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Revision of the fauna of Tintinnida (Ciliata) of the White Sea (1757) *

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Of the 44 species of Tintinnida recorded earlier for the White Sea, 27 have been reduced to synonyms. Three species have been encountered in the White Sea for the first time. This paper contains illustrated descriptions of all the encountered species with an indication of their variability in the White Sea.

White Sea tintinnids were first mentioned in the work of Merezhkovsky (1878). Since then, this group has attracted the attention of numerous researchers (Virketis, 1926, 1929; Khmyznikova, 1947; Epshtein, 1957, 1957a; Ivanova, 1963; Pertsova and Chibisova, 1970; Burkovsky, 1971). The unavailability of a key has forced researchers into making sense out of uncoordinated and rather inconsistent data. For example, Kofoid and Campbell (1929), wishing to record the entire diversity of tintinnids known at that time,

* The numbers in the right-hand margin are the pages of the Russian text - translator.

singled out practically each form into an independent species. Other specialists (Meunier, 1910, 1919; Jörgensen, 1924; Schulz and Wulff, 1927; Wulff and Schulz, 1929), assuming the presence of considerable phenotypic variability in ciliates, on the contrary, increased the size of certain species. It stands to reason that even direct compliance with these different works would produce different results when listing the species. The probability of incorrect species identification increased even more due to the difference existing between a number of White Sea forms and the forms of corresponding species encountered in other areas of the World Ocean. Indeed, an analysis of works on the White Sea shows that similar forms were often identified as different species, and entirely different ciliate species were claimed to be identical. As a result, the whole list of species of White Sea tintinnids, which included 44 names of species, became one of synonyms.

In order to reach a final conclusion regarding this question, we conducted a study of the morphology, variability and distribution of these ciliates. Our investigation was conducted in 1971-1972 and took in all the seasons and all the main regions of the White Sea with the exception of the mouth and Mezen Bay. The list of synonyms was compiled on the basis of the results of our own investigation and certain literature date. Whenever the authors limited themselves to mentioning the species, we assumed that the form encountered by them did not differ significantly from the one it was identified with.

We encountered a total of 17 species of ciliates (3 were new for the White Sea). Taking into account the three tintinnids that we failed to observe, but that had been encountered earlier by other authors, this group in the White Sea consisted of 20 species.

Leprotintinnus bottnicus (Nord. Jörgensen, 1912) (1758)

(fig. 1, 1a, c)

L. bottnicus (N.) Jörg.: Virketis, 1926, 1929; L. pellucides Jörg.: Khmyznikova, 1947.

The shell is opaque, finely incrusted with tiny particles of sand, oblong cylindrical, tubular, with a gradually or rather sharply narrowing, open posterior end. Its dimensions are 110-170 x 20-24 μ. In shape, the shell is intermediate between L. pellucides and L. bottnicus. On the basis of this, we assume that the form identified as L. pellucides by Khmyznikova in 1947 (the author gives neither a diagram nor description) is identical to (1759)
our form, in which case only one species of this genus, L. bottnicus, inhabits the White Sea. The shells of L. bottnicus vary in the intensity of incrustation and size. The shells encountered near the strait of the White Sea are larger and more heavily incrusted (fig. 1, 1a) than those in the main basin and in Kandalaksha Bay (fig. 1, 1b). Being a fairly rare species it is encountered singly everywhere; only in Kandalaksha Bay were fairly high numbers of the species observed (up to 1000 specimens/m^3 in July 1972).

It is known to inhabit the Barents, North and Baltic seas.

Tintinnopsis beroidea Stein, 1867

(fig. 1, 2a-2c)

T. beroidea: Virketis, 1926, 1929; Epshtein, 1957; Pertsova and Chibisova, 1970; Burkovsky, 1971; T. tubulosoides Meunier: Pertsova and Chibisova, 1970; T. karajacensis Br.: Virketis, 1926, 1929; Pertsova and Chibisova, 1970; Burkovsky, 1970, 1970a; 1971; T. cincta (Cl. et L.)Dad.: Ephstein, 1957; Ivanova, 1963; T. strigosa Meun.: Epshtein, 1957; T.acuminata Dad.: Virketis, 1926, 1929; T. tubulosa Lavander: Burkovsky, 1971.

