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TWO NEW FAMILIES AND A NEW SPECIES OF MYXOSPOREANS (MYXOZOA, MYXOSPOREA) OF THE MEDITERRANEAN AND BLACK SEA FISHES

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Two New Families and a New Species of Myxosporeans (Myxozoa, Myxosporea) from the Mediterranean and Black Sea Fishes. Yurakhno V. M. — Descriptions of two new families — Polysporoplasmidae fam. n. (Syn. Sphaerosporidae Davis, 1917 in Sitja-Bobadilla, Alvarez-Pellitero, 1995) and Gadimyxidae fam. n. (syn. Parvicapsulidae Schulman, 1953 in Kшie et al., 2007), and one new species of myxosporeans — *Gadimyxa ovale* sp. n. — parasites of fishes of the Mediterranean and the Black Seas are presented. Species of the genus Gadimyxa is found for the first time in the Black Sea.

Key words: Myxosporea, Polysporoplasmidae fam. n., Gadimyxidae fam. n., *Gadimyxa ovale* sp. n., fishes, Mediterranean, Black Sea.

Два новых семейства и новый вид миксоспоридий (Myxozoa, Myxosporea) из рыб Средиземного и Черного морей. Юрахно В. М. — Описаны два новых семейства — Polysporoplasmidae fam. n. (син. Sphaerosporidae Davis, 1917 по Sitja-Bobadilla, Alvarez-Pellitero, 1995) и Gadimyxidae fam. n. (син. Parvicapsulidae Schulman, 1953 по Kшie et al., 2007), а также нового вида миксоспоридий — *Gadimyxa ovