Stein 1883 | - | - | - | 1(1) | |
| Order PHYCOCYSTACEAE | Apstein 1909 | - | - | - | 1(1) | |
| Pyrocystaceae | F. Stein 1883 | 1(1) | 2(2) | 2(2) | 5(5) | 5(5) | |
| Order PHYCOCYSTACEAE | Apstein 1909 | - | - | - | 1(1) | |
| Pyrocystaceae | F. Stein 1883 | 1(1) | 2(2) | 2(2) | 5(5) | 5(5) | |
| Order PHYCOCYSTACEAE | Apstein 1909 | - | - | - | 1(1) | |
| Pyrocystaceae | F. Stein 1883 | 1(1) | 2(2) | 2(2) | 5(5) | 5(5) | |
| Order PHYCOCYSTACEAE | Apstein 1909 | - | - | - | 1(1) | |
| Pyrocystaceae | F. Stein 1883 | 1(1) | 2(2) | 2(2) | 5(5) | 5(5) | |
| Order PHYCOCYSTACEAE | Apstein 1909 | - | - | - | 1(1) | |
| Pyrocystaceae | F. Stein 1883 | 1(1) | 2(2) | 2(2) | 5(5) | 5(5) | |
| Order PHYCOCYSTACEAE | Apstein 1909 | - | - | - | 1(1) | |
| Pyrocystaceae | F. Stein 1883 | 1(1) | 2(2) | 2(2) | 5(5) | 5(5) | |
| Order PHYCOCYSTACEAE | Apstein 1909 | - | - | - | 1(1) | |
| Pyrocystaceae | F. Stein 1883 | 1(1) | 2(2) | 2(2) | 5(5) | 5(5) | |
| Order PHYCOCYSTACEAE | Apstein 1909 | - | - | - | 1(1) | |
| Pyrocystaceae | F. Stein 1883 | 1(1) | 2(2) | 2(2) | 5(5) | 5(5) | |
| Order PHYCOCYSTACEAE | Apstein 1909 | - | - | - | 1(1) | |
Revision of the dinoflagellate species

| Order TOVELLIALES Moestrup & Calado 2018 | na | na | na | na | 5(5) |
|-----------------------------------------|----|----|----|----|-----|
| Family Tovelliaeae Moestrup, Lindberg & Daugbjerg 2005 |
| Katodinium Fott 1957                     | -  | -  | t  | 1(1) |
| Opisthoaulax Calado 2011 1(1)            |
| Tovella Moestrup, Lindberg & Daugbjerg 2005 1(1) |
| Woloszynska Thompson 1951               |
| Order DINOPHYCEAE ORDO INCERTAE SEDIS Chatton ex A.R. Loebl. III |
| Katodinium Fott 1957 - - - - 1(1) |
| Family Amphidomataceae Sournia 1984 |
| Azadinium Elbrächter & Tillmann 2009 - - - 1(1) |
| Family Psychodiscaceae Willey & Hickson 1909 |
| Katodinium F. Stein 1883 - - - - 1(1) |

| Class NOCTILUCO PHYCEAE | na | na | na | na |
|-------------------------|----|----|----|----|
| Order NOCTILUCALES Haeckel 1894 |
| Spatulodinium J. Cachon & M. Cachon 1968 |

| Family Kofoidiaceae Taylor 1976 |
|----------------------------------|
| Kofoidinium Pavill. 1928 - - - 1(1) |
| Family Leptodiscaceae Taylor 1976 |
| Petalodinium J. Cachon & M. Cachon 1996 - - - 1(1) |
| Scaphodinium Margalef 1963 - - - 1(1) |
| Family Noctiluaceae Saville-Kent 1881 |
| Noctiluca Suriray in Lamarck 1816 1(1) |
| Spatulodinium J. Cachon & M. Cachon 1968 - - - 1(1) |
| Family Protodinisphaeraceae Kof. & Swezy 1921 |
| Pronoctiluca Fabre-Domergue 1889 - - - 1(1) |
| Class OXYRRHIDOPHYCEAE Cavalier-Smith 1998 - - - 1(1) |
| Order OXYR RHINAELES Sournia 1993 - - - - 1(1) |
| Family Oxyrrhinaceae Sournia 1984 |
| Oxyrrhis Dujardin 1841 - - - - 1(1) |
| Class SYNDINIO PHYCEAE A.R. Loebl. 1976 - - - - 1(1) |
| Order SYNDINIALES A.R. Loebl. 1976 - - - - 1(1) |
| Family Syndiniaceae Chatton 1920 |
| Syndinium Chatton 1910 - - - - 1(1) |

| In total | 98 | 189 | 122 | 419 | 420 |
|----------|----|-----|-----|-----|-----|

Note: na — not accepted; the taxon was not accepted or recognized in the analyzed period of study; s — taxon (the genus or one of its species previously cited for the BS) currently regarded as a synonym; [ ] — a genus in square brackets means that now its taxonomic position has changed; t — taxon was transferred to another family.

The generic spectrum of the BS dinoflagellates includes 92 taxonomically accepted genera. Among them Protoperidinium (59 species), Gymnodinium (48), Ceratium (34), Dinophysis (33), Prorocentrum (22), Gyrodinium (20), Amphidinium (21), Gonyaulax (19) and Oxytoxum (14) lead in species number. They incorporate 65% of the revealed species diversity, while 52 genera are represented in the BS by one species each. From the point of view of the
reliability of their records in the BS, their composition is heterogeneous. Among them are several recent records including the newly described genus *Azadinium*, which is a producer of azaspiracid toxins causing shellfish poisoning in mussels (Elbrächter et al., 2009; Salas et al., 2011). It has been cited for Bulgarian coast (Moncheva, 2010; see references in the supplement). Some of abovementioned genera are represented by species that are widely distributed in the BS and are a common component of phytoplankton. These are *Monaster rete* (= *Achradinia pulchra, A. sulcata*), *Levanderina fissa*, *Kapelodinium vestifici* (= *Amphidinium extensum, Gyrodinium glaucum*), *Spatulodinium pseudonsoctiluca* (= *Gymnodinium pseudonsoctiluca, G. conicum, G. viride*) and others; some of them are often developed in mass: *Akasiwo sanguinea, Lessardia elongata* and *Noctiluca scintillans*.

According to analyzed data, the composition of dinoflagellate dominating species varied in various periods of study. In the period before 1950, *Ceratium furca, C. fusus, C. tripos, Prorocentrum micans, Protoperidinium divergens, Dinophysis caudata, Diplopsalis lenticula* and *Protoperidinium steinii* were the most common. Later, *Protoperidinium conicum, Pyrophacus horologium, Dinophysis rotundata, Prorocentrum micans, P. cordatum, P. compressum, Ceratium furca* and *C. tripos* formed the dominating complex of phytoplankton. In the 1970—1990s, *Ceratium furca, C. fusus, C. tripos, Dinophysis caudata, Phalacroma rotundatum* and *Diplopsalis lenticula* led in abundance. At present, dominating dinoflagellates include *Prorocentrum cordatum, P. micans, P. compressum, Scrippsiella acuminata, Heterocapsa triqueta* and *Lingulodinium polyedra*; they are likely to be more resistant to anthropogenic contamination.

According to our data, 201 taxa were first found after the 1990s. Three species — *Dinophysis mucronata* (Ivanov, 1965), *Gymnodinium dissimile* and *G. paulseinii* (Denisenko, 1965), were cited only once more than half a century ago and have been never found again. These are probably misidentifications (in the list they are marked with an asterisk). The sharp (almost threefold) increase in the number of species after 1990 is due to a number of reasons. They include development of new technologies promoting microalgae research and international cooperation in marine phytoplankton studies; the climate change causing “mediterranization” of the BS (Kuzmenko, 1966; Andrusovich et al., 1994; Bryantsev, 1994) and intensification of cross-border shipping have also contributed to the appearance of invasive species of dinoflagellates in the various areas of the sea (Alexandrov, 2004; Shiganova et al., 2012). A number of freshwater species recorded in the desalinated areas of the sea have also been added to the list.

The number of citations of a particular species may be an additional marker of its reliable identification. 116 species were mentioned only in one or two sources. All of them, except for *Prorocentrum cordatum var. aralensis*, until the 1970s, were not indicated for the BS. 229 taxa have been cited in more than six sources and 167 — in ten or more ones.
Conclusions

The present article can be considered as a summary of the studies of the BS dinoflagellates. An annotated list is far from being perfect. It may contain the names of erroneously identified species, given that most experts deal with the routine processing of phytoplankton samples without access to high-precision optics. Microalgae sample processing protocols are virtually unavailable to other users, many institutions do not store collected samples, and most of the identified species were not documented with illustrations in scientific publications. In addition, our knowledge of the epibenthic, symbiotic and parasitic dinoflagellate species remains negligible. With the ongoing discovery of new species and new groups of cryptic species based on molecular phylogenetic analyses, it is clear that species diversity is presently underestimated. Further efforts to study the species diversity of the BS should be aimed at more accurate identification of species using modern methodologies. To continue updating the BS phytoplankton database, where complete information on each species is freely available, will also contribute to the progress in studying the biodiversity of the BS.

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445
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1 Институт эволюционной экологии НАН Украины
ул. Акад. Лебедева, 37, Киев 03143, Украина
2 Институту Ciencias Marinas y Pesquerias, Universidad Veracruzana, Laboratorio de Botánica Marina y Plantología, Calle Mar Mediterraneo 314, Fracc. Costa Verde, Boca del Rio, Veracruz, C.P. 94294, Mexico
3 Институт ботаники им. Н.Г. Холодного НАН Украины
Терещенковская, 2, Киев 01004, Украина
4 Институт морских биологических исследований им. А.О. Ковалевского РАН,
Ленинский просп., 14, Москва, Россия
5 SurDEP, Centurion, Pretoria, Wierda Glen Estate, South Africa
6 Региональный центр мониторинга Национального уч-та им. И.И. Мечникова
пер. Майковского, 7, Одесса 65082, Украина
7 Украинский центр экологии моря, 89, Французский бульвар, Одесса 65000, Украина
8 Институт экологии Университета Хайфы

РЕВИЗИЯ ВИДОВОГО СОСТАВА ДИНОФЛАГЕЛЛЯТ ЧЕРНОГО МОРА

Критически обобщены данные о разнообразии динофлагеллят Черного моря (ЧМ) авторов всех причерноморских стран (России, Грузии, Турции, Болгарии, Румынии и Украины) за период с 1886 по 2018 гг. Проверенный список динофлагеллят включает 420 видов (447, включая внутривидовые таксоны — ввт) из 92-х родов, которые относятся к 47 семействам, 16 порядкам и 4 классам. Это значительно превышает количество таксонов динофлагеллят, ранее указанных для ЧМ, что обусловлено повышенным интересом к этой группе водорослей в последние десятилетия, а также благодаря международной кооперации исследований. Изменение климата и интенсификация международного судоходства способствовали проникновению в ЧМ инвазивных видов. Список также дополнен пресноводными видами, зарегистрированными в опресненных районах моря. Имеющиеся данные о таксонах существенно расширили наши представления о разнообразии динофлагеллят ЧМ, однако состав ведущих порядков не изменился: Peridiniales (124 ввт), Gymnodiniales (96/96), Gonyaulacales (73/91), Dinophysiales (40/41), Prorocentrales (23/25) и Amphidiniales (21/22) составляют 85% найденных видов. По количеству таксонов самыми богатыми оказались роды: Protoperidinium (59/62), Gymnodinium (48/48), Ceratium (34/51), Dinophysis (33/34), Prorocentrum (22/24), Gyrodinium (20/20), Amphidinium (21/22), Gonyaulax (19/19) и Ostreopsis (14/14). Единственным видом были представлены 52 рода, 201 таксон видового и внутривидового ранга был впервые приведен после 1990 г. Чек-лист причерноморских динофлагеллят приведен с приметами в настоящее время таксона-менскими названиями и их синонимами, указанными для Черного моря. Ссылки содержат 116 литературных источников и неопубликованных оригинальных данных. Дальнейшее изучение видового разнообразия Черного моря должно быть направлено на более точную идентификацию видов согласно современной методологии. Продолжение формирования базы данных по фитопланктону ЧМ с доступной полной информацией о каждом виде, также будет способствовать прогрессу в изучении биоразнообразия Черного моря.