The shell is opaque, incrusted with sand particles of different size, cylindrical, narrowing in the posterior one-third portion. The posterior end is narrowly rounded or slightly acuminate, less frequently with a caudal process made up of sand particles. Its dimensions are

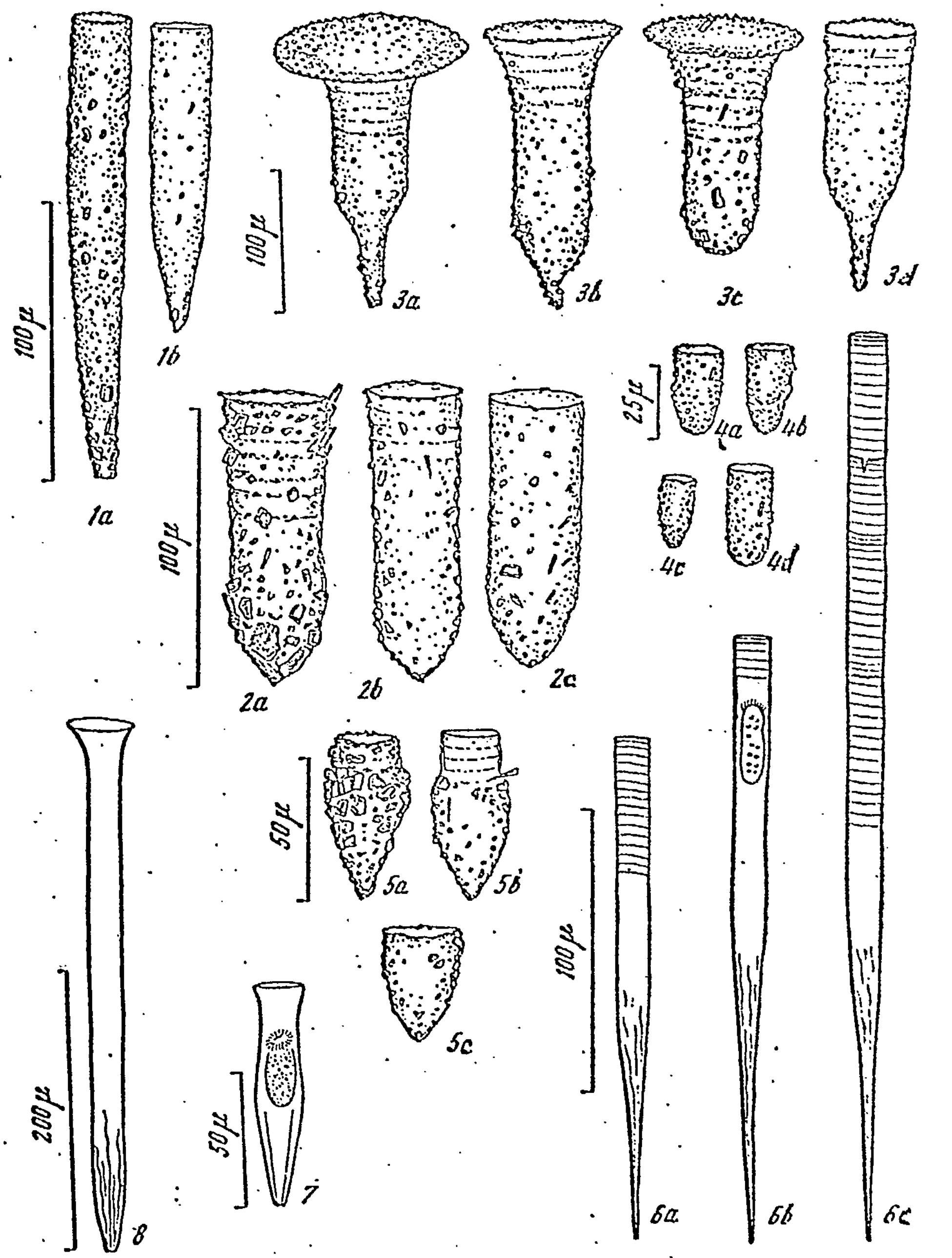

Рис. 1. *Leptotinitinus bottnicus* (1а, 1б), *Tintinnopsis beroiden* (2а—2в), *T. campanula* (3а—3г), *T. nana* (4а—4г), *T. parvula* (5а—5в), *Helicostomella subulata* (6а—6в), *Steenstrupiella robusta* (7) и *Salpingella acuminata* (8)

1758

Fig. 1. Leptotinitinus bottnicus (1a, 1b), Tintinnopsis beroiden (2a-2c), T. campanula (3a-3d), T. nana (4a-4d), T. parvula (5a-5c), Helicostomella subulata (6a-6c), Steenstrupiella robusta (7) and Salpingella acuminata (8).

