



# New records of three dinophycean genera *Dinophysis*, *Histioneis*, and *Parahistioneis* (Dinophysiales, Dinophyceae) from coastal waters of Jeju Island, Korea

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## Abstract

A total of 19 species of three genera *Dinophysis*, *Histioneis*, and *Parahistioneis* of the family Dinophysaceae are reported here from samples obtained using a 20- $\mu$ m mesh net from June 2006 to December 2014 around Jeju Island including the East China Sea, and 16 of these species are new to Korean waters. A checklist of the three genera of dinoflagellates reported from coastal and oceanic Korean waters is presented. Short descriptions and synonyms are given for each species. The dinoflagellates of the family Dinophysaceae belong to mostly marine species, and include many tropical and/or subtropical species. Recently, the composition of dinoflagellate species has changed around Jeju Island as well as in Korean waters due to global warming and climate change. Tropical and subtropical dinoflagellates occur frequently in the coastal waters of Jeju Island, which reflects the ecosystem shift around the sea adjacent to Jeju Island from a temperate to a subtropical / tropical region.

**Key words:** Dinophysaceae, *Dinophysis*, *Histioneis*, Jeju Island, *Parahistioneis*

## INTRODUCTION

The dinophysoids are a well-defined order of marine dinoflagellates with 280 recognized species classified in three families: Amphisoleniaceae, Dinophysaceae, and Oxyphysaceae (Gómez et al. 2011). According to Algae-Base, the Dinophysaceae family has 15 genera (Guiry and Guiry 2015). *Dinophysis*, *Histioneis*, and *Parahistioneis* presented in this study are the main genera and comprise many species (130, 78, and 12, respectively) (Guiry and Guiry 2015). Dinoflagellates are a major component in the phytoplankton community and are comprised of various species in terms of habitat and nutrient uptake. These species contribute to primary production in oceans and include diverse tropical species reported in many waters

worldwide (Dodge 1982). The three genera are mainly found and recorded in tropical/subtropical area from many oceans in the world (Gómez 2005a, 2005b, 2007).

The marine ecosystem around Jeju Island has been changing from temperate to sub-tropical and/or tropical conditions over the last two decades (Yeh and Kim 2010, Kang et al. 2012). The increasing seawater temperature and the expansion of the high-salinity and high-temperature Kuroshio Current could have affected the marine ecosystem around Jeju Island, forcing tropical planktonic and benthic species to adapt to survive around Jeju Island (Kim et al. 2013). Dinoflagellates could potentially be used as an indicator species for the changing marine ecosys-

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tem. A total of 153 planktonic dinoflagellates from Korean waters have been described by Shim et al. (1981), Han and Yoo (1983a, 1983b), Yoo and Lee (1986), Lee et al. (1993), and Shim (1994). During the last decade, more than 170 planktonic and benthic dinoflagellates have been added to a checklist of dinoflagellates by several researchers in Korea (Kim et al. 2013, Shah et al. 2013, Lee et al. 2014). However, there were few taxonomic studies on the family Dinophysaceae except Shin et al. (2004). The objectives of this study were to check the list and to describe some newly recorded species, focusing on the genera of the family Dinophysaceae including *Dinophysis*, *Histioneis*, and *Parahistioneis*.

## MATERIALS AND METHODS

Samplings were done at coastal stations around Jeju Island of the Republic of Korea and the East China Sea, as the station's informations are mentioned in Lee et al. (2014), from June 2006 to the end of 2014. Plankton samples were obtained by using a 20- $\mu$ m-mesh plankton net and fixed with formaldehyde (final concentration of about 1%) or glutaraldehyde (final concentration of about 1%). Planktonic dinoflagellates were identified by using an Axioplan microscope (Carl Zeiss, Oberkochen, Germany). To make slide specimens for one species, the dinoflagellate samples were washed with distilled water, and then the method described in Kim et al. (2013) was followed. To allow for more detail observations, dinoflagellate cells were isolated with a micropipette, placed on a cover slip, air-dried and coated with gold for observation under a field emission scanning electron microscope (JSM-6700F; JEOL, Tokyo, Japan). For the species identification, several monographs were used that were reported from different oceans, such as the Indian Ocean (Taylor 1976), Japan's adjacent sea (Yamaji 1984), the British and Atlantic Ocean (Dodge 1982, 1985), the Kuroshio Current (Fujioka 1990), Korean waters (Shim 1994), and Gulf of Mexico (Okolodkov 2014). A dinoflagellate classification of the new combination with the family Dinophysaceae was cited from AlgaeBase (Guiry and Guiry 2015).