Ключевые слова: Dinoflagellata, Черное море, микроводоросли, фитопланктон, видовой состав

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Krakhmalnyi A.F. et al.

448
## Supplement

### A checklist of dinoflagellates of the Black Sea (1886–2018)

The species are arranged alphabetically. Synonyms (which are found in references used to create checklist) are given below the corresponding valid name after the “=” sign. The numbers following a species name in the checklist refer to the list of references. References where the valid name was found are given in bold. References to the synonyms are given in parentheses (semicolon delimited if several synonyms are used). References 1-124 were numbered according in the database on the website http://phyto.bss.plankton.kiev.ua/wiki, 125-144 were added by the authors of the article and not included in the database.

| Taxa | References |
|------|------------|
| 1 Akashiwo sanguinea (K. Hirasaka) G. Hansen & Moestrup = Gymnodinium sanguineum K. Hirasaka; Gymnodinium splendens M. Lebour | 9, 10, 11, 19, 20, 27, 57, 68, 81, 82, 83, 99, 126, 129, 130, 131, 136, 138, 142, 144 (2, 3, 12, 14, 25, 27, 33, 36, 42, 100, 108, 125, 132; 1, 4, 6, 7, 8, 21, 23, 24, 34, 49, 74, 85, 86, 89, 92, 94, 107) |
| 2 Alexandrium affine (Inoue & Fukuyo) Balech | 11, 131, 135 |
| 3 Alexandrium catenella (Whedon & Kof.) Balech | 131, 135 |
| 4 Alexandrium minutum Halim | 11, 19, 77, 99, 111, 130, 131 |
| 5 Alexandrium monilatum (J.F. Howell) Balech = Gessnerium mochimaense Halim ex Halim | 9, 11, 82, 107, 142 (6) |
| 6 Alexandrium ostenfeldii (Paulsen) Balech & Tangen = Gonioblastis ostenfeldii Paulsen | 9, 11, 12, 19, 20, 27, 36, 79, 126, 129, 132, 136, 138, 142 (1, 4, 14, 15, 18) |
| 7 Alexandrium pseudogonyaulax (Biecheler) Horiguchi ex K. Yuki & Fukuyo | 27, 47, 131, 132, 135, 142 |
| 8 Alexandrium tamarense (M. Lebour) Balech | 2, 11, 12, 27, 33, 125, 127, 131, 132, 135, 142 |
| 9 Amphidinium aculeatum Schröd. | 1, 18, 129 |
| 10 Amphidinium acutissimum J. Schiller | 2, 8, 9, 10, 14, 24, 27, 67, 126, 129, 132, 140, 142 |
| 11 Amphidinium conradii J. Schiller | 9, 27, 38, 47, 131, 132, 142 |
| 12 Amphidinium crassum Lohmann = Amphidinium phaeocystica M. Lebour | 1, 2, 6, 8, 11, 12, 14, 20, 21, 23, 27, 93, 126, 132, 142 (1, 2, 8, 23) |
| 13 Amphidinium cucurbita Kof. & Swezy | 1, 9, 14, 23, 126, 142 |
| 14 Amphidinium curvatum J. Schiller | 1, 2, 9, 14, 23, 126, 142 |
| 15 Amphidinium flagellans J. Schiller | 1, 9, 14, 23, 126, 142 |
| 16 Amphidinium fusiforme G.W. Martin | 27, 132, 142 |
| 17 Amphidinium globosum Schröd. | 1, 9, 11, 14, 23, 126, 136, 142 |
| 18 Amphidinium inflatum Kof. | 11, 27, 47, 132, 142 |
| 19 Amphidinium klebsii Kof. & Swezy | 10, 14, 126 |
| 20 Amphidinium klebsii f. ponticum Roukh. | 69, 126 |
| 21 Amphidinium lanceolatum Schröd. | 5, 9, 14, 27, 38, 47, 126, 132, 140, 142 |
| 22 Amphidinium longum Lohmann | 1, 2, 6, 8, 9, 10, 11, 12, 14, 21, 23, 24, 27, 109, 126, 129, 132, 136, 142 |
| 23 Amphidinium mananninii Herdman | 38, 131 |
| 24 Amphidinium operculatum Clap. & J. Lachm. | 1, 2, 6, 8, 9, 10, 11, 13, 14, 18, 19, 24, 27, 36, 126, 129, 132, 142 |
| 25 Amphidinium ovum Herdman | 1, 3, 5, 9, 11, 14, 15, 18, 19, 23, 126, 129, 142 |
| 26 Amphidinium rhynchochalum Anissimowa | 6, 14, 126, 142 |
| 27 Amphidinium sphenoides A. Wulff | 2, 10, 11, 12, 142 |

continued on the next page
| Taxa                                   | References               |
|----------------------------------------|--------------------------|
| 28 Amphidinium stigmatum               | J. Schiller              |
| 29 Amphidinium turbo                    | Kof. & Swezy              |
| 30 Amphidinium wigrense                 | Wolosz.                  |
| 31 Amphidoma languida                   | Tillmann, Salas & Elbrächter |
| 32 Amphisolenia bidentata               | Schröd.                  |
| 33 Amylax triacantha                   | = Gonyaulax triacantha Jörg. |
| 34 Apocalathium aciculiferum            | (Lemmerm.) Craveiro, Daugbjerg, Moestrup & Calado |
| 35 Archaeperidinium minutum             | (Kof.) Jörg.              |
| 36 Azadinium spinosum                   | Elbrächter & Tillmann    |
| 37 Blixaea quinquecornis                | (T.H. Abé) Gottschling   |
| 38 Bysmatrum subsalsum                  | (Ostenf.) M.A. Faust & Steidinger |
| 39 Centrodinium intermedium             | Pavill.                  |
| 40 Ceratium arietinum                   | Cleve                     |
| 41 Ceratium belone                      | Cleve                     |
| 42 Ceratium biceps                      | Clap. & J. Lachm.        |
| 43 Ceratium candelabrum                 | (Ehrenb.) F. Stein       |
| 44 Ceratium carriense                   | Gourret                   |
| 45 Ceratium carriense var. volans       | (Cleve) Jörg.             |
| 46 Ceratium compressum                  | Gran                      |
| 47 Ceratium contrarium                  | Pavill.                   |
| 48 Ceratium dalmaticum                  | Schröder                  |
| 49 Ceratium declinatum                  | (Karsten) Jörg.           |
| 50 Ceratium declinatum f. majus         | Jörg.                     |
| 51 Ceratium declinatum f. normale       | Jörg.                     |
| 52 Ceratium dens                        | Ostenf. & Schmidt        |
| 53 Ceratium extensum                    | (Gourret) Cleve           |
| 54 Ceratium falcatus                    | (Kof.) Jörg.              |
| Taxa | References |
|------|------------|
| 55   | Ceratium furca (Ehrenb.) Clap. & J. Lachm. 130, 137, 139 (as *Tripos furca*); 1-4, 6-14, 18-22, 25-27, 33-35, 38, 49, 51, 54-59, 63, 67, 68, 72-75, 78, 84-87, 89, 92, 94, 99, 103, 105, 108-110, 116, 117, 119, 123, 125, 127, 129, 132, 136, 142, 144 (126) |
|      | = Neoceratium furca (Ehrenb.) Gómez, Moreira & López-García |
| 56   | Ceratium furca var. berghii Jörg. 1, 6, 11, 14, 27, 72, 73, 132, 142 (115, 126) |
|      | = Neoceratium furca var. berghii (Jörg.) Krachm. |
| 57   | Ceratium furca var. eugrammum (Ehrenb.) J. Schiller 7, 10, 11, 14, 15, 19, 24, 25, 27, 38, 47, 99, 117, 129, 131, 132, 136, 140, 142 (115, 126) |
|      | = Neoceratium furca var. eugrammum (Ehrenb.) Krachm. |
| 58   | Ceratium fusus (Ehrenb.) Dujardin 130 (as *Tripos fusus*); 1-4, 6-14, 18, 20-22, 26, 27, 33-36, 49, 51, 54, 55-59, 63, 67, 68, 72-75, 78, 85-87, 89, 92, 94, 99, 103, 105, 108-110, 116-119, 123, 125, 127, 129, 132, 136, 139, 142, 144 (126) |
|      | = Neoceratium fusus (Ehrenb.) Gómez, Moreira & López-García |
| 59   | Ceratium fusus var. schuettii Lemmerm. 132, 142 |
| 60   | Ceratium fusus var. seta (Ehrenb.) Sournia 7, 11, 14, 25, 27, 38, 84, 131, 132, 142 |
| 61   | Ceratium hexacanthum Gourret 2, 7, 9, 14, 142 (126) |
|      | = Neoceratium hexacanthum (Gourret) Gómez, Moreira & López-Garcia |
| 62   | Ceratium hexacanthum var. aestuarium (Schröd.) J. Schiller 38, 131 |
| 63   | Ceratium hexacanthum var. contortum (Lemmerm.) Jörg. 38, 131 |
| 64   | Ceratium hircus Schröd. 10, 142 |
| 65   | Ceratium hirundinella (O. Müll.) Dujardin 1, 6, 14, 18, 19, 56, 99, 108, 126, 136, 142, 144 |
| 66   | Ceratium horridum Gran 7, 9, 25, 125, 142 (142; 142) |
|      | = Ceratium tenue Ostenf. & Schmidt; Ceratium tenue var. buceros (Zacharias) Balech |
| 67   | Ceratium horridum f. denticulatum Jörg. 25 |
| 68   | Ceratium horridum var. buceros (Zacharias) Sournia 7 (9) |
| 69   | Ceratium incisum (Karsten) Jörg. 9, 25, 142 |
| 70   | Ceratium inflatum (Kof.) Jörg. 1, 7, 9, 10, 14, 23, 25, 38, 51, 68, 74, 99, 142 (126) |
|      | = Neoceratium inflatum (Kof.) Gómez, Moreira & López-Garcia |
| 71   | Ceratium kofoidii Jörg. 9, 25, 142 |
| 72   | Ceratium lineatum (Ehrenb.) Cleve 1, 2, 9-11, 14, 19, 25, 38, 125, 129, 136, 142 (126) |
|      | = Neoceratium lineatum (Ehrenb.) Gómez, Moreira & López-Garcia |
| 73   | Ceratium longipes (Bailey) Gran 2, 7, 9, 11, 14, 142 (126) |
|      | = Neoceratium longipes (Bailey) Gómez, Moreira & López-Garcia |
| 74   | Ceratium longirostrum Gourret 7, 9, 14, 25, 27, 47, 132, 140, 142 (126) |
|      | = Neoceratium longirostrum (Gourret) Gómez, Moreira & López-Garcia |
| 75   | Ceratium macroceros (Ehrenb.) Vanhöffen 1, 7, 9, 10, 14, 51, 74, 142 (126, 131) |
|      | = Neoceratium macroceros (Ehrenb.) Gómez, Moreira & López-Garcia |
| 76   | Ceratium massiliense (Gourret) O. Jörg. 9, 38, 142 (131) |
|      | = Neoceratium massiliense (Gourret) Gómez, Moreira & López-Garcia |