80-120 x 35-40 μ. The shells are highly variable, particularly in size, the nature of the incrustation and the distinctness of the annulate structure in the upper part. Two phenotypes with a whole series of transitional forms between them are the most frequently encountered. Some of the shells are the smallest encountered in this species in the White Sea (80-100 x 35-40 μ), sparsely incrusted, semi-transparent, with or without a very weakly defined annulate structure (fig. 1, 2c). These, apparently the younger forms usually identified as T. beroidea, are encountered together with the others which are more heavily incrusted, opaque, larger (100-120 x 35-40 μ) and have a fairly well-defined annulate structure in the anterior part of the shell (fig. 1, 2a). The annulate structure is usually accentuated by rows of sand particles along the rings. Shells of this type are usually referred to in the literature as C. tubulosoides. The lack of any definite opinion as to which shells belong to which species has resulted in unbelievable confusion. Meanwhile, our investigations have shown that the annulate structure is an unreliable diagnostic character which is sooner a reflection of the age than of species characteristics. Considering that the two phenotypes are constantly encountered together and that a number of transitional forms are observed, we have related them to the same species.

T. beroidea is encountered on the entire area of the White Sea. The highest numbers have been observed in Onega Bay and at its outlet (up to 14,000 specimens/m^3 in July 1972), and the lowest numbers in Dvina Bay and along the Tersky coast. It is known to inhabit the Barents, Chukchi, Bering, Okhotsk, North, Norwegian and Black Seas.

Tintinnopsis campanula (Ehrbrg) Daday, 1887

(fig. 1, 3a-3d)

T. campanula (Ehrbrg) Daday: Virketis, 1926, 1929; Khmyznikova, 1947; Epshtein, 1957, 1957a; Pertsova and Chibisova, 1970; Burkovsky, 1970;

T. cincta (Cl and L.) Daday: Epshtein, 1957; Ivanova, 1963.

The shell is semi-transparent or opaque, incrusted mostly with very small particles of sand, bell-shaped. The posterior spinelike end is usually incrusted with larger and more closely spaced sand particles. The shell dimensions are 150-210 x 80-140 μ. The caudal process is 15-60 μ, but may be lacking (fig. 1, 2c). The form having no caudal process is frequently considered as the independent species *T. bütschli* Daday. (1760)
We have also encountered specimens with an unfinished adoral zone (fig. 1, 3d), which are often referred to as *T. cincta* (Cl. and L.) Daday. This, apparently, is the form Epshtein had in mind (1957). The anterior portion of the shell in *T. campanula* bears rather distinct, thin striae (4-7 rings) which are subtly accentuated by the tiny particles of sand along the rings. The body of the ciliate is cone-shaped, barely visible through the shell, with 20-24 membranelles in the adoral zone, 2 macronuclei (40 x 15μ) and 2 micronuclei (2-3μ).

This is a widely distributed and prolific species in the White Sea. Its numbers are particularly high in Kandalaksha Bay (up to 18,000 specimens/m^3 in July 1972). It is known to inhabit the Baltic, North, Mediterranean and Black seas.

Tintinnopsis fimbriata Meunier, 1919

(fig. 2, 1a-1d)

T. fimbriata Meunier: Epshtein, 1957; *T. meunieri* K. and C.: Virketis, 1926; Khmyznikova, 1947; Epshtein, 1957; Pertsova and Chibisova, 1970; *T. nitida* Br.: Virketis, 1926, 1929; *T. baltica* Br.: Epshtein, 1957, 1957a; *T. ecaudata* K. and C.: Virketis, 1929.