## RESULTS AND DISCUSSION

A total of 29 species of three genera (*Dinophysis*, *Histioneis*, *Parahistioneis*) belonging to the family Dinophysaceae from Jeju Island were identified and classified as below. Among them, 16 species were described as newly

recorded in Korean waters in this paper, and 3 were re-described; newly recorded and re-described species were marked with asterisks and sharps, respectively. Criteria for the identification of this family were cell shape, epitheca and hypotheca shape, girdle displacement, thecal tabulation and ornamentation, apical and antapical spine or wing shape, and so forth. Photos were taken by light microscope (LM) and scanning electron microscope (SEM) focused on the criteria from the dorsal and ventral views.

## Checklist of *Dinophysis*, *Histioneis*, and *Parahistioneis* in the family Dinophysaceae around Jeju Island

### Class Dinophyceae West & Fritsch 1927

#### Order Dinophysiales

#### Family Dinophysaceae

#### Genus *Dinophysis* Ehrenberg 1840

*Dinophysis acuminata* Claparède & Lachmann

\**Dinophysis acutoides* Balech

*Dinophysis caudata* Saville-Kent

*Dinophysis cuneus* (Schütt) Abé

\**Dinophysis diegensis* Kofoid

\**Dinophysis doryphora* (Stein) Abé

\**Dinophysis expulsa* Kofoid & Michener

*Dinophysis fortii* Pavillard

*Dinophysis hastata* Stein

# *Dinophysis infundibulum* Schiller

\**Dinophysis micropterygia* Dangeard

\**Dinophysis miles* Cleve

*Dinophysis mitra* (Schütt) Abé

*Dinophysis ovum* Schütt

# *Dinophysis parvula* (Schütt) Balech

\**Dinophysis porodictyum* (Stein) Abé

\**Dinophysis punctata* Jørgensen

# *Dinophysis rapa* (Stein) Balech

*Dinophysis recurva* Kofoid & Skogsberg

*Dinophysis rotundata* Claparède & Lachmann

\**Dinophysis rudgei* Murray & Whitting

*Dinophysis schuettii* Murray & Whitting

\**Dinophysis tripos* Gourret

\**Dinophysis* sp. 1

\**Dinophysis* sp. 2

#### Genus *Histioneis*

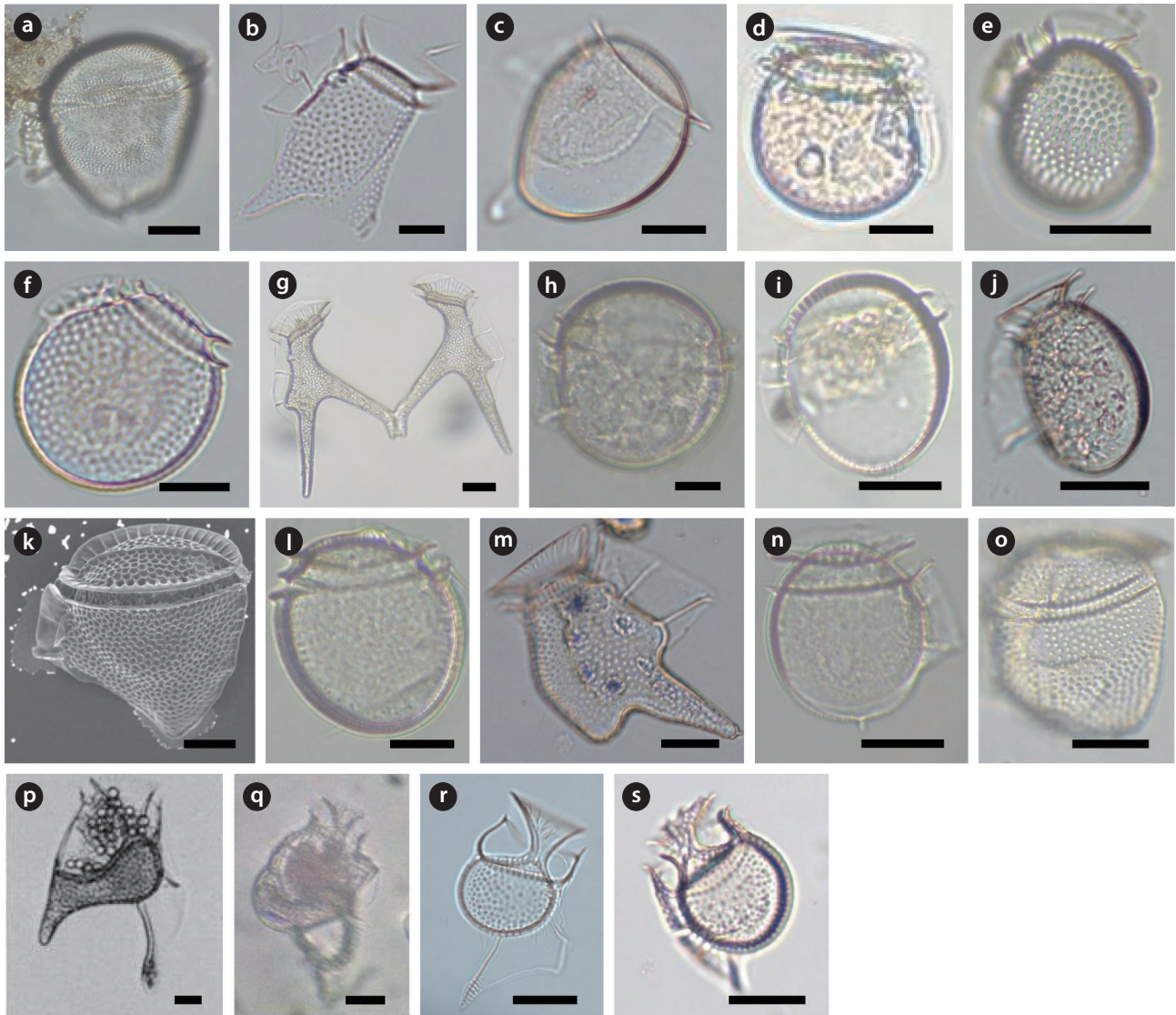
\**Histioneis biremis* Stein

\**Histioneis depressa* Schiller

#### Genus *Parahistioneis*

\**Parahistioneis para* (Murray & Whitting) Kofoid & Skogsberg

\**Parahistioneis reticulate* (Kofoid) Kofoid & Skogsberg



**Fig. 1.** Light micrographs and scanning electron micrograph (SEM) of the genus *Dinophysis*, *Histioneis*, and *Parahistioneis*. (a) *Dinophysis acutoides*, left lateral view, (b) *Dinophysis diegensis*, left lateral view, (c) *Dinophysis doryphora*, left lateral view, (d) *Dinophysis expulsa*, right lateral view, high focus, (e) *Dinophysis infundibulum*, left lateral view, (f) *Dinophysis micropterygia*, left lateral view, (g) *Dinophysis miles*, two cells connected at the megacystic bridge, (h) *Dinophysis parvula*, left lateral view, (i) *Dinophysis porodictyum*, left lateral view, high focus, (j) *Dinophysis punctata*, left lateral