continued on the next page
| Taxa                                      | References                                      |
|-------------------------------------------|-------------------------------------------------|
| **77** Ceratium massiliense f. armatum     | (25, 142; 115, 126)                             |
| (Karsten) J. Schiller                     |                                                 |
| = Ceratium massiliense var. armatum       |                                                 |
| (G. Karst.) Jörg.; Neoceratium massiliense|                                                 |
| var. armatum (G. Karst.) Krachm.          |                                                 |
| **78** Ceratium massiliense f. protuberans | 14                                              |
| (G. Karst.) Jörg.                         |                                                 |
| = Ceratium massiliense var. protuberans   |                                                 |
| (G. Karst.) Jörg.                         |                                                 |
| **79** Ceratium minutum                   | 1, 6, 9, 10, 14, 15, 23, 72, 129, 142 (126)    |
| Jörg.                                     |                                                 |
| = Neoceratium minutum (Jörg.) Gómez,      |                                                 |
| Moreira & López-García                    |                                                 |
| **80** Ceratium pavillardii               | 142                                             |
| Jörg.                                     |                                                 |
| **81** Ceratium pentagonum                | 1, 2, 7, 9, 10, 14, 23, 24, 38, 67, 108, 129, 136, 142 (126) |
| Gourret                                   |                                                 |
| = Neoceratium pentagonum (Gourret)        |                                                 |
| Gómez, Moreira & López-García             |                                                 |
| **82** Ceratium protuberans               | 1, 23                                           |
| (G. Karst.) Paulsen                       |                                                 |
| **83** Ceratium pulchellum                | 2, 7, 9, 11, 27, 142 (7, 25)                    |
| Schröd.                                   |                                                 |
| = Ceratium tripos var. pulchellum (Schröd.)| Lopez ex Sournia                               |
| **84** Ceratium teres                     | 9, 14, 25, 34, 38, 142 (126, 131)               |
| Kof.                                      |                                                 |
| = Neoceratium teres (Kof.) Gómez, Moreira |                                                 |
| & López-Garcia                            |                                                 |
| **85** Ceratium trichoceros               | 38 (131)                                        |
| (Ehrenb.) Kof.                            |                                                 |
| = Neoceratium trichoceros (Ehrenb.)       |                                                 |
| Gómez, Moreira & López-Garcia             |                                                 |
| **86** Ceratium tripos (O. Müll.) Nitzsch | 130 (as Tripus muelleri); 1-14, 18-22, 26, 27, 33-36, 38, 47, 49, 51, 54-59, 63, 67, 72-75, 78, 84-87, 89, 92, 94, 103-105, 108, 109, 116, 117, 123, 125, 127, 129, 132, 142, 144 (126, 136) |
| = Neoceratium tripus (O. Müll.) Gómez,    |                                                 |
| Moreira & López-Garcia                    |                                                 |
| **87** Ceratium tripos f. ponticum        | 132, 142 (19, 27; 115)                          |
| Jörg.                                     |                                                 |
| = Ceratium tripos var. ponticum Jörg.;    |                                                 |
| Neoceratium tripus f. ponticum (Jörg.)    |                                                 |
| Krachm.                                   |                                                 |
| **88** Ceratium tripos f. subsalsum       | 14, 15 (115, 126)                               |
| Ostenf.                                   |                                                 |
| = Neoceratium tripos f. subsalsum (Ostenf.)| Krachm.                                        |
| **89** Ceratium tripos var. atlanticum    | 25, 38, 131 (115)                               |
| Ostenf.                                   |                                                 |
| = Neoceratium tripos var. atlanticum      |                                                 |
| (Ostenf.) Krachm.                         |                                                 |
| **90** Ceratium tripos var. neglectum     | 142                                             |
| Ostenf.                                   |                                                 |
| **91** Ceratium volans                    | 9                                               |
| Cleve                                     |                                                 |
| **92** Chimonodinium lomnickii            | 144 (19)                                        |
| (Wołosz.) Craveiro, Calado, Daughbjerg, G.|                                                 |
| Hansen & Moestrup                         |                                                 |
| = Peridinium lomnickii Wołosz.            |                                                 |
| **93** Cladopycis brachiolata             | 1, 9, 10, 14, 126                               |
| F. Stein                                  |                                                 |
| **94** Cochlodinium adriaticum            | 9, 10, 11, 14, 35, 100, 126, 129 (1, 8, 23, 27, 38, 68, 78, 132, 142) |
| (J. Schiller) J. Schiller                 |                                                 |
| = Gyrodinium adriaticum J. Schiller        |                                                 |
| **95** Cochlodinium archimedes             | 1, 10, 11, 14, 15, 18, 21, 24, 126, 129, 142   |
| (C.H.G. Pouchet) Lemmerm.                 |                                                 |
| **96** Cochlodinium brandii               | 2, 3, 9, 10, 14, 15, 19, 126, 129               |
| A. Wulff                                  |                                                 |
| **97** Cochlodinium helicoideas            | 9, 14, 27, 47, 126, 132, 142 (12, 23, 27, 50, 132) |
| M. Lebour                                 |                                                 |
| = Cochlodinium helix Kof. & Swezy          |                                                 |
| **98** Cochlodinium lebouriae              | 1, 9, 14, 23, 126, 142                          |
| Kof. & Swezy                              |                                                 |

continued on the next page
| Taxa | References |
|------|-------------|
| **99** Cochlodinium pirum (F. Schütt) Lemmerm. | 1, 3, 9, 14, 15, 27, 126, 129, 132, 142 (18, 101) |
| = Gymnodinium pirum F. Schütt | |
| **100** Cochlodinium pupa M. Lebour | 11, 27, 85, 132, 142 |
| **101** Cochlodinium schuetii Kof. & Swezy | 142 |
| **102** Cystodinium bataviense G.A. Klebs | 1, 10, 14, 23, 27, 126, 129, 132, 142 |
| **103** Dinophysis acuminata Clap. & J. Lachm. | 1, 2, 4, 6-11, 14, 15, 18, 19, 21, 25, 27, 33, 34, 36, 38, 58, 63, 67, 72, 73, 75, 77, 85, 89, 92, 94, 99, 109, 116, 125, 126, 129, 130, 132, 136, 141, 142, 144 (1, 2, 6, 8, 14, 20, 21, 23, 27, 72, 73, 77, 89, 92, 100, 109, 126, 132, 141, 142; 1, 2, 8, 14, 21, 23, 77, 126, 141, 142; 1, 12, 14, 23, 77, 126, 129, 141, 142; 13, 29, 21) |
| = Dinophysis baltica (Paulsen) Kof. & Skogsb.; Dinophysis baltica (Paulsen) Wołosz.; Dinophysis levanderi Wołosz.; Dinophysis paulsenii Wołosz.; Dinophysis ventricosa Clap. & J. Lachm.; Dinophysis cassubica Wołosz. | |
| **104** Dinophysis acuta Ehrenb. | 1, 2, 3, 6-12, 14, 15, 18, 20, 21, 25-27, 33, 34, 36, 54-56, 58, 67, 72, 73, 77, 85, 89, 92, 100, 105, 108, 109, 125, 126, 129, 130, 132, 141, 142 (142) |
| = Dinophysis dens Pavill. | |
| **105** Dinophysis amandula Sournia | 2, 14, 27, 126, 132, 142 |
| **106** Dinophysis apiculata Meunier | 1, 9, 10, 14, 23, 77, 126, 141, 142 |
| **107** Dinophysis arctica Mereschk. | 1, 9, 13, 14, 15, 18, 27, 67, 77, 126, 129, 132, 141, 142 |
| **108** Dinophysis caudata W.S. Kent | 1-4, 6-12, 14, 15, 18-21, 25, 26, 27, 33, 34, 36, 38, 45, 49, 54, 58, 63, 67, 72, 73, 75, 77, 78, 85, 89, 92, 94, 99, 105, 108, 109, 117, 123, 125, 126, 127, 129, 130, 132, 136, 141, 142, 144 (25; 7, 22, 55, 56, 87, 101, 105) |
| = Dinophysis diegensis Kof.; Dinophysis homuncula F. Stein; | |
| **109** Dinophysis caudata f. acutiformis Kof. & Skogsb. | 14, 15 |
| **110** Dinophysis dentata J. Schiller | 7, 9, 67, 77, 142 |
| **111** Dinophysis fortii Pavill. | 1, 2, 7-10, 12, 14, 15, 18, 21, 24-27, 33, 34, 36, 38, 45, 49, 57, 58, 67, 74, 77, 78, 86, 89, 92, 126, 127, 129, 130, 132, 136, 141, 142, 144 |
| **112** Dinophysis hastata F. Stein | 1, 2, 4, 6, 7, 9, 10, 12, 14, 15, 18, 20, 25, 26, 33, 54, 58, 67, 72-74, 77, 85, 94, 105, 109, 125, 126, 129, 130, 136, 141, 142, 144 |
| **113** Dinophysis infundibulum J. Schiller | 25, 142 |
| **114** Dinophysis irregularis (M. Lebour) Balech | (2, 21) |
| = Phalacroma irregularare M. Lebour | |
| **115** Dinophysis islandica Paulsen | 27, 132, 141, 142 |
| **116** Dinophysis laevis Clap. & J. Lachm. | 142 |
| **117** Dinophysis meunieri J. Schiller | 9, 136 |
| **118** Dinophysis minutaf (Cleve) Balech | 9, 14, 27, 77, 126, 132, 141, 142 |
| **119** Dinophysis mucronata (Kof. & Skogsb.) Sournia | 1 |
| **120** Dinophysis nasuta (F. Stein) Parke & Dixon | 141 |
| **121** Dinophysis norvegica Clap. & J. Lachm. | 1, 2, 8, 9, 11, 14, 15, 27, 33, 36, 56, 67, 77, 126, 130, 132, 136, 141, 142 |
| **122** Dinophysis odiosa (Pavill.) L.S. Tai & Skogsb. | 10, 42, 79, 129, 131, 141 |
| **123** Dinophysis ovata Clap. & J. Lachm. | 7, 13, 14, 18, 20, 77, 126, 129, 141, 142 (1, 9, 15, 21, 67, 123) |
| = Phalacroma ovatum (Clap. & J. Lachm.) Jörg. | |
| **124** Dinophysis ovum F. Schütt | 1-10, 14, 15, 18, 19, 21, 24, 27, 34, 36, 38, 57, 67, 72, 73, 74, 77, 78, 85, 89, 92, 94, 109, 116, 117, 123, 126, 129, 132, 136, 141, 142 |
| **125** Dinophysis parva J. Schiller | 7, 9 |
A checklist of dinoflagellates of the Black Sea - continued from the previous page