The shell is opaque, heavily incrusted with large and small particles of sand, cup-shaped, with uneven, recurved edges of the mouth. The posterior end is sharp or drawn out in the form of a short spine.

The diameter of the mouth is equal to or greater than the diameter of (1761)
the shell. The shell dimensions are 80-150 x 70-100μ.

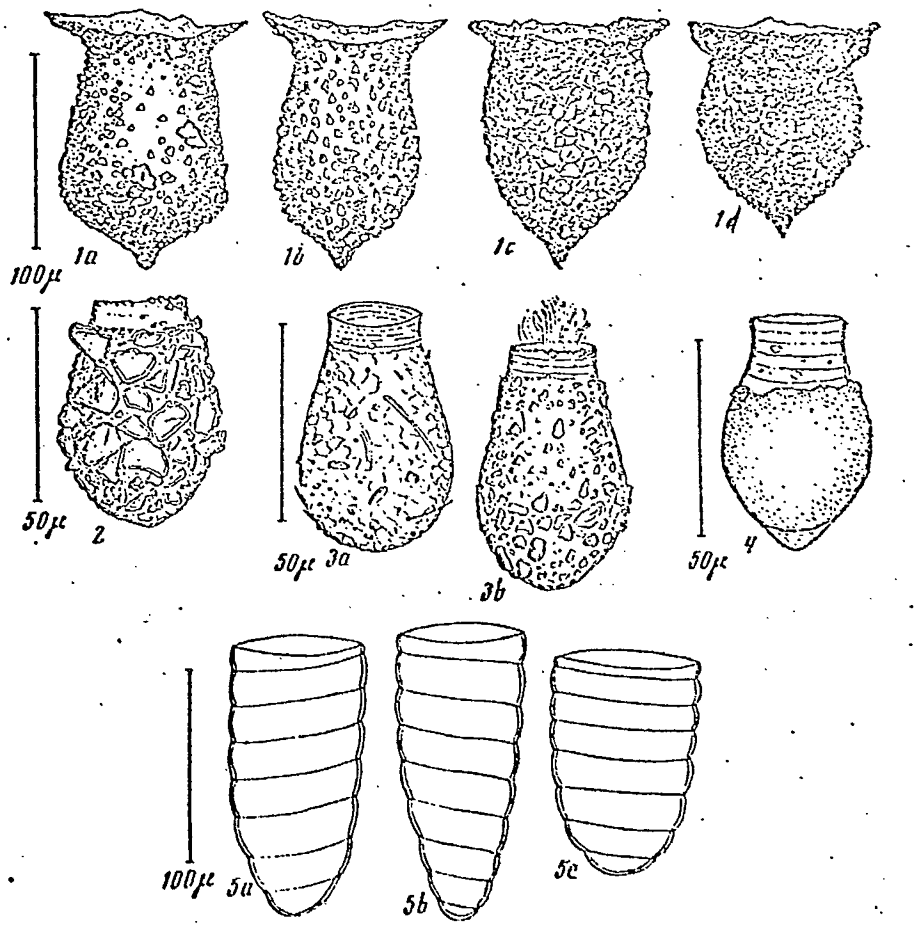

Рис. 2. *Tintinnopsis fimbriata* (1a—1г), *Stenosemella oliva* (2), *Codonellopsis ovata* (3a, 3б), *C. pusilla* (4) и *Coxliella meunieri* (5a—5в)

Fig. 2. Tintinnopsis fimbriata (1a-1d), Stenosemella oliva (2), Codonellopsis ovata ((3a, 3B), C. pusilla (4) and Coxliella meunieri (5a-5c)

Two phenotypes with a number of transitional forms between them are the most common in the White Sea. Fig. 2, 1a, 1b, depicts the sparsely incrusted shells. The largest diameter of the shell is on the posterior one-third portion. The shell dimensions are 120-150 x 75-100 μ. Fig. 2, 1c, 1d depicts shells with a denser and heavier incrustation, which are encountered together with those described above in winter and in summer. The latter form is often referred to in the literature as T. meunieri K. and C. The middle portion of the shell has the largest diameter. The shell dimensions are 80-120 x 70-80 μ.