view, (k) *Dinophysis mitra*, left lateral view of SEM, (l) *Dinophysis rudgei*, right lateral view, high focus, (m) *Dinophysis tripos*, right lateral view, (n) *Dinophysis* sp. 1, right lateral view, (o) *Dinophysis* sp. 2, dorsal view, high focus, (p) *Histioneis biremis*, right lateral view, (q) *Histioneis depressa*, dorsal view, (r) *Parahistioneis para* right lateral view, (s) *Parahistioneis reticulata*, left lateral view. Scale bars, 20  $\mu$ m.

## Taxonomic description of unrecorded dinoflagellates

### Genus *Dinophysis* Ehrenberg 1840

**Holotype species:** *Dinophysis acuta* Ehrenberg.

**Description:** Small to medium-sized (25–100  $\mu$ m) laterally more or less compressed cells with a cingulum and sulcus with visible or even large lists. The characteristics of this genus (the high girdle with lists giving the form of

a collar, the flattened cell with the sulcus running down the right-hand side of the picture, and the list giving the form of a sail) make it relatively easy to identify (Guiry and Guiry 2015).

**Numbers of names and species:** There are 293 species (and infraspecific) names in the database at present, of which 130 have been flagged as currently accepted taxonomically (Guiry and Guiry 2015).

***Dinophysis acutoides* Balech 1967 (Fig. 1a)**

**Synonym:** No synonym.

**References:** Fujioka 1990, p. 43, pl. 21, fig. 8.

**Specimen examined:** Serial No. LJB2010013 / NIBR No. NIBRFL0000125609.

**Description:** The cell is relatively small. The epitheca is dome-shaped, and the hypotheca looks like an inverted triangle. The ventral sulcus list gives the form of a small sail. Lateral view of the cells are reticulated.

**Size:** 55–60 µm long, 55–55 µm wide in the lateral view.

**Sampling:** 15 Sep 2010. East China Sea in the southern sea of Jeju (32°00′115″ N, 126°45′013″ E).

**Habitat:** Marine species. This was found in the surface layer with a water temperature of 28.2°C and salinity of 33.5 psu.

**Distribution:** Adriatic Sea (Vilicic et al. 2002); Britain (Parke and Dixon 1976).

**Note:** This species might be treated as a synonym of *Dinophysis acuta* Ehrenberg that is a type species of the genus *Dinophysis* and regarded as a heterotypic synonym of *Phalacroma acutum* (F. Schütt) Pavillard (Hastrup Jensen and Daugbjerg 2009, Guiry and Guiry 2015).

***Dinophysis diegensis* Kofoid 1907 (Fig. 1b)**

**Synonym:** No synonym.

**References:** Yamaji 1984, p. 100, pl. 32, fig. 11; Fujioka 1990, p. 45, pl. 22, fig. 1.

**Specimen examined:** Serial No. LJB2010015 / NIBR No. NIBRFL0000125611.

**Description:** The cell size is medium, and the epitheca is slightly flattened. The sulcus list's shape is sharp and supported by three ribs. Triangle-like wings exist in the ventral part of the hypotheca, which extends with a long and sharp posterior process.