| Taxa                                      | References                                      |
|-------------------------------------------|-------------------------------------------------|
| **126** Dinophysis parvula (F. Schütt) Balech | = Phalacroma parvulum (F. Schütt) Jörg. 25, 142 (2, 7, 9) |
| 127 Dinophysis pulchella (M. Lebour) Balech | = Phalacroma pulchellum M. Lebour 126, 129, 136, 141, 142 (1, 4, 9, 10, 15, 18, 21, 24, 58, 94, 116) |
| 128 Dinophysis punctata Jörg.              | 7, 9, 25, 142                                   |
| 129 Dinophysis recurva Kof. & Skogs.       | 21, 27, 132, 141, 142                           |
| 130 Dinophysis rudgei G. Murr. & Whitting  | = Phalacroma rudgei G. Murr. & Whitting 19, 25, 126, 141, 142 (1, 6, 15, 18, 72, 74, 75, 129, 136) |
| 131 Dinophysis sacculus F. Stein           | 1-4, 6-12, 14, 15, 18-22, 24, 25, 27, 33, 35, 36, 38, 49, 58, 67, 72, 73, 74, 77, 84, 85, 86, 89, 92, 94, 100, 109, 117, 123, 126, 129, 130, 132, 136, 141, 142, 144 |
| 132 Dinophysis schuettii G. Murr. & Whitting | 9, 14, 39, 126, 131                            |
| 133 Dinophysis similis Kof. & Skogs.       | 7, 9, 77                                        |
| 134 Dinophysis sphaerica F. Stein         | 1, 2, 7-10, 14, 15, 21, 27, 38, 89, 92, 100, 126, 132, 141, 142 |
| 135 Dinophysis sphaeroidea (J. Schiller) Balech | = Phalacroma sphaeroideum J. Schiller; Dinophysis schilleri Sournia 77 (1, 4, 6, 10, 15, 18, 21, 38, 129, 136; 14, 6, 9, 10, 14, 126, 141;142) |
| 136 Dinophysis tripus Gourret              | 1, 9, 14, 15, 18, 19, 33, 36, 45, 77, 126, 129, 141, 142 |
| 137 Diplopelta asymmetrica (Mangin) Balech | = Peridiniopsis asymmetrica Mangin 126, 142 (14) |
| 138 Diplopsalis lenticula Bergh            | = Glenodinium lenticula (Bergh) J. Schiller 2, 3, 9-12, 14, 19-22, 25-27, 33, 38, 50, 56, 57, 63, 68, 78, 83, 99, 100, 101, 108, 111, 116, 125-127, 129, 130, 132, 136, 137, 139, 142, 144 (1, 4, 6, 8, 18, 21, 34, 49, 51, 54, 55, 58, 72, 73, 74, 74, 84, 85, 86, 89, 92, 94, 105, 109, 110, 117, 123, 125) |
| 139 Diplopsalis lenticula var. globularis Kisselev | 10, 12, 26, 129, 142 |
| 140 Diplopsalis orbicularis var. temaris (T.H. Abé) Krachm. | 14 |
| 141 Diplopsalopsis bomba (F. Stein) J.D. Dodge & S. Toriumi | = Dissodium asymmetricum (Mangin) A.R. Loebl.; Peridiniopsis asymmetrica M. Lebour |
| 142 Diplopsalopsis orbicularis (Paulsen) Meunier | = Peridinium orbiculare Paulsen 9, 14, 111, 126, 129, 132, 136, 142, 144 (1, 4, 8, 15, 18, 21, 27, 50, 89, 92, 94) |
| 143 Durinskia agilis (Kof. & Swezy) Saburova, Chomérat & Hoppenrath | = Gymnodinium agile Kof. & Swezy 144 (1, 2, 4, 6, 8, 9, 12, 14, 15, 18, 20, 21, 27, 68, 74, 94, 126, 129, 132, 136, 142) |
| 144 Durinskia dybowskii (Wolosz.) S. Carty | = Durinskia baltica (Levander) S. Carty & Cox; Peridinium balticum (Levander) Lemmerm. 144 (126; 2) |
| 145 Durinskia oculata (F. Stein) G. Hansen & Flaim | = Glenodinium oculatum F. Stein; Peridiniopsis oculata (F. Stein) Bourr. 126, 134 (1, 8-10, 20, 24, 101; 14, 27, 129, 132, 142) |
| 146 Ensiculifera carinata Matsuoka, Kobayashi & Gains | 111 |
| 147 Glenodiniopsis steinii Wolosz. = Glenodinium cinctum Ehrenb.; Sphaerodinium cinctum (Ehrenb.) Wolosz. | 14, 129 (11, 18, 101; 1, 14, 27, 126, 132, 142) |
| 148 Glenodinium behningii (Er. Lindem.) Kisselev | 1, 8, 9, 14, 27, 89, 92, 132, 142 |
| 149 Glenodinium inflatum Meunier | 1, 4, 9, 11, 14, 23, 27, 94, 126, 132, 136, 142 |
| 150 Glenodinium obliquum C.H.G. Pouchet | 1, 2, 9, 14, 15, 18, 27, 126, 129, 132, 142 |

continued on the next page
A checklist of dinoflagellates of the Black Sea - continued from the previous page

| Taxa                                      | References                                      |
|-------------------------------------------|------------------------------------------------|
| **151 Glenodinium paululum** Er. Lindem.  | 1-4, 6, 8-11, 14, 15, 18, 20, 21, 24, 26, 27, 34, 38, 49, 57, 74, 84, 85, 89, 92, 94, 110, 117, 118, 119, 123, 126, 129, 132, 136, 142 |
| **152 Glenodinium pilula** (Ostenf.) J. Schiller = Diplopsalis pilula Ostenf. | 1, 2, 4-6, 8-12, 14, 15, 18, 20, 21, 26, 27, 74, 84, 89, 92, 94, 129, 132, 142 (126) |
| **153 Glenodinium pulvisculus** (Ehrenb.) F. Stein | 1, 8, 9, 14, 18, 27, 101, 126, 129, 132, 142 |
| **154 Glochidinium penardiforme** (Er. Lindem.) Boltovskoy = Glenodinium penardiforme (Er. Lindem.) J. Schiller; Peridintopsis penardiformis (Er. Lindem.) Bourr. | 126, 134, 137, 144 (8, 132;14, 27;142) |
| **155 Goniodoma orientale** (Er. Lindem.) Balech = Gonyaulax orientalis Er. Lindem. | (1, 2, 6-11, 14, 23, 126, 132, 142, 144) |
| **156 Goniodoma sphaericum** G. Murr. & Whitting | 85, 142 |
| **157 Goniodoma striatum** Mangin | 132, 142 |
| **158 Gonyaulax africana** J. Schiller | 7, 9, 130, 142 |
| **159 Gonyaulax apiculata** (Penard) Entz | 2, 6, 9, 11, 14, 19, 20, 51, 126, 129, 136, 142 |
| **160 Gonyaulax birostris** F. Stein | 9, 25 |
| **161 Gonyaulax cocklea** Meunier | 1, 4-6, 8, 9, 11, 14, 19, 20, 23, 26, 27, 68, 94, 126, 129, 132, 136, 142, 144 |
| **162 Gonyaulax diegensis** Kof. | 1, 2, 4-6, 14, 15, 18, 25, 27, 34, 49, 58, 67, 72, 89, 92, 94, 100, 126, 129, 132, 136, 142 |
| **163 Gonyaulax digitalis** (C.H.G. Pouchet) Kof. | 1, 2, 4, 6-12, 14, 15, 18, 20, 21, 26, 27, 49, 51, 54, 55, 58, 67, 68, 74, 93, 94, 99, 100, 105, 116, 125, 126, 127, 129, 130, 132, 136, 142, 144 |
| **164 Gonyaulax elegans** Rampi | 7, 9, 142 |
| **165 Gonyaulax fragilis** (F. Schütt) Kof. | 1, 9, 14, 23, 126, 142 |
| **166 Gonyaulax gracilis** J. Schiller | 9, 10, 14, 126, 142 |
| **167 Gonyaulax lebouriae** Balech | 132, 142 |
| **168 Gonyaulax minima** Matzen. | 1, 2, 5, 6, 8, 10, 14, 15, 18-21, 26, 27, 34, 35, 38, 58, 67, 72, 78, 100, 110, 123, 126, 129, 132, 142, 144 |
| **169 Gonyaulax minuta** Kof. & Michener | 9, 11 |
| **170 Gonyaulax monacantha** Pavill. | 7, 9, 11, 25, 142 |
| **171 Gonyaulax monospina** Rampi | 7, 9, 142 |
| **172 Gonyaulax polygramma** F. Stein | 1-4, 6-12, 14, 15, 18-21, 25-27, 33, 34, 36, 38, 49, 51, 54, 58, 63, 67, 72, 73, 85, 86, 89, 92, 94, 99, 101, 105, 109, 111, 126, 127, 129, 132, 136, 142 |
| **173 Gonyaulax scrippae** Kof. | 1, 2, 5, 6, 8-11, 14, 15, 18-21, 26, 27, 33, 54, 55, 58, 68, 89, 92, 99, 105, 126, 129, 132, 142, 144 |
| **174 Gonyaulax spinifera** (Clap. & J. Lachm.) Diesing = Peridinium spiniferum Clap. & J. Lachm. | 1, 2, 4, 6-15, 18-21, 25-27, 33, 35, 38, 49, 51, 54, 55, 58, 67, 74, 77, 84, 85, 89, 92, 94, 100, 105, 108, 116, 117, 123, 125, 126, 127, 129, 130, 132, 136, 142, 144 (1, 4, 8, 13, 15, 18, 51, 58, 94) |
| **175 Gonyaulax turbynei** G. Murr. & Whitting | 34 |
| **176 Gonyaulax verior** Sournia = Gonyaulax diacantha (Meunier) J. Schiller; Gonyaulax longispina M. Lebour | 7, 9, 11, 14, 27, 126, 132, 142 (1, 6-8, 25, 93; 6) |
| **177 Gymnodinium agiliforme** J. Schiller | 1-5, 8-12, 14, 15, 18-21, 24, 27, 84, 126, 129, 132, 136, 142, 144 |

continued on the next page
| Taxa                                           | References                  |
|------------------------------------------------|-----------------------------|
| **Gymnodinium albulum** Er. Lindem.            | 19, 21, 132, 142            |
| **Gymnodinium antarcticum** A.E. Thessen, D.J. Patterson & S.A. Murray = *Gymnodinium frigidum* Balech | (2, 27, 132, 142)          |
| **Gymnodinium arcticum** A. Wulff              | 2, 10, 12, 27, 129, 132, 142 |
| **Gymnodinium arcuatum** Kof.                  | 14, 27, 126, 132, 142       |
| **Gymnodinium aureolum** (Hulburt) G. Hansen  | **Gyrodinium aureolum** Hulbert *(12, 27, 68, 132, 135)* |
| **Gymnodinium biconicum** J. Schiller          | 2, 7, 9, 142                |
| **Gymnodinium cneoides** T.M. Harris           | 144                         |
| **Gymnodinium dissimile** Kof. & Swezy         | 84                          |
| **Gymnodinium excavatum** Van Meel             | 27, 132, 142                |
| **Gymnodinium eurytopum** Skuja                | 142                         |
| **Gymnodinium flavum** Kof. & Swezy            | 6, 9, 11, 21, 142           |
| **Gymnodinium fuscum** (Ehrenb.) F. Stein      | 3, 4, 8, 9, 11, 14, 27, 38, 49, 94, 126, 129, 132, 136, 142 |
| **Gymnodinium fusiforme** Kof. & Swezy         | 136                         |
| **Gymnodinium galeiforme** Matzen.             | 6, 9                        |
| **Gymnodinium gibbera** J. Schiller            | 9, 49, 136                  |
| **Gymnodinium gracile** Bergh                  | 11, 142 (9)                 |
| **Gymnodinium grammaticum** (C.H.G. Pouchet) Kof. & Swezy = *Gymnodinium grammaticum* C.H.G. Pouchet | 1, 9, 14, 23, 27, 84, 126, 132, 142 (21) |
| **Gymnodinium hamulus** Kof. & Swezy           | 6, 11, 142                  |
| **Gymnodinium heterostriatum** Kof. & Swezy    | 2, 11, 19, 27, 47, 132, 142 |
| **Gymnodinium impudicum** (S. Fraga & I. Bravo) G. Hansen & Moestrup = *Gyrodinium impudicum* S. Fraga & I. Bravo | (14, 27, 126, 132, 142) |
| **Gymnodinium inversum** Nygaard                | 27, 132, 142                |
| **Gymnodinium kowalevskii** Pitzik              | 10, 12, 21, 24, 38, 129     |
| **Gymnodinium lachmannii** W.S. Kent           | 6, 9                        |
| **Gymnodinium lacustre** J. Schiller           | 11, 14, 21, 27, 47, 126, 129, 132, 140, 142, 144 |
| **Gymnodinium lanskoii** Roukh.                | 10, 129                     |
| **Gymnodinium lantzschii** Utermöhl            | 11, 144                     |
| **Gymnodinium latum** Skuja                    | 142                         |
| **Gymnodinium marinum** W.S. Kent              | 1, 9, 11, 14, 23, 27, 126, 132, 142 |
| **Gymnodinium minor** M. Lebour                | 1, 8, 10, 14, 23, 27, 126, 132, 142 |
| **Gymnodinium mirabile** Penard                | 27                          |
| **Gymnodinium najadeum** J. Schiller           | 1-6, 8-12, 14, 15, 18-21, 24, 27, 34, 49, 57, 68, 84, 89, 92, 100, 126, 129, 132, 136, 142, 144 |
| **Gymnodinium neapolitanum** J. Schiller       | 1, 3, 4, 8, 9, 11, 14, 15, 18, 20, 27, 84, 89, 92, 100, 126, 129, 132, 136, 142 |
| **Gymnodinium paradoxum** J. Schiller          | 4, 9, 14, 27, 38, 126, 131, 132, 136, 142 |
| **Gymnodinium palseini** J. Schiller           | 84                          |
| **Gymnodinium punctatum** C.H.G. Pouchet       | 5, 11, 21                   |