The species is found in the coastal zone, near the mouths of rivers or streams. Mass development of this species was recorded in Jan. 1972 in the Rugozero Inlet (Kandalaksha Bay) at a temperature of -1.4°C, and in July 1972 in Dvina Bay at a temperature of 1-8°C. In both cases, the numbers totalled from 9,000 to 13,000 specimens/m^3. This is undoubtedly a psychrophilic, eurythermal and euryhaline species. It is known to inhabit the Kara, Chukchi, North and Baltic Seas.

Tintinnospsis nana Lohmann, 1908

(fig. 1, 4a-4d)

The shell is opaque, very small, almost cylindrical or conical, rounded at the posterior end, rather sparsely incrusted with tiny sand particles. The shell dimensions are 25-35 x 12-15 μ. It is constantly observed in our material as small conical forms (fig. 1, 4c) corresponding to T. nana L., and as larger, cylindrical forms with a wide posterior end (fig. 1, 4d), identical to T. minuta (Wailes) K. and C. The presence of transitional specimens, both in the shape of the shell and size, makes it difficult to single out any distinct diagnostic characters which could be used. We believe that all the shells enouuntered by us belong to the same species which we have named T. nana L.

The species was first encountered in the White Sea. It was observed in great numbers in the Strait (up to 60,000 specimens/m^3) and in Dvina Bay in July 1972. It is apparently a psychrophilic and euryhaline form, known to inhabit the Barents (as T. fistularis Meunier) and North seas.

Tintinnopsis parvula Jörgensen, 1912

(fig. 1, 5a-5c)

T. parvula Jörgensen: Epshtein, 1957; Pertsova and Chibisova, 1970; T. parva Merkle: Epshtein, 1957; T. rapa Meunier: Pertsova and Chibisova, 1970; T. nucula (Fol) Br.: Epshtein, 1957.

The shell is opaque, incrusted with small and larger particles of sand. The anterior end of the shell is cylindrical, has a fine annulate structure in sparsely incrusted forms (fig. 1, 5c); the other half of the shell is cone-shaped, the posterior end is narrowly rounded or acuminate. The shell dimensions are 40-60 x 22-28 μ. In certain (young?) specimens, the upper cylindrical portion is lacking (fig. 1, 5c). Such specimens are in no way different from the form described by Merkle as T. parva M. (in Kofoid and Campbell, 1929) and encountered in Onega Bay by Epshtein (1957).

The species is widely distributed in the White Sea. It is particularly common along the Karelian coast and in Onega Bay (up to 5000 specimens/m^3 in July 1972) and is known to inhabit the Barents, Baltic, Mediterranean, Black, Chukchi and Bering seas.

Tintinnopsis tubulosa Levander, 1900 (1762)

This species was first observed by Khmyznikova (1947) and described by Pertsova and Chibisova (1970). The authors note the frequent occurrence of this species, which we have not yet encountered.

Stenosemella oliva Meunier, 1910

(fig. 2, 2)

Tintinopsis ventricosa (Cl. and L.) Jörg.: Virketis, 1926, 1929; Epshtein, 1957; S. nivalis Meunier: Pertsova and Chibisova, 1970.

The shell is opaque, incrusted with small and rather large particles of sand, ellipsoidal, with a narrow collar *, usually without annular striation. The shell dimensions are 55-60 x 38-40 μ. White Sea Stenosemella are without a doubt more closely related to S. oliva than to S. nivalis, and especially S. ventricosa for which they are often mistaken. However, all three species are so similar that we wonder whether they are not the same species.

This species is encountered in the strait, the main basin, and in Kandalaksha and Onega Bays, everywhere singly. It is known to inhabit the Barents and Kara Seas, in the latter being noted as Tintinnopsis ventricosa (Rossolimo, 1927).

Codonellopsis ovata Jörgensen, 1924

(fig.2, 3a, 3b)

C. pusilla (Cleve): Pertsova and Chibisova, 1970; Burkovsky, 1971.

The shell is semi-transparent, incrusted with small and larger particles of sand, distinctly pear-shaped, with a rounded posterior end. The shell narrows anteriorly, a high transparent collar with spiral whorls serving as a continuation of the shell walls at the front. The incrustation is more or less uniform, but not continuous. The shell dimensions are 60-70 x 40-50 μ. The shells incrusted with large particles of sand resemble S. oliva, but are distinguished from it by the presence of spiral whorls on the collar, discontinuous incrustation and a more symmetrical pear-shaped form.