**Size:** 85–100 µm long, 60 µm wide in the lateral view.

**Sampling:** 26 Jul 2010. Kimnyung coast in the northern sea of Jeju (33°34′254″ N, 126°45′640″ E).

**Habitat:** Marine species. This was found in the surface layer with a water temperature of 24.8°C and salinity of 34.4 psu.

**Distribution:** Europe: Adriatic Sea (Vilicic et al. 2002), Mediterranean (Gómez 2003), Spain (Reguera et al. 2007); South America: Brazil (Odebrecht 2010).

**Note:** This species might be regarded as a taxonomic synonym of *Dinophysis caudata* Saville-Kent (Reguera et al. 2007, Guiry and Guiry 2015).

***Dinophysis doryphora* (Stein) Abé 1967 (Fig. 1c)**

**Basionym:** *Phalacroma doryphorum* Stein.

**Synonym:** No synonym.

**References:** Abé 1967, p. 67, fig. 26; Fujioka 1990, p. 45, pl. 22, fig. 2; Omura et al. 2012, p. 63.

**Specimen examined:** Serial No. LJB2010016 / NIBR No. NIBRFL0000125612.

**Description:** The cell is small and oval-shaped in the lateral view. The epitheca is convex dome-shaped, and its lower part has a process-like spine. The left sulcus list extends up to half of the hypotheca.

**Size:** 63–75 µm long, 57–63 µm wide dorso-ventrally.

**Sampling:** 26 Jul 2010. Kimnyung coast in the northern sea of Jeju (33°34′254″ N, 126°45′640″ E).

**Habitat:** Marine species. This was found in the surface layer with a water temperature of 24.8°C and salinity of 34.4 psu.

**Distribution:** This is widely distributed in tropical and subtropical warm waters (Abé 1967). Europe: Adriatic Sea (Vilicic et al. 2002); Atlantic Islands: Canary Islands (Gil-Rodríguez et al. 2003); South America: Brazil (Odebrecht 2010); Asia: China (Liu 2008), Taiwan (Shao 2003–2014).

**Note:** This species name might be regarded as a taxonomic synonym of *Phalacroma doryphorum* Stein (Hastrup Jensen and Daugbjerg 2009, Guiry and Guiry 2015).

***Dinophysis expulsa* Kofoid & Michener 1911 (Fig. 1d)**

**Synonym:** *Phalacroma expulsum* (Kofoid & Michener) Kofoid & Skogsberg.

**References:** Kofoid and Michener 1911, p. 292; Omura et al. 2012, p. 61.

**Specimen examined:** Serial No. LJB2014005.

**Description:** The cell is relatively small. In the lateral view, the cell is wide and round, and looks like an outline of a round pouch. In the lateral view, the sulcus list extends along the lateral axis and becomes wider toward the lower part. The cell length is 1.14 times longer than its width. The epitheca is low (not seen in the lateral view), and its width is 0.57 times the overall cell width.

**Size:** 53–59 µm long, 44–55 µm wide dorso-ventrally.

**Sampling:** 18 Sep 2014. Seogwipo coast in the southern sea of Jeju (33°13′31.4″ N, 126°34′17.2″ E).

**Habitat:** Marine species. This was found in the surface layer with a water temperature of 24.2–26.2°C and salinity of 33.5–34.4 psu.

**Distribution:** Europe: Mediterranean (Gómez 2003); Australia and New Zealand: Australia (McCarthy 2013).

***Dinophysis infundibulum* Schiller 1928 (Fig. 1e)**

**Synonym:** No synonym.

**References:** Yamaji 1984, p. 100, pl. 32, fig. 14; Fujioka 1990, p. 45, pl. 22, fig. 7; Omura et al. 2012, p. 59.

**Specimen examined:** Serial No. LJB2009010 / NIBR No.

NIBRFL0000125572.

**Description:** The cell is relatively small and close to an ellipsoidal shape in the overall view. The lower part of the hypotheca has no process. The epitheca is very narrow compared to those of other species in the genus.

**Size:** 35–45 µm long, 40 µm wide in the lateral view.

**Sampling:** 27 Nov 2009. Chagwido coast in the eastern sea of Jeju (33°19′02.7″ N, 126°08′02.4″ E).

**Habitat:** Marine species.

**Distribution:** Europe: Black Sea (BSPC Editorial Board 2014), Britain (Parke and Dixon 1976).

**Note:** The original “infundibulus” is a noun in apposition and has been corrected to “infundibulum” (a funnel) by Guiry and Guiry (2015). This species was reported as a new record for Korea by Shin et al. (2004) (Table 1), and

reported as a re-described species in the coastal waters of Jeju in the present study.