continued on the next page
| Taxa | References |
|------|------------|
| Gymnodinium pygmaeum | 9, 14, 27, 38, 47, 126, 131, 132, 142 |
| Gymnodinium radiatum | Kof. & Swezy | 9, 14, 48, 126, 142 |
| Gymnodinium rhomboides | F. Schütt | 1, 4-6, 8-11, 14, 15, 18, 21, 24, 27, 49, 67, 74, 86, 89, 92, 94, 100, 126, 129, 136 |
| Gymnodinium semidivisum | J. Schiller | 1, 9, 14, 23, 84, 126, 142 |
| Gymnodinium simplex | (Lohmann) Kof. & Swezy | 2, 3, 7-12, 14, 19, 20, 21, 23, 24, 26, 27, 36, 38, 84, 99, 126, 127, 129, 132, 142, 144 |
| Gymnodinium sphaericum | (Calkins) Kof. & Swezy | 9, 27, 132, 136, 142 |
| Gymnodinium stellatum | Hulburt | 12, 19, 27, 47, 79, 132, 142 |
| Gymnodinium sulcatum | Kof. & Swezy | 1, 8, 9, 11, 14, 23, 27, 126, 132, 142 |
| Gymnodinium uberrimum | (G.J. Allman) Kof. & Swezy | = Gymnodinium rotundatum G.A. Klebs; Gymnodinium uberrimum var. rotundatum (G.J. Allman) Kof. & Swezy | 2, 9, 11, 14, 27, 36, 47, 82, 106, 107, 126, 132, 135, 140, 142, 144 (2, 7, 9, 21, 49, 85; 136) |
| Gymnodinium variabile | Herdman | 9-11, 14, 21, 27, 35, 84, 126, 129, 132, 142 |
| Gymnodinium wulffii | J. Schiller | 1, 2, 3, 5, 6, 8-10, 12, 14, 19-21, 23, 24, 26, 27, 35, 110, 117, 119, 120, 123, 126, 129, 132, 136, 137, 139, 142, 144 |
| Gyrodinium britannia | Kof. & Swezy | 1, 2, 8, 9, 14, 23, 126, 142 |
| Gyrodinium capsulatum | Kof. & Swezy | 1, 9, 14, 23, 126, 142 |
| Gyrodinium cornutum | (C.H.G. Pouchet) Kof. & Swezy | 8, 9, 14, 27, 68, 100, 126, 129, 132, 140, 142 |
| Gyrodinium dorsum | Kof. & Swezy | 1, 9, 14, 23, 126, 142 |
| Gyrodinium estuariale | Hulburt | 19 |
| Gyrodinium flagellare | J. Schiller | 11, 12 |
| Gyrodinium flavum | Kof. | 85 |
| Gyrodinium fusiforme | Kof. & Swezy | 2-4, 6-8, 10, 12, 14, 19-21, 23, 24, 26, 27, 33-36, 38, 49, 50, 57, 72, 74, 84-86, 89, 92, 94, 117, 123, 126, 127, 129, 132, 136, 142, 144 |
| Gyrodinium fusus | (Meunier) Akselman | 1, 2, 9, 11, 129 |
| Gyrodinium helveticum | (Penard) Y. Takano & T. Horiguchi = Gymnodinium helveticum Penard; Gymnodinium helveticum var. apiculatum Utermöhl; Glenodinium apiculatum Zacharias | (9, 14, 126, 129, 142; 136; 1, 4, 6, 8, 10, 11, 15, 18, 20, 24, 49, 74, 86, 132) |
| Gyrodinium hyalinum | (A.J. Schill.) Kof. & Swezy | 6, 142 |
| Gyrodinium lacryma | (Meunier) Kof. & Swezy | 1, 2, 4, 6-11, 14, 20, 21, 23, 24, 26, 27, 34, 49, 50, 74, 84, 86, 89, 92, 94, 118, 126, 129, 132, 136, 139, 142, 144 |
| Gyrodinium nasutum | (A. Wulff) J. Schiller | 1, 2, 4, 6, 8, 9, 11, 14, 27, 34, 50, 85, 93, 126, 132, 136, 142, 144 |
| Gyrodinium ovum | (F. Schütt) Kof. & Swezy | 11, 27, 47, 132, 142 |
| Gyrodinium pellucidum | (A. Wulff) J. Schiller | 7, 9, 20, 136, 142 |
| Gyrodinium pingue | (F. Schütt) Kof. & Swezy | 1-4, 6, 9-12, 14, 19, 21, 23, 24, 27, 34, 38, 57, 74, 84, 94, 116, 117, 126, 129, 132, 136, 142, 144 |
| Gyrodinium prunus | (A. Wulff) M. Lebour | 9, 14, 23, 126 |
| Gyrodinium pusillum | (A.J. Schill.) Kof. & Swezy = Gymnodinium pusillum A.J. Schill. | 7, 9-11, 24, 142 (2) |
| Gyrodinium spirale | (Bergh) Kof. & Swezy = Spirodinium spirale Entz | 1, 2, 6, 8, 9, 11, 12, 14, 15, 18, 19, 20, 27, 33, 34, 50, 72, 73, 85, 126, 127, 129, 130, 132, 142, 144 (18) |

continued on the next page
| Taxa | References |
|------|------------|
| Gyrodinium wulffii | 11, 38 |
| Hemidinium nasutum | 144 |
| Herdmania litoralis | 1, 2, 3, 11, 129 |
| Heterocapsa rotundata | 9, 11, 13, 129 |
| Heterocapsa triquetra | 2-4, 6-12, 14, 19, 20, 24-27, 33-36, 68, 81, 82, 94, 99, 100, 108, 118, 125, 126, 127, 129, 130, 132, 136, 138, 139, 140, 142, 144 |
| Heterodinium mediterraneum | 2, 63 |
| Heterodinium murrayi | 7, 9, 142 |
| Huia caspica | 1, 2, 8, 9, 14, 15, 20, 23, 27, 93, 132, 136, 142; 126 |
| Hypnodinium sphaericum | 1, 4, 14, 15, 18, 49, 86, 94, 126, 129, 136 |
| Kapelodinium vestifici | 1, 4, 9, 10, 11, 14, 21, 23, 49, 129, 136, 142 |
| Karenia brevis | 12, 36 (12, 19) |
| Karenia mikimotoi | (12) |
| Kofoidinium lebouriae | 2, 9, 20, 27, 126, 129, 132, 142 |
| Kofoidinium velleloides | 99 |
| Kolkwitzia acuta | 14, 126, 136, 144; 1, 4, 8, 20, 27, 49, 89, 92, 132, 142 |
| Kryptoperidinium foliaceum | 2, 9, 20, 27, 126, 129, 132, 142 |
| Kryptoperidinium foliaceum var. ponticum | 115, 129 (10, 98) |
| Lebouridinium glaucum | 144 (2, 12, 126, 129, 142; 109, 136) |
| Lessardia elongata | 11, 52, 129, 139, 144 |
| Levanderina fissa | 1, 2, 3, 6, 9, 14, 15, 19, 27, 34, 38, 126, 129, 132, 142; 18, 101; 4, 9, 136; 142 |

continued on the next page
| Taxa | References |
|------|-------------|
| **Lingulodinium polyedra** (F. Stein) J.D. Dodge  
= *Gonyaulax polyedra* F. Stein | 2, 3, 6, 9-12, 14, 15, 20, 26, 27, 35, 36, 68, 77, 81, 82, 99, 100, 108, 126, 129, 130, 132, 136, 137, 139, 142, 144 (1, 4, 5, 7, 8, 18, 19, 21, 25, 34, 38, 49, 51, 54, 55, 58, 67, 72, 73, 74, 85, 89, 92, 94, 104, 105, 109, 110, 123, 125, 140) |
| **Margalefidinium citron** (Kof. & Swezy) Gómez, Richlen & D.M. Anderson  
= *Cochlodinium citron* Kof. & Swezy | 2, 14, 27, 33, 47, 77, 126, 131, 132, 135, 139, 142 |
| **Mesoporos perforatus** (Gran) Lillick  
= *Exuviaella perforata* Gran; *Porella perforata* (Gran) J. Schiller | 2, 7, 9, 10, 12, 14, 19, 25, 27, 111, 126, 129, 132, 142, 144 (1, 15, 18, 21, 34, 38, 38, 78) |
| **Micracanthodinium bacilliferum** (J. Schiller) Deflandre  
= *Cladopyxis bacillifera* J. Schiller | 129 (10, 142) |
| **Micracanthodinium setiferum** (Lohmann) Deflandre  
= *Cladopyxis setifera* Lohmann | 11 (8, 27, 132, 142) |
| **Noctiluca scintillans** (Macartney) Kof. & Swezy  
= *Noctiluca miliaris* Suriray & Lamarck | 7, 9, 14, 19, 25, 27, 33, 36, 45, 99, 108, 125, 126, 129, 130, 132, 136, 139, 142 (1, 13, 15, 18, 22, 50, 51, 59, 72, 73, 87, 93, 105, 109) |
| **Nusuttodinium aeruginosum** (F. Stein) Takano & T. Horiguchi  
= *Gymnodinium aeruginosum* F. Stein | (9, 14, 27, 47, 126, 132, 140, 142) |
| **Nusuttodinium amphidinioides** (Geitler) Takano & T. Horiguchi  
= *Amphidinium amphidinioides* (Geitler) J. Schiller | (9, 14, 126, 142) |
| **Oblea rotunda** (M. Lebour) Balech & Sournia  
= *Glenodinium rotundatum* (M. Lebour) J. Schiller; *Peridiniopsis rotunda* M. Lebour | 5, 9-12, 14, 19, 27, 111, 126, 127, 129, 132, 136, 142, 144 (1, 3, 4, 6, 18, 23, 55, 67, 74, 93, 94, 105;10) |
| **Opisthoaulax vorticella** (F. Stein) Calado  
= *Katodinium vorticella* (F. Stein) A.R. Loebl.; *Katodinium vorticellum* (F. Stein) Fott; *Gymnodinium vorticella* F. Stein; *Massartia vorticella* (F. Stein) J. Schiller | 129, 130 (132, 142; 9, 14, 27, 126, 142;18, 101; 1, 6, 8, 15, 21, 27) |
| **Oxyrrhis marina** Dujardin | 2, 129, 132, 142 |
| **Oxytoxum adriaticum** J. Schiller | 2, 9, 21, 142 |
| **Oxytoxum brunelli** Rampi | 142 |
| **Oxytoxum caudatum** J. Schiller | 10, 12, 24, 142 |
| **Oxytoxum gladiolus** F. Stein | 2, 3, 10, 24, 129, 142 |
| **Oxytoxum laticeps** J. Schiller | 67 |
| **Oxytoxum milneri** G. Murr. & Whitting | 7, 9, 142 |
| **Oxytoxum mitra** F. Stein | 7, 9, 142 |
| **Oxytoxum parvum** J. Schiller | 9, 14, 38, 117, 126, 131 |
| **Oxytoxum reticulatum** Bütschli | 10, 142 |
| **Oxytoxum scolopax** F. Stein | 10, 142 |
| **Oxytoxum sphaeroideum** F. Stein | 10, 34, 142 |