This species is quite common in the White Sea. The maximum numbers are observed in the western part of the basin (up to 30,000 specimens/m^3

* Literal translation of the word used in the Russian text - translator.

in July 1972), and the minimum numbers in Dvina Bay and along the Tersky coast. It has been encountered in the Norwegian Sea.

Codonellopsis pusilla (Cleve), 1900

(fig. 2, 4)

This species was first discovered in the White Sea. The shell is semi-transparent, with no incrustation (!), pear-shaped, with a well defined transparent collar bearing spiral whorls. Its dimensions are 50-55 x 32-37 μ . It completely corresponds to the initial description. It is undoubtedly related to C. ovata, is constantly found alongside it, and is, perhaps, not an independent species. Indeed, the form depicted in fig. 2, 3a, can serve as an example of transition from C. pusilla to the heavily incrusted C. ovata (fig. 2, 3b). Elaborating on this, it can be assumed that S. oliva is even more heavily incrusted. Some of the shells of this species sometimes bear traces of spiral whorls. It is not excluded that the shells depicted in fig.2 (2), 2 (3a, 3b) and 2 (4) belong to the same species, but differ in age. However, this assumption has yet to be proved. It is a very rare species, found in the North Atlantic.

Codonellopsis lata Kofoid and Campbell, 1929. (1763)

This species has been described by Pertsova and Chibisova (1970) under the name Tintinnopsis sacculus Brandt. This is a rare species, which we have not yet encountered. There is also the possibility that this species was observed in the White Sea by Khmyznikova (1947) and named Metacylis vitreoides K. and C.

Coxliella meunieri Kofoid and Campbell, 1929

(fig. 2, 5a-5c)

The shell is of organic matter, transparent, not incrusted, with a very fine reticular structure, cone-shaped, sometimes almost cylindrical, with 6-10 (more often 8) spiral whorls. The posterior end of the shell is always rounded, the adoral edge is even, without denticles. The shell dimensions are 85-165 x 50-90 µ . The species was first discovered in the White Sea. In certain places, its numbers have amounted to 1000 specimens/m^3 (Kandalaksha Bay in July 1972). It is known to inhabit the Barents and Kara seas.

Helicostomella subulata (Ehrenberg) Jörgensen, 1924

(fig. 1, 6a-6c)

The shell is of organic matter, transparent, has the form of a thin cylindrical or conical tube, ending in a needle-shaped process with numerous vertical folds. The upper part of the shell bears several spiral whorls with tiny denticles. The shell sometimes appears to have a number of extensions (fig. 1, 6c). Its dimensions are 172-285 x 14-18 µ .

This species is quite common in the White Sea. Everywhere it is encountered in large numbers (up to 10,000 specimens/m^3). It is known to inhabit the Bering, Chukchi, Okhotsk, Barents, Norwegian, North and Black seas.

Favella taraikaensis Hada, 1937

(fig. 3, 1)

Favella sp.: Pertsova and Chibisova, 1970; Burkovsky, 1970a.

The shell is of organic matter, transparent, not incrusted, cup-shaped, ending in a spinelike process, usually of a sturdier structure and bearing longitudinal grooves. The adoral edge is smooth or slightly dentate. A transparent collar forms two spiral whorls. The structure of the collar is less defined than that of the shell walls. The shell dimensions are 180-245 x 66-85 µ .

This species is usually rarely encountered in the White Sea; however, its numbers reached 10,000 specimens/m^3 over the entire area during the hot summer of 1972, in places superseding the typical White Sea ciliate Parafavella denticulata. It is known to inhabit the Sea of Okhotsk. It is distinguished from the closely related F. ehrenbergi (Cl. and L.) Jörg. by the presence of a suboral swelling and grooves on its spinelike process. It is not excluded that both forms belong to the same species.