***Dinophysis micropterygia* Dangeard 1927 (Fig. 1f)**

**Synonym:** No synonym.

**References:** Dodge 1985, p. 22.

**Specimen examined:** Serial No. LJB2010017 / NIBR No. NIBRFL0000125613.

**Description:** The cell is small and round. The epitheca and cingulum list widths are almost the same in size. The epitheca is small and at the top of cell. The sulcus lists are small and one third of the size of the hypotheca.

**Size:** 55 µm long, 45 µm wide in the lateral view.

**Sampling:** 25 May 2010. Seongsan-ri coast in the eastern sea of Jeju (33°26′26.8″ N, 126°57′11.7″ E).

**Table 1.** Checklist of *Dinophysis*, *Histioneis*, and *Parahistioneis* in the family Dinophysaceae described from Korean waters

Species name	Shim et al. (1981)	Han and Yoo (1983a)	Lee et al. (1993)	Shim (1994)	Shin et al. (2004)	Kim et al. (2013)	Present study
<i>Dinophysis acuminata</i> Claparede & Lachmann		•	•	•	•		
<i>Dinophysis acutoides</i> Balech							•
<i>Dinophysis caudata</i> Saville-Kent	•		•	•	•		
<i>Dinophysis cunea</i> (Schütt) Abé						•	
<i>Dinophysis dens</i> Pavillard					•		
<i>Dinophysis diegensis</i> Kofoid							•
<i>Dinophysis doryphora</i> (Stein) Abé							•
<i>Dinophysis expulsa</i> Kofoid & Michener							•
<i>Dinophysis fortii</i> Pavillard			•	•	•		
<i>Dinophysis hastata</i> Stein						•	
<i>Dinophysis infundibulum</i> Schiller					•		•
<i>Dinophysis irregularis</i> (Lebour) Balech					•		
<i>Dinophysis lapidistrigiliformis</i> Abé					•		
<i>Dinophysis micropterygia</i> Dangeard							•
<i>Dinophysis miles</i> Cleve							•
<i>Dinophysis mitra</i> Schütt					•	•	
<i>Dinophysis ovum</i> Schütt	•			•			
<i>Dinophysis parvula</i> (Schütt) Balech					•		•
<i>Dinophysis porodictyum</i> (Stein) Abé							•
<i>Dinophysis punctata</i> Jørgensen							•
<i>Dinophysis rapa</i> (Stein) Balech					•		•
<i>Dinophysis recurva</i> Kofoid & Skogsberg				•			
<i>Dinophysis rotundata</i> Claparède et Lachmann		•	•	•	•		
<i>Dinophysis rudgei</i> Murray & Whitting							•
<i>Dinophysis schuettii</i> Murray & Whitting						•	
<i>Dinophysis tripos</i> Gourret							•
<i>Dinophysis</i> sp. 1							•
<i>Dinophysis</i> sp. 2							•
<i>Histioneis biremis</i> Stein							•
<i>Histioneis depressa</i> Schiller							•
<i>Parahistioneis para</i> Murray & Whitting							•
<i>Parahistioneis reticulata</i> Kofoid							•
<i>Phalacroma sphaeroideum</i> Schiller					•		
No. of species	2	2	4	6	12	4	19

**Habitat:** Marine species. This was found in the surface layer with a water temperature of 16.7°C and salinity of 33.3 psu.

**Distribution:** Europe: Britain (Parke and Dixon 1976); Australia and New Zealand: Australia (McCarthy 2013); Extra-Australian: Caribbean Sea, Gulf of Mexico, tropical Atlantic Ocean, US (Virginia), British Isles, Papua New Guinea, Antarctic waters (McCarthy 2013).

***Dinophysis miles* Cleve 1900 (Fig. 1g)**

**Synonym:** No synonym.

**References:** Kim 2008, p. 29; Omura et al. 2012, p. 60.

**Specimen examined:** Serial No. LJB2009013 / NIBR No. NIBRFL0000125575.

**Description:** Two cells are connected as known megacytic stages, in which two daughter cells are still connected by binary fission. The dorsal part of the hypotheca has a long process that connects a process of the other cell side and another long process toward the posterior axis. The cell size is very large and tall in the overall view, but the hypothecal process is thin and narrow.

**Size:** 150–170 µm long, 30–40 µm wide in the lateral view.

**Sampling:** 25 Jan 2010. Seongsan-ri coast in the eastern sea of Jeju (33°26'26.8" N, 126°57'11.7" E).

**Habitat:** Marine species.

**Distribution:** Asia: China (Liu 2008), Taiwan (Shao 2003–2014); Australia and New Zealand: Australia (McCarthy 2013).

***Dinophysis parvula* (Schütt) Balech 1967 (Fig. 1h)**

**Basionym:** *Phalacroma porodictyum* var. *parvula* Schütt.

**Synonym:** Homotypic synonyms: *Phalacroma porodictyum* var. *parvula* Schütt 1895, *Phalacroma parvulum* (Schütt) Jørgensen 1923. Heterotypic Synonym: *Prodinophysis parvula* (Schütt) Balech.