continued on the next page
| Taxa                                      | References                          |
|-------------------------------------------|-------------------------------------|
| 289 Oxytoxum turbo Kof.                   | 27, 47, 126, 132, 142               |
| 290 Oxytoxum variabile J. Schiller        | 2, 9, 10, 12, 14, 24, 27, 38, 57, 79, 84, 126, 129, 131, 132, 142 |
| 291 Oxytoxum viride J. Schiller           | 10, 38, 67, 131                     |
| 292 Palaeophalacroma uncinatum J. Schiller | 9                                    |
| 293 Palatinus apiculatus (Ehrenb.) Craveiro, Calado, Daugbjerg & Moestrup  = Peridinium palatinum Lauterborn | 129                                |
| 294 Parvodinium goslaviense (Wołosz.) S. Carty  = Peridinium goslaviense Wołosz. | 144 (11)                           |
| 295 Parvodinium inconspicuum (Lemmerrn.) S. Carty  = Peridinium inconspicuum Lemmerrn. | (1, 6, 8, 27, 72, 73, 93, 132, 142) |
| 296 Parvodinium lubieniense (Wołosz.) S. Carty  = Peridinium lubieniense Wołosz. | (6)                                |
| 297 Parvodinium umbonatum (F. Stein) S. Carty  = Peridinium umbonatum F. Stein; Peridinium pusillum (Penard) Lemmerrn. | (9, 11, 14, 126, 137, 142; 6, 20, 27, 132, 142) |
| 298 Paulsenella chaetoceratis (Paulsen) Chatton | 1, 8, 10, 14, 23, 27, 93, 126, 132, 142 |
| 299 Pentapharsodinium dalei Indelicato & A.R. Loebl. | 27, 111                           |
| 300 Pentapharsodinium tyrhenicum (Balech) Montresor, Zingone & Marino | 27, 111                           |
| 301 Peridiniella catenata (Levander) Balech | 2, 10, 142                        |
| 302 Peridiniella danica (Paulsen) Okolodkov & J.D. Dodge  = Glenodinium danicum Paulsen | 9, 20, 126, 129, 136, 142, 144 (1, 2, 4, 6, 8-11, 14, 15, 18, 21, 27, 67, 68, 72, 73, 74, 84, 89, 92, 94, 118, 129, 132) |
| 303 Peridiniella sphaeroidea Kof. & Michener | 111                               |
| 304 Peridiniopsis cunningtonii Lemmerrn. | 143                              |
| 305 Peridiniopsis elpatiewskyi (Ostenf.) Bourr.  = Peridinium elpatiewskyi (Ostenf.) Lemmerrn. | 14, 126, 143 (9)                  |
| 306 Peridiniopsis quadridens (F. Stein) Bourr.  = Glenodinium quadridens (F. Stein) J. Schiller | 136 (4, 21)                      |
| 307 Peridiniopsis thompsonii (Thomps.) Bourr. | 9, 14, 143                       |
| 308 Peridinium bipes F. Stein  = Peridinium bipes f. tabulatum (Ehrenb.) Lefèvire; Peridinium tabulatum Ehrenb. | 4, 5, 8-10, 14, 20, 49, 126; 136 (1, 13, 18, 129) |
| 309 Peridinium cinctum (O. Müll.) Ehrenb.   | 1, 2, 4, 7-11, 14, 19, 21, 24, 27, 38, 85, 89, 92, 94, 100, 117, 126, 129, 132, 136, 142 |
| 310 Peridinium willei Huittf.-Kaas         | 1, 4, 9, 14, 18, 126, 129, 136, 142 |
| 311 Petalodinium porcelio J. Cachon & M. Cachon | 9, 91, 142                        |
| 312 Phalacroma acutum (F. Schütt) Pavill.  = Dinophysis acutoides Balech | 1, 9, 23 (14, 126)               |
| 313 Phalacroma cuneus F. Schütt  = Dinophysis cuneus (F. Schütt) T.H. Abé | A.F. Krakhmalnyi (pers. obs.)* |
| 314 Phalacroma cuneolus Kof. & Skogsbl. | 136                               |
| 315 Phalacroma favus Kof. & Michener  = Dinophysis favus (Kof. & Michener) T.H. Abé | 9 (142)                           |
| 316 Phalacroma oxytoxoides (Kof.) Gómez, Moreira & López-Garcia  = Oxyphysis oxytoxoides Kof. | (6, 9, 11, 82, 107, 125, 142) |

continued on the next page
| Taxa | References |
|------|------------|
| **317** Phalacroma rotundatum (Clap. & J. Lachm.) Kof. & Michener | 1, 2-4, 6, 8, 9, 15, 18, 21, 34, 38, 49, 54, 55, 58, 63, 67, 72, 73, 74, 78, 84, 85, 86, 89, 92, 94, 99, 105, 108, 109, 116, 117, 118, 125, 129, 130, 136, 144 (7, 10-14, 18, 20, 22, 25-27, 33, 36, 50, 56, 77, 100, 125-127, 130, 132, 141, 142; 14; 10) |
| **318** Plectodinium nucleovolvatum Biecheler | 7, 9 |
| **319** Podolampas bipes F. Stein | 19 |
| **320** Podolampas elegans F. Schütt | 7, 9, 19, 142 |
| **321** Podolampas palmipes F. Stein | 99 |
| **322** Podolampas spinifera Okamura | 9, 14, 39, 99, 126, 131 |
| **323** Polykrikos geminatus (F. Schütt) D.X. Qiu & Senjie Lin | (9, 14, 15, 19, 21, 26, 27, 47, 126, 129, 132, 140, 142; 19) |
| **324** Polykrikos hartmannii W.M. Zimmermann | (2, 10, 11, 21, 24, 129, 142) |
| **325** Polykrikos schwartzii Bütschli | 2, 4, 8-11, 12, 14, 20, 21, 23, 24, 26, 27, 34, 36, 50, 51, 68, 85, 94, 126, 129, 132, 136, 139, 142, 144 |
| **326** Preperidinium meunieri (Pavill.) Elbrächter | 2, 9, 11 (12; 27, 132, 142; 1, 6, 58; 14, 126) |
| **327** Pronoctiluca acuta (Lohmann) J. Schiller | 2, 8-10, 21, 24, 27, 38, 50, 129, 131, 132, 142 |
| **328** Pronoctiluca pelagica Fabre-Dom. | 2, 3, 7, 8, 9, 10, 11, 12, 21, 24, 27, 34, 38, 50, 63, 85, 129, 130, 131, 132, 142 |
| **329** Pronoctiluca spinifera (Lohmann) J. Schiller | 7, 9, 11, 85 |
| **330** Prorocentrum aporum (J. Schiller) J.D. Dodge | 7, 9, 10, 25, 26, 129, 130, 142 (6, 21, 84) |
| **331** Prorocentrum balticum (Lochmann) A.R. Loebl. | 2, 4, 8-11, 14, 25-27, 33, 35, 36, 45, 94, 99, 111, 125, 126, 129, 132, 136, 142 (1, 7, 15, 18, 21, 54, 55, 58, 89, 92, 105) |
| **332** Prorocentrum caspicum (Kisselev) Krachm. | 14, 27, 126, 132, 142 (1, 34, 89, 92) |
| **333** Prorocentrum compressum (Bailey) T.H. Abé & J.D. Dodge | 2-4, 8-12, 14, 19, 20, 25-27, 33, 36, 57, 68, 94, 99, 100, 108, 109, 111, 126, 127, 129, 130, 132, 136, 142, 144 (1, 5-7, 15, 18, 21, 22, 34, 38, 49, 51, 54-56, 58, 63, 67, 72-75, 78, 84-86, 89, 92, 105, 110, 116, 117, 123, 125) |
| **334** Prorocentrum cordatum var. aralensis (Kisselev) Krachm. | 14, 23 |
| **335** Prorocentrum dentatum F. Stein | 2, 7, 9, 19, 25, 30, 126, 142 |
| **336** Prorocentrum gracile F. Schütt | 11, 19, 108 |

continued on the next page
A checklist of dinoflagellates of the Black Sea - continued from the previous page

| Taxa | References |
|------|------------|
| **339** *Prorocentrum lima* (Ehrenb.) F. Stein  
= *Exuviaella marina* Cienk.; *Prorocentrum marinum* J.D. Dodge & B.T. Bibby; *Exuviaella marina* var. *lima* (Ehrenb.) J. Schiller | 2, 7, 9-11, 14, 24, 33, 36, 77, 111, 125, 126, 129, 142 (1, 6, 13, 18, 21, 34, 38, 84, 117; 3-5, 8, 10, 19, 57, 94, 100, 132, 136, 142; 1) |
| **340** *Prorocentrum maximum* (Gourret) J. Schiller | 7-9, 14, 25, 27, 100, 126, 132, 142 |
| **341** *Prorocentrum micans* Ehrenb. | 1-15, 18-22, 25-27, 33-36, 38, 45, 49, 54-59, 63, 67, 68, 72-75, 78, 81, 82, 84-86, 89, 90, 92, 94, 99, 100, 105, 108-110, 116, 117, 120, 123, 125-127, 129, 130, 132, 137, 139, 140, 142, 144 |
| **342** *Prorocentrum micans* var. *micans* f. *duplex* Krachm. & Terenko | 126, 128, 132, 142 |
| **343** *Prorocentrum nanum* J. Schiller  
= *Exuviaella pusilla* (J. Schiller) J. Schiller; *Prorocentrum pusillum* (J. Schiller) J.D. Dodge & B.T. Bibby | 10, 84, 126, 129 (1, 10, 15, 18, 84, 142; 5, 9, 14) |
| **344** *Prorocentrum oblongum* (J. Schiller) T.H. Abé | 27, 132, 142 |
| **345** *Prorocentrum obtusum* Ostenf. | 1, 4, 8, 9, 11, 14, 23, 34, 36, 38, 74, 94, 126, 136 |
| **346** *Prorocentrum ovum* (J. Schiller) J.D. Dodge | 7, 9, 142 |
| **347** *Prorocentrum ponticus* Krachm. & Terenko | 14, 27, 95, 111, 126, 132, 142 |
| **348** *Prorocentrum pyriforme* (J. Schiller) Taylor | 7, 25 |
| **349** *Prorocentrum reticulatum* M.A. Faust | 2, 21 |
| **350** *Prorocentrum rostratum* F. Stein | 9, 142 |
| **351** *Prorocentrum rotundatum* J. Schiller | 7, 9, 25, 84, 142 |
| **352** *Prorocentrum scutellum* Schröd.  
= *Prorocentrum sphaeroideum* J. Schiller | 1, 2, 4, 5, 7-10, 12, 14, 15, 18, 19, 21, 25, 27, 34, 36, 38, 49, 74, 86, 108, 116, 126, 129, 132, 136, 137, 139, 142, 144 (27, 132, 142) |
| **353** *Prorocentrum triestinum* J. Schiller | 9, 11, 25, 108, 142 |
| **354** *Prorocentrum vaginula* (F. Stein) J.D. Dodge  
= *Exuviaella vaginula* (F. Stein) Lemmerm.; *Prorocentrum vaginulum* (Ehrenb.) J.D. Dodge | 5, 8, 14, 27, 36, 126, 132, 142 (1, 15, 23, 67; 2, 9, 10, 24, 129) |
| **355** *Prosoaulax lacustris* (F. Stein) Calado & Moestrup  
= *Amphidinium eilenkinii* Skvortsov; *Amphidinium larvale* Er. Lindem.; *Amphidinium lacustre* F. Stein; *Amphidinium turicense* Huber-Pestalozzi | 144 (9, 14, 126; 27, 47, 132, 140, 142; 9, 14, 19, 27, 47, 132, 142; 27, 132, 142) |
| **356** *Protoceratium areolatum* Kof. | 2, 6, 7, 9, 10, 14, 25, 27, 126, 129, 132, 142 |
| **357** *Protoceratium reticulatum* (Clap. & J. Lachm.) Bütschli  
= *Peridinium reticulatum* Clap. & J. Lachm.; *Gonyaulax grindleyi* Reinecke; *Peridiniopsis reticulatum* (Clap. & J. Lachm.) Starmach | 1, 4-12, 14, 15, 18, 19, 26, 27, 34, 36, 49, 54, 55, 58, 67, 72-75, 77, 84-86, 94, 100, 105, 109, 117, 125-127, 129, 130, 132, 142, 144 (13; 2, 7, 10, 20, 33, 108; 136) |
| **358** *Protoceratium spinulosum* (G. Murr. & Whitting) J. Schiller | 108 |
| **359** *Protoperidinium abei* (Paulsen) Balech | 5, 9, 12, 142 |
| **360** *Protoperidinium achromaticum* (Levander) Balech  
= *Peridinium achromaticum* Levander | 9, 11, 27, 50, 126, 129, 132, 142 (1, 5, 6, 8, 14, 15, 18, 67, 72, 73, 89, 92) |
| **361** *Protoperidinium bipes* (Paulsen) Balech  
= *Glenodinium bipes* Paulsen; *Minuscula bipes* M. Lebour.; *Peridinium minusculum* Pavill. | 2, 4, 9-12, 14, 15, 19, 27, 35, 108, 126, 129, 130, 132, 136, 142, 143, 144 (55, 105; 7, 20; 1, 3, 4, 6-8, 10, 18, 21, 26, 34, 38, 49, 50, 57, 58, 67, 72, 73, 86, 89, 92, 94, 109, 110, 117, 118, 136) |
| **362** *Protoperidinium breve* Paulsen | 2, 11, 12, 20, 26, 27, 34, 57, 126, 129, 132, 142 |