Parafavella denticulata (Ehrenberg) Kofoid and Campbell, 1929. P. (Cyttarocylis) denticulata Ehrbrg.: Virketis, 1926, 1929; Epshtein, 1957a; Pertsova and Chibisova, 1970; Burkovsky, 1970, 1970a, 1971; P. (C.) denticulata v. media Br.: Virketis, 1926, 1929; P. (C.) denticulata v. cylindrica Jörgensen: Virketis, 1926; P. edentata (Br.) K. and C.: Virketis, 1929; Pertsova and Chibisova, 1970: P. media (Br.) K. and C.: Epshtein, 1957; Pertsova and Chibisova, 1970; Burkovsky, 1971; P. gigantea (Br.) K. and C.: Epshtein, 1957, 1957a; Ivanova, 1963; Pertsova and Chibisova, 1970; Burkovsky, 1971; P. robusta (Jörg.) K. and C.: Khmyznikova, 1947; P. tenuis Wulff: Khmyznikova, (1764)
1947; P. rotundata (Jörg.) K. and C.: Pertsova and Chibisova, 1970; P. subrotundata (Jörg.) K. and C.: Pertsova and Chibisova, 1970.

This species is widely distributed in the White Sea, highly variable (Burkovsky, 1973, and can be very abundant (up to 20,000 specimens/m^3).

It is found in the northern and temperate zones of the Atlantic, and in the Arctic Ocean.

Parafavella (?) obtusa (Aurivillius) K. and C.

(fig. 3, 2)

Ptychocylis acuta Br.: Pertsova and Chibisova, 1970; Burkovsky, 1971.

The shell is of organic matter, transparent, with an asymmetrical (!), alveolate, double-walled structure, usually broadening posteriorly and then narrowing abruptly in the last one-third portion, less frequently cylindrical. it lacks a caudal process. The adoral edge has no denticles. The shell dimensions are 110-130 x 60-70 μ. It is distinguished from the initial

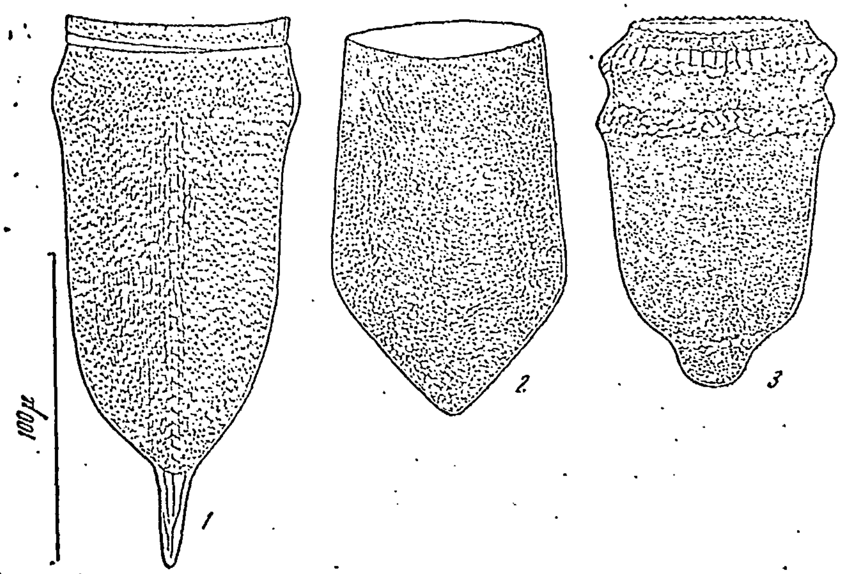

Рис. 3. *Favella taraikaensis (1), Parafavella (?) obtusa (2)* и *Ptychocylis obtusa (3)*.

Fig. 3. Favella taraikaensis (1), Parafavella (?) obtusa (2) and Ptychocylis obtusa (3)

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description by the asymmetrical alveolate structure of the shell walls, which makes this species more like certain species of the genus Ptychocylis, as well as by the absence of denticles along the adoral edge. Perhaps these are young, immature, or, on the contrary, degenerated specimens of Parafavella obtusa. This is a very rare species. It has been observed in June 1971 at a temperature of 4-6°C, and is known to inhabit the Norwegian and Greenland seas.