**References:** Balech 1967, p. 83; Fujioka 1990, p. 45, pl. 22, fig. 9; Omura et al. 2012, p. 62.

**Specimen examined:** Serial No. 2009-11 / NIBR No. NIBRFL0000125573.

**Description:** The cell is medium-sized and almost round. The epitheca has a prominent dome shape. The hypotheca has no process and a very round shape. The sulcus list of the hypotheca is relatively small (almost not visible).

**Size:** 60–80 µm long, 60–70 µm wide in the lateral view.

**Sampling:** 16 Aug 2009. Iho coast in the northern sea of Jeju (33°30'18.7" N, 126°27'05.1" E).

**Habitat:** Marine species.

**Distribution:** Europe: Adriatic Sea (Vilicic et al. 2002), Black Sea (BSPC Editorial Board 2014), Britain (Parke and Dixon 1976), Croatia (Vilicic et al. 2009); South America: Brazil (Odebrecht 2010).

**Note:** This species was reported as a new record for Korea by Shin et al. (2004) (Table 1), and reported as a re-described species in the coastal waters of Jeju in the present study.

***Dinophysis porodictyum* (Stein) Abé (Fig. 1i)**

**Synonym:** No synonym.

**References:** Dodge 1985, p. 25; Omura et al. 2012, p. 62.

**Specimen examined:** Serial No. LJB2010018 / NIBR No. NIBRFL0000125614.

**Description:** The cell is small and round. The epitheca looks like a convex dome, and the hypotheca is round. The cingulum list is thick compared to the cell size, whereas the sulcus list is almost not visible at half of the hypotheca length.

**Size:** 55 µm long, 40 µm wide in the lateral view.

**Sampling:** 09 Sept 2010. East China Sea of the southern sea of Jeju (32°00'115" N, 126°45'013" E).

**Habitat:** Marine species. This was found in the surface layer with a water temperature of 24.8°C and salinity of 30.4 psu.

***Dinophysis punctata* Jørgensen 1923 (Fig. 1j)**

**Synonym:** No synonym.

**References:** Jørgensen 1923, p. 23, fig. 28; Dodge 1982, p. 43, fig. 3I.

**Specimen examined:** Serial No. LJB200807.

**Description:** The posterior part of the hypotheca has no process, and the anterior part is slightly convex. The epitheca has a funnel-like anterior process supported by the small collar-shaped anterior process. The surface of the hypotheca is reticulated with many tiny pores.

**Size:** 40–50 µm long, 40 µm wide in the lateral view.

**Sampling:** 11 Oct 2008. Hamo-ri coast in the western sea of Jeju (33°11'44.7" N, 126°13'57.5" E).

**Habitat:** Marine species.

**Distribution:** Europe: Black Sea (Gómez and Boicenco 2004, BSPC Editorial Board 2014), Britain (Parke and Dixon 1976), Mediterranean (Gómez 2003); Atlantic Islands: Canary Islands (Gil-Rodríguez et al. 2003); South America: Brazil (Odebrecht 2010); Antarctic and the subantarctic islands: Antarctica/Subantarctic Islands (McMinn and Scott 2005).

***Dinophysis rapa* (Stein) Balech**

**Synonym:** No synonym.

**References:** Fujioka 1990, p. 45, pl. 22, fig. 10; Omura et al. 2012, p. 62.

**Specimen examined:** Serial No. LJB200706.

**Description:** The epitheca is slightly convex and broad, unlike other species in the genus. The hypotheca is narrower toward the posterior-ward and finally looks like an inverted triangle in the overall view. The lateral surface of the hypotheca is reticulated with many dots.

**Size:** 60–80 µm long, 60–70 µm wide in the lateral view.

**Sampling:** 13 Mar 2007. Gosan-ri coast in the western sea of Jeju (33°15′31.8″ N, 126°09′52.6″ E).

**Habitat:** Marine species.

**Distribution:** Europe: Adriatic Sea (Vilicic et al. 2002); Atlantic Islands: Canary Islands (Gil-Rodríguez et al. 2003); South America: Brazil (Odebrecht 2010); Asia: China (Liu 2008).

**Note:** This name might be currently regarded as a taxonomic synonym of *Phalacroma rapa* Jørgensen (Okolodkov 2014, Guiry and Guiry 2015). This species was reported as a new record for Korea by Shin et al. (2004) (Table 1), and reported as a re-described species in the coastal waters of Jeju in the present study.