continued on the next page
| Taxa | References |
|------|------------|
| 363  | Protoperidinium brevipes (Paulsen) Balech  
**= Peridinium brevipes Paulsen** | 2, 9-11, 14, 19, 20, 24-27, 33, 34, 99, 108, 126, 129, 130, 132, 136, 142, 144 (1, 4, 5, 7, 8, 15, 18, 21, 38, 49, 51, 58, 74, 86, 94, 117) |
| 364  | Protoperidinium brochii (Kof. & Swezy) Balech  
**= Peridinium brochii Kof. & Swezy** | 2, 9-11, 14, 25, 50, 108, 126, 142, 144 (1, 6, 15, 18, 21, 51, 54, 55, 58, 67, 72, 73, 105, 109, 116) |
| 365  | Protoperidinium bulla (Meunier) Balech  
**= Peridinium bulla Meunier** | 14, 126 (8) |
| 366  | Protoperidinium claudicans (Paulsen) Balech  
**= Peridinium claudicans Paulsen** | 2, 9, 11, 14, 25, 27, 57, 125, 129, 132, 142 (1, 7, 8, 51, 89, 92) |
| 367  | Protoperidinium compressum (T.H. Abé) Balech | 11, 142 |
| 368  | Protoperidinium conicoides (Paulsen) Balech  
**= Peridinium conicoides Paulsen** | 2, 3, 9-12, 14, 20, 27, 33, 50, 108, 125, 126, 130, 132, 142 (1, 4, 6-8, 15, 18, 38, 49, 51, 54-56, 58, 59, 63, 72, 73, 85, 87, 89, 92, 94, 103, 105, 109, 116, 117) |
| 369  | Protoperidinium conicum (Gran) Balech  
**= Peridinium conicum (Gran) Ostenf. & A.W.F. Schmidt;**  
**Protoperidinium conicum f. concavum Matzen.;**  
**Protoperidinium conicum f. concavum (Matzen.) Krachm.** | 9-11, 14, 20, 25, 27, 33, 50, 108, 125, 126, 130, 132, 142 (1, 18) |
| 370  | Protoperidinium conicum var. concavum (Matzen.) Balech  
**= Peridinium conicum f. concavum Matzen.;**  
**Protoperidinium conicum f. concavum (Matzen.) Krachm.** | 142 (1, 8, 58, 93; 14, 132) |
| 371  | Protoperidinium crassipes (Kof.) Balech  
**= Peridinium crassipes Kof.** | 2, 3, 9-12, 14, 20, 26, 27, 34, 36, 77, 108, 119, 120, 126, 127, 129, 130, 132, 142, 143, 144 (1, 4, 6-8, 15, 18, 38, 49, 51, 54, 55, 58, 67, 72-74, 78, 85, 86, 93, 94, 105, 109, 110, 116, 123) |
| 372  | Protoperidinium curtipes (Jörg.) Balech  
**= Peridinium curtipes Jörg.** | 9, 10, 14, 19, 20, 68, 126, 129, 136, 142 (1, 4, 5, 15, 18, 38, 54, 55, 94, 105) |
| 373  | Protoperidinium curvipes (Ostenf.) Balech  
**= Peridinium curvipes Ostenf.** | 2, 3, 9-12, 14, 19, 20, 25-27, 33, 34, 50, 57, 68, 99, 108, 125-127, 129, 130, 132, 136, 142, 143, 144 (1, 4, 6-8, 18, 21, 38, 49, 51, 54, 55, 58, 67, 72-74, 78, 85, 86, 93, 94, 105, 109, 110, 116, 117) |
| 374  | Protoperidinium decipiens (Jörg.) Parke & J.D. Dodge  
**= Peridinium decipiens Jörg.** | 9, 10, 14, 19, 20, 26-27, 33, 34, 50, 57, 68, 99, 108, 125-127, 129, 130, 132, 136, 142, 143, 144 (1, 4, 6-8, 18, 21, 38, 49, 51, 54, 55, 58, 67, 72-74, 78, 85, 86, 93, 94, 105, 109, 110, 116, 117) |
| 375  | Protoperidinium deficiens (Meunier) Balech  
**= Peridinium deficiens Meunier** | 9, 142 (7) |
| 376  | Protoperidinium depressum (Bailey) Balech  
**= Peridinium depressum Bailey** | 2, 9-12, 14, 15, 25-27, 33, 34, 50, 99, 108, 125-127, 129, 130, 132, 136, 142, 143 (1, 4, 7, 8, 18, 21, 38, 49, 51, 54, 55, 67, 74, 85, 86, 89, 92, 94, 105, 117) |
| 377  | Protoperidinium diabolus (Cleve) Balech  
**= Peridinium diabolus Cleve** | 2, 9, 14, 25, 27, 50, 108, 126, 129, 132, 142 (1, 7, 8, 15, 51, 85) |
| 378  | Protoperidinium divergens (Ehrenb.) Balech  
**= Peridinium divergens Ehrenb.** | 2, 3, 9-12, 14, 19, 20, 25-27, 33, 34, 50, 57, 68, 99, 108, 125-127, 129, 130, 132, 136, 142, 144 (1, 4, 6-8, 18, 21, 22, 38, 49, 51, 54-56, 58, 59, 63, 72, 73, 78, 85, 87, 89, 92, 94, 103, 105, 109, 110, 116, 117) |
| 379  | Protoperidinium elegans (Cleve) Balech  
**= Peridinium elegans Cleve** | 9, 10, 14, 19, 26, 142 (1, 5, 6, 15, 51, 55, 105) |
| 380  | Protoperidinium excentricum (Paulsen) Balech  
**= Peridinium excentricum Paulsen** | 9, 10, 11, 14, 19, 27, 126, 129, 130, 132, 136, 142 (1, 5-8, 15, 18, 20, 72-74, 89, 92, 109) |
| 381  | Protoperidinium globulus (F. Stein) Balech  
**= Peridinium globulus F. Stein** | 2, 9-12, 14, 25, 27, 33, 50, 99, 108, 126, 129, 132, 136, 142 (1, 4, 6, 7, 8, 18, 21, 38, 49, 51, 58, 67, 72, 73, 93, 94, 109, 116) |
| 382  | Protoperidinium gracile Gran & Braar. | 142 |
| Taxa                                        | References                                                                 |
|---------------------------------------------|-----------------------------------------------------------------------------|
| 383  Protoperidinium grande (Kof.) Balech   | 9, 12, 25, 142 (7)                                                          |
| = Peridinium grande Kof.                    |                                                                             |
| 384  Protoperidinium granii (Ostenf.) Balech| 2, 9-12, 14, 19, 20, 24-27, 33, 34, 50, 57, 68, 99, 100, 119, 125-127, 129, 130, 132, 136, 142 (1, 3, 4, 6-8, 18, 21, 38, 49, 51, 58, 67, 74, 85, 89, 92, 94, 110, 118, 123) |
| = Peridinium granii Ostenf.                 |                                                                             |
| 385  Protoperidinium grenlandicum (Wołosz.) Balech | 27, 132, 142                                                                  |
| 386  Protoperidinium inflatum (Okamura) Balech | 9, 50, 142                                                                  |
| 387  Protoperidinium joergensenii (Balech) Balech | 2, 9-11, 14, 27                                                              |
| 388  Protoperidinium knipowitschii (Usachev) Balech | 2, 9, 11, 12, 14, 126, 129, 136, 144 (4, 6, 8, 10, 89, 92, 109, 129, 132, 136, 142) |
| = Peridinium knipowitschii Usachev          |                                                                             |
| 389  Protoperidinium leonis (Pavill.) Balech | 2, 6, 8, 9, 11, 14, 27, 50, 125, 126, 130, 132, 142, 144 (7, 20, 51)           |
| = Peridinium leonis Pavill.                 |                                                                             |
| 390  Protoperidinium leonis var. concavilaterale (Kisselev) Krachmalny | 14, 27, 126                                                                  |
| 391  Protoperidinium longipes Balech        | 25, 27, 35, 132, 142                                                        |
| 392  Protoperidinium longispinum (Kof.) Balech | 2, 9, 12, 14, 27, 126, 132, 142 (136)                                       |
| = Peridinium longispinum Kof.               |                                                                             |
| 393  Protoperidinium mariellebouriae (Paulsen) Balech | 7, 9, 33, 142                                                              |
| 394  Protoperidinium mediterraneum (Kof.) Balech | 33, 142                                                                      |
| 395  Protoperidinium mite (Pavill.) Balech   | 14, 126, 129, 132, 142 (8, 10, 15, 100)                                     |
| = Peridinium granii f. mite (Pavill.) J. Schiller |                                                                               |
| 396  Protoperidinium monovelum (T.H. Abé) Balech | (136)                                                                     |
| = Peridinium monovelum T.H. Abé             |                                                                             |
| 397  Protoperidinium nudum (Meunier) Balech  | 27, 132, 142                                                                |
| 398  Protoperidinium oblongum (Auriv.) Parke & J.D. Dodge | 9, 12, 26, 129, 130, 142, 143                                             |
| 399  Protoperidinium oceanicum (Vanhöffen) Balech | 2, 9-11, 14, 19, 27, 33, 50, 99, 108, 126, 129, 132, 142 (1, 6, 8, 15, 18, 38, 51, 54, 55, 58, 67, 72, 73, 89, 92, 105, 109) |
| = Peridinium oceanicum Vanhöffen            |                                                                             |
| 400  Protoperidinium ovatum C.H.G. Pouchet   | 126, 132, 142, 144 (1, 8, 14, 15, 23, 93; 2, 10, 14, 19, 27)                |
| = Peridinium globulus var. ovatum (C.H.G. Pouchet) | J. Schiller; Protoperidinium globulus var. ovatum (C.H.G. Pouchet) Balech |                                                                               |
| 401  Protoperidinium ovum (J. Schiller) Balech | 34                                                                         |
| 402  Protoperidinium pallidum (Ostenf.) Balech | 2, 9-12, 14, 15, 27, 50, 99, 108, 125-127, 129, 130, 132, 136, 142, 144 (1, 4, 6, 7, 18, 51, 54, 55, 58, 72, 73, 74, 94, 105, 109) |
| = Peridinium pallidum Ostenf.               |                                                                             |
| 403  Protoperidinium parthenopes Zingone & Montresor | 111                                                                        |
| 404  Protoperidinium paulsenii (Pavill.) Balech | 130                                                                       |
| 405  Protoperidinium pedunculatum (F. Schütt) Balech | 2, 9-11, 14, 27, 126, 129, 132, 136, 142 (1, 4, 7, 8, 15, 18, 21, 51, 54, 55, 56, 58, 93, 105) |
| = Peridinium pedunculatum F. Schütt         |                                                                             |
| 406  Protoperidinium pellucidum Bergh        | 2, 3, 9-12, 14, 15, 19, 20, 25-27, 33-35, 50, 57, 99, 108, 125-127, 129, 130, 132, 136, 139, 142, 144 (1, 4-8, 18, 21, 49, 51, 54, 55, 58, 72, 73, 85, 89, 92, 101, 105, 109) |
| = Peridinium pellucidum (Bergh) F. Schütt   |                                                                             |
| 407  Protoperidinium pentagonum (Gran) Balech | 2, 9-11, 14, 25, 27, 50, 99, 108, 125, 126, 129, 132, 136, 142, 144 (1, 6-8, 15, 18, 20, 38, 49, 51, 54, 55, 72-74, 85, 86, 93, 105, 109, 116, 117) |
| = Peridinium pentagonum Gran                |                                                                             |
| 408  Protoperidinium ponticum Vershinin & Morton | 80, 111, 126, 131, 142                                                      |
| 409  Protoperidinium punctulatum (Paulsen) Balech | 7, 9, 25, 108, 125, 142                                                   |