Ptychocylis obtusa Brandt, 1896

(Fig. 3, 3)

P. obtusa Br.: Virketis, 1926, 1929; Epshtein, 1957; Ivanova, 1963; Pertsova and Chibisova, 1970; Burkovsky, 1971; P. urnula v. acuta Br.: Virketis, 1926, 1929; *P. obtusa* v. *drygalskii* Br.: Virketis, 1926, 1929; *P. cylindrica* Meunier: Epshtein, 1957; *P. drygalskii* Br.: Pertsova and Chibisova, 1970; Burkovsky, 1971.

The shell is of organic matter, transparent, vaselike, gradually narrowing posteriorly and ending in a broadly rounded cone. The shell has two well-defined annular thickenings which are typical for this genus. The shell walls have an asymmetrical alveolate structure which is also typical for this genus. The adoral edge bears numerous short denticles. The shell dimensions are 100-130 x 54-78 μ. The White Sea *P. obtusa* is intermediate (1765)
between the conical *P. acuta* Br. and the cylindrical *P. cylindrica* Meunier in shell shape, and between P. obtusa Br. and P. *drygalskii* Br. in structure, and so has appeared under all these names in the literature.

This species is widely distributed in the White Sea, in places being highly abundant (up to 10,000 specimens/m^3). It is, apparently, a psychrophilic form, and is known to inhabit the Barents, Norwegian, Kara, Chukchi, Bering and Okhotsk seas.

Ptychocylis artica Brandt, 1896

This species was first observed in the White Sea by Virketis (1926); the first description of the White Sea form belongs to Pertsova and Chibisova (1970). The absence of an adoral cone distinguishes it from *P. obtusa*. Perhaps it is a variation of *P. obtusa*. We have not observed this species.

Steenstrupiella robusta Kofoid and Campbell, 1929.

(fig. 1, 7)

S. robusta K. and C.: Pertsova and Chibisova, 1970; *Amphorella subulata* (Ehrenberg): Virketis, 1926.

The shell is of organic matter, transparent, has neither a fine structure nor any incrustation, is shaped like a tube, the front part of which forms a small funnel, while the posterior portion bears vertical folds.

The shell dimensions are 65-80 x 14-17 μ.

The species is widely distributed, but not abundant. It is found in the temperate zones of the Atlantic.

Salpingella acuminata (Cl. and L.) Jorgensen, 1924

(fig. 1, 8)

S. acuminata (Cl and L.) Jörg.: pertsova and Chibisova, 1970; Tintinnus acuminatus Cl. and L.: Virketis, 1926.

The shell is of organic matter, transparent, tubular; the front portion forms a funnel and gradually narrows, while the posterior end bears an opening and longitudinal grooves. The shell dimensions are 250-350 x 35-43 μ.

This is a very rare species, and is encountered singly everywhere. It is known to inhabit the Barents, Norwegian and North seas.

As a result of our revision, the list of species diminished from 44 to 17 (27 species were reduced to synonyms), mostly at the expense of the genera Tintinnopsis (from 19 to 6), Parafavella (from 9 to 1) and Ptychocylis (from 6 to 2). Having taken into account the three new White Sea ciliates, the fauna of tintinnids now comprises 20 species (11 genera). The most abundant is the genus Tintinnopsis (6 species), followed by Codonellopsis (3 species), Ptychocylis (2 species) and Parafavella (2 species). The other genera are represented by only one species.

Seven species can be regarded as the most common of the White Sea fauna (T. beroidea, T. campanula, T. fimbriata, T. parvula, H. subulata, P. denticulata, P. obtusa). As a rule, these are distributed over the entire area of the sea and are abundant everywhere or in certain places. Our data have permitted us to include T. nana and C. ovata in this group; these species have not been observed by any other researchers, apparently because of their extremely small dimensions and similarity with other species.

F. taraikaensis deserves special attention. In 1963, 1970 and 1971, single specimens of this Sea of Okhotsk [sic] species were found in Kandalaksha Bay. However, during the hot summer of 1972, this species was encountered over the entire area of the White Sea with extremely (1766)
high numbers being observed in Kandalaksha Bay (up to 20,000 specimens/m^3), thus superseding P. denticulata. The other ten species are encountered irregularly and never in great abundance in the White Sea. Only L. Bottnicus, S. robusta and C. meunieri form small and temporary accumulations.

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