***Dinophysis rudgei* Murray & Whitting 1899 (Fig. 1l)**

**Synonym:** No synonym.

**References:** Yamaji 1984, p. 101, fig. 2.

**Specimen examined:** Serial No. LJB2009012 / NIBR No. NIBRFL0000125574.

**Description:** The cell is generally elliptical, but the epitheca is small and round. The cell surface is reticulated regularly. No process exists in the lower part of the hypotheca.

**Size:** 60–70 µm long, 50–60 µm wide in the lateral view.

**Sampling:** 16 Aug 2009. Hamo-ri coast in the western sea of Jeju (33°11′44.7″ N, 126°13′57.5″ E).

**Habitat:** Marine species.

***Dinophysis tripos* Gourret 1883 (Fig. 1m)**

**Synonym:** Heterotypic synonym: *Dinophysis caudata* var. *tripos* (Gourret) Gail.

**References:** Dodge 1982, p. 47, fig. 4B; Yamaji 1984, p. 100, pl. 32, fig. 15.

**Specimen examined:** Serial No. LJB2010019 / NIBR No. NIBRFL0000125615.

**Description:** It is similar to *Dinophysis caudata* in shape, but the hypothecal processes look two and much sharper. The sulcus list is wider and bigger than those of other *Dinophysis* species, and it is slightly bigger than that

of *Dinophysis caudata*.

**Size:** 100 µm long, 80 µm wide in the lateral view.

**Sampling:** 26 Jul 2010, Kimnyung coast in the northern sea of Jeju (33°34′25.4″ N, 126°45′6.0″ E).

**Habitat:** Marine species. This was found in the surface layer with a water temperature of 24.8°C and salinity of 34.4 psu.

**Distribution:** Europe: Adriatic Sea (Vilicic et al. 2002), Baltic Sea (Hällfors 2004), Black Sea (Gómez and Boicenco 2004, BSPC Editorial Board 2014), France (Guilloux et al. 2013), Mediterranean (Gómez 2003); Central America: Gulf of California (Gárate-Lizárraga et al. 2014); South America: Brazil (Odebrecht 2010), Colombia (Lozano-Duque et al. 2011); Australia and New Zealand: Australia (McCarthy 2013), New Zealand (Chang et al. 2012).

**Note:** Faust and Gullede (2002) noted a synonymy between this species and *Dinophysis caudata* var. *tripos* (Gorret) Gail 1950. According to Dodge (1982), *Dinophysis caudata* is the currently accepted name for *Dinophysis tripos* Gourret.

***Dinophysis* sp. 1. (Fig. 1n)**

**Specimen examined:** Serial No. LJB2009015 / NIBR No. NIBRFL0000125577.

**Description:** This species is small in size with a narrow epitheca, but the upper part of the epitheca has a large, prominent funnel-like anterior process. The middle part of the hypotheca is convex and narrower towards the posterior.

**Size:** 40–50 µm long, 35–45 µm wide in the lateral view.

**Sampling:** 05 Sep 2009, Seongsan-ri coast in the eastern sea of Jeju (33°26′26.8″ N, 126°57′11.7″ E).

**Habitat:** Marine species.

***Dinophysis* sp. 2. (Fig. 1o)**

**Specimen examined:** Serial No. LJB2009016 / NIBR No. NIBRFL0000125578.

**Description:** The cell is generally small, the epitheca is convex, and the hypotheca is slightly convex below the sulcus list but slightly concave and narrower posteriorward.

**Size:** 35–45 µm long, 30–40 µm wide in the lateral view.

**Sampling:** 27 Nov 2009, Chagwido coast in the western sea of Jeju (33°19′02.7″ N, 126°08′02.4″ E).

**Habitat:** Marine species.

**Genus *Histioneis* 1883**

**Holotype species:** *Histioneis remora* Stein.

**Description:** The flagellate is medium-sized to large (30–150 µm) with elaborate to bizarre wings and lists.

The cell body is divided by large cingular lists into a small to largely reduced epicone, nearly flat to rather strongly vaulted, and a larger ovoid to naviculoid hypocone as seen from the lateral side. Only in very few species, the hypocone forms a conspicuous antapical horn (Guiry and Guiry 2015).

**Numbers of names and species:** There are 92 species (and infraspecific) names in the database at present, of which 78 have been flagged as currently accepted taxonomically (Guiry and Guiry 2015).

#### *Histioneis biremis* Stein 1883 (Fig. 1p)

**Synonym:** No synonym.

**References:** Stein 1883, p. 31; Kofoid and Skogsberg 1928; Fujioka 1990, p. 47, pl. 23, fig. 3; Omura et al. 2012, p. 67; Gul and Saifullah 2010, p. 2653, fig. 14a, b.