continued on the next page
A checklist of dinoflagellates of the Black Sea - continued from the previous page

| Taxa | References |
|------|------------|
| **410** Protoperidinium pyriforme (Paulsen) Balech | 2, 9, 11, 14, 15, 25, 27, 35, 126, 108, 132, 136, 142 (1, 4, 6, 7, 23, 67) |
| = Peridinium pyriforme Paulsen | (2, 9-11, 14, 15, 25, 27, 35, 126, 108, 132, 136, 142) |
| **411** Protoperidinium pyriforme subsp. breve (Paulsen) Balech | 142 (4-6, 8, 10, 21, 26, 38, 49, 136) |
| = Peridinium breve (Paulsen) Paulsen | (10, 11, 24, 126, 132, 136, 142) |
| **412** Protoperidinium quarneresense (Schröd.) Balech | 10, 11, 24, 126, 132, 136, 142 (1, 23, 89; 14, 27, 136) |
| = Peridinium globulus var. quarneresense Schröd.; Protoperidinium globulus var. quarneresense (Schröd.) Krachm. | (2, 9-12, 14, 126, 131, 142) |
| **413** Protoperidinium sinaicum (Matzen.) Balech | 2, 9, 14, 126, 131, 142 (38, 51, 85) |
| = Peridinium sinaicum (Matzen.) Balech | (2, 9-12, 14, 126, 131, 142) |
| **414** Protoperidinium solidicorne (Mangin) Balech | 2, 9-12, 14, 126, 131, 142, 144 (1, 4-8, 15, 18, 21, 51, 54, 55, 58, 94, 105, 136) |
| = Peridinium solidicorne Mangin | (1, 4-8, 15, 18, 21, 51, 54, 55, 58, 94, 105, 136) |
| **415** Protoperidinium spiniferum Balech | 12, 14, 19, 27, 50, 126, 132, 142, 144 |
| **416** Protoperidinium steinii (Jörg.) Balech | 2, 9-12, 14, 15, 19, 20, 25-27, 34, 50, 57, 68, 99, 108, 125-127, 129, 130, 136, 142, 144 (1, 3, 4, 6-8, 18, 21, 22, 38, 49, 51, 55, 58, 63, 67, 72-74, 78, 84-86, 89, 92, 94, 105, 109, 116, 117; 13, 18, 22) |
| = Peridinium steinii Jörg.; Peridinium michaelis Ehrenb. | (1, 3, 4, 6-8, 18, 21, 22, 38, 49, 51, 55, 58, 63, 67, 72-74, 78, 84-86, 89, 92, 94, 105, 109, 116, 117; 13, 18, 22) |
| **417** Protoperidinium subinerme (Paulsen) A.R. Loebl. | 2, 9-11, 14, 19, 25, 26, 50, 125, 126, 129, 130, 142, 144 (1, 5-7, 15, 18, 58, 72, 73, 109) |
| = Peridinium subinerme Paulsen | (2, 9-11, 14, 19, 25, 26, 50, 125, 126, 129, 130, 142, 144) |
| **418** Protoperidinium thorianum (Paulsen) Balech | 9, 10, 19, 125, 129, 142 (6) |
| = Peridinium thorianum Paulsen | (9, 10, 19, 125, 129, 142) |
| **419** Protoperidinium tuba (J. Schiller) Balech | (10) |
| = Peridinium tuba J. Schiller | (10) |
| **420** Protoperidinium verrucosum (Meunier) Balech | 20 |
| = Gymnodinium fusus F. Schütt; Peridinium verrucosum Meunier | (20) |
| **421** Pseliodinium fusus (F. Schütt) Gömez | (1, 2, 4, 8, 14, 19, 21, 23, 26, 27, 34, 49, 84, 89, 92, 94, 100, 126, 129, 132, 136, 142; 9) |
| = Gymnodinium fusus F. Schütt; Gyrodinium falcatum Kof. & Swezy | (1, 2, 4, 8, 14, 19, 21, 23, 26, 27, 34, 49, 84, 89, 92, 94, 100, 126, 129, 132, 136, 142; 9) |
| **422** Pseliodinium vaubanii Sournia | 10 |
| **423** Ptychodiscus noctiluca F. Stein | 2, 6, 9, 10, 11, 142 |
| **424** Pyrocystis elegans Pavill. | 9, 10, 25, 99, 142 |
| **425** Pyrocystis fusiformis Wyville-Thompson | 7, 131, 142 |
| **426** Pyrocystis hamulus Cleve | 38, 131 |
| **427** Pyrocystis lunula (F. Schütt) F. Schütt | 1, 9, 10, 14, 26, 51, 84, 85, 117, 126, 129, 142 (18) |
| = Diplodinium lunula (F. Schütt) G.A. Klebs | (1, 9, 10, 14, 26, 51, 84, 85, 117, 126, 129, 142) |
| **428** Pyrocystis pseudonociluca Wyville-Thompson | 38 (2, 10, 24, 129, 131, 142) |
| = Pyrocystis nociluca G. Murr. & Haeckel | 38 (2, 10, 24, 129, 131, 142) |
| **429** Pyrophacus horologium F. Stein | 1, 4, 6-11, 14, 15, 18, 20, 25, 27, 34, 35, 49, 54, 55, 58, 67, 72-75, 84, 85, 89, 92, 94, 99, 101, 105, 108, 109, 126, 129, 132, 136, 142, 144 |
| **430** Pyrophacus steinii (J. Schiller) Wall & Dale | 2, 7, 9, 11, 99, 142 (14, 15, 24, 126) |
| = Pyrophacus horologium var. steinii J. Schiller | 2, 7, 9, 11, 99, 142 (14, 15, 24, 126) |
| **431** Scaphodinium mirabile Margalef | 9, 91, 112, 130, 142 |

continued on the next page
### Taxa References

| Taxa | References |
|------|------------|
| **432 Scrippsiella acuminata** (Ehrenb.) Kretschmann, Elbrachté, Zinsmeister, S. Soehner, Kirsch, Kusber & Gottschling  
= Scrippsiella trochoidea (F. Stein) A.R. Loebl.; Glenodinium trochoidea F. Stein; Peridinium trochoidea (F. Stein) Lemmerm.; Goniodoma acuminatum (Ehrenb.) F. Stein | 129, 144 (2-4, 6, 8-12, 14, 20, 25-27, 33-36, 57, 68, 81, 82, 83, 94, 99, 100, 108, 111, 118-120, 125-127, 129, 130, 132, 136, 139, 142; 18, 54; 1, 5, 7, 19, 21, 23, 38, 51, 84, 85, 93, 105, 110, 116, 117, 123; 9, 18, 22, 59, 101) |
| **433 Scrippsiella sweeneyae** Balech & A.R. Loebl. | 11, 142 |
| **434 Spatulodinium pseudonocelitica** (C.H.G. Pouchet) J. Cachon & M. Cachon  
= Gymnodinium pseudonocelitica C.H.G. Pouchet; Gymnodinium conicum Kof. & Swezy; Gymnodinium viride M. Lebour | 9, 11, 14, 27, 47, 91, 126, 129, 132, 135, 142, 144 (2, 21, 34; 6, 9, 142; 20) |
| **435 Sphaerodinium limneticum** Wołosz. | 27, 132, 142 |
| **436 Spiniferodinium palustre** (A.J. Schill.) Kretschmann & Gottschling  
= Gymnodinium palustre A.J. Schill. | (20) |
| **437 Syndinium turbo** Chatton | 136 |
| **438 Thecadinium kofoidii** (Herdm.) J. Schiller | 142 |
| **439 Torodinium robustum** Kof. & Swezy | 1, 9-12, 14, 19, 23, 78, 126, 129, 130, 142, 144 |
| **440 Torodinium teredo** (C.H.G. Pouchet) Kof. & Swezy | 2, 12 |
| **441 Tovellia coronata** (Wołosz.) Moestrup, Lindberg & Daugbjerg  
= Gymnodinium coronatum Wołosz. | 11, 144 |
| **442 Triadinium polyedricum** (C.H.G. Pouchet) J.D. Dodge  
= Goniodoma polyedricum (C.H.G. Pouchet) Jörg. | (1, 2, 4, 6-9, 11, 14, 15, 18, 19, 22, 27, 67, 94, 126, 129, 132, 136, 142) |
| **443 Unruhdinium penardii** (Lemmerm.) Gottschling  
= Glenodinium penardii Lemmerm.; Peridiniopsis penardii (Lemmerm.) Bour. | 144 (8, 100; 14, 27, 126, 132, 133, 134, 137, 142, 143) |
| **444 Warnowia maculata** (Kof. & Swezy) Er. Lindem. | 11, 27, 47, 132, 142 |
| **445 Warnowia schuettii** (Kof. & Swezy) J. Schiller | 27, 33, 47, 132, 142 |
| **446 Woloszynskia neglecta** (A.J. Schill.) Wyville-Thompson  
= Gymnodinium neglectum (A.J. Schill.) Er. Lindem. | 9, 142, 144 (6, 21) |
| **447 Woloszynskia pascheri** (Suchlandt) Stosch | 27, 132, 142, 144 |

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