**Specimen examined:** Serial No. LJB2013013 / no NIBR Number by submission by only light micrograph photos.

**Description:** This species is large and strikingly asymmetrical in the forms. The body is postero-obliquely depressed and furnished with a spur-like posterodorsal protuberance. The transverse furrow is three to six times wider dorsally than ventrally, inclined dorsoposteriorly at 25°-30°, and gently or moderately concave. The anterior cingular list with a short stalk flares widely distally. The left sulcal list has two main ribs between which there may be some short ribs, reticulation, or a submarginal rib. The epitheca is as deep as the hypotheca, slightly convex, highest in or near the center, and subhorizontal. The anterior margin of the hypotheca is gently sigmoid, convex ventrally and concave dorsally, gently concave, or almost straight. The anterior cingular list has a short but distinct stalk. The posterior cingular list appears to be closed. The left sulcal list is simple in shape and has two main ribs. The thecal wall is areolate and porulate.

**Size:** 90–95 µm long.

**Sampling:** 01 Oct 2010. Chagwido coast in the western sea of Jeju (33°19'02.7" N, 126°08'02.4" E).

**Habitat:** Marine species.

**Distribution:** Widely distributed in Indo-Pacific region, but rare in tropical and subtropical waters. Asia: China (Liu 2008).

#### *Histioneis depressa* Schiller 1928 (Fig. 1q)

**Synonym:** No synonym.

**References:** Wood 1968, p. 143; Taylor 1976, p. 234; Steidinger and Tangen 1996, p. 435, pl. 13; Omura et al. 2012, p. 65; Gul and Saifullah 2010, p. 2654, fig. 16.

**Specimen examined:** Serial No. LJB2013014.

**Description:** The armored cell is small and forms an anterior cingular funnel in the lateral view. The circular cingular chamber appears to be fused to the prominent left sulcal list. The left sulcus list is sac-like and directed dorsally. The subovoid U-shaped space is midpoint to ventral on the posterior margin of the cell body without surface reticulations or rib spurs. Chloroplasts are absent.

**Size:** 65-70 µm long.

**Sampling:** 01 Oct 2010. Chagwido coast in the western sea of Jeju (33°19'02.7" N, 126°08'02.4" E).

**Habitat:** Marine species.

**Distribution:** Oceanic, tropical, and warm temperate waters. Europe: Mediterranean (Gómez 2003); South America: Brazil (Odebrecht 2010); Asia: China (Liu 2008), Taiwan (Shao 2003-2014); Australia and New Zealand: Australia (McCarthy 2013).

#### Genus *Parahistioneis* Kofoid & Skogsberg 1928

**Holotype species:** *Parahistioneis diomedae* (Kofoid & Michener) Kofoid & Swezy.

**Description:** Species in this genus are very much like those of *Histioneis* Stein but differ mainly by the absence of the submarginal cross-rib of the posterior cingular list. This is regarded as insufficient for separating the species at the genus level; consequently, Balech (1971) has considered *Parahistioneis* synonymous with *Histioneis* Stein (Guiry and Guiry 2015).

**Numbers of names and species:** There are 20 species (and infraspecific) names in the database at present, of which 12 have been flagged as currently accepted taxonomically (Guiry and Guiry 2015).

#### *Parahistioneis para* (Murray & Whitting) Kofoid & Skogsberg 1928 (Fig. 1r)

**Synonym:** No synonym.

**References:** Fujioka 1990, p. 49, pl. 24, fig. 9.

**Specimen examined:** Serial No. LJB2010020 / NIBR No. NIBRFL0000125616.

**Description:** The cell is relatively small. The extended cingulum list looks like a broom. The sulcus list is transparent and extended as a hypotheca tail.

**Size:** 30-40 µm long without list, 25-35 µm wide in the lateral view without list.

**Sampling:** 15 Sep 2010. East China Sea in the southern sea of Jeju (32°00'115" N, 126°45'013" E).

**Habitat:** Marine species. This was found in the surface layer with a water temperature of 28.0°C and salinity of 32.7 psu.



***Parahistioneis reticulata* (Kofoid) Kofoid & Skogsberg 1928 (Fig. 1s)**

**Basionym:** *Histioneis reticulata* Kofoid.

**Synonym:** Homotypic Synonym: *Histioneis reticulata* Kofoid.

**References:** Kofoid and Skogsberg 1928, p. 605; Yamaji 1984, p. 100, pl. 32, fig. 20; Omura et al. 2012, p. 67.

**Specimen examined:** Serial No. LJB201021 / NIBR No. NIBRFL0000125617.

**Description:** The small cell looks like *Parahistioneis para*, but it has a more prominent sulcus list that is different from the cingulum list. There is no extended sulcus list as in *Parahistioneis para*.

**Size:** 30-40 µm long without list, 25-35 µm wide in the later view without list.

**Sampling:** 15 Sep 2010. East China Sea in the southern sea of Jeju (32°00'115" N, 126°45'013" E).

**Habitat:** Marine species. This was found in the surface layer with a water temperature of 28.2°C and salinity of 33.5 psu.

**Distribution:** Atlantic Islands: Canary Islands (Gil-Rodríguez et al. 2003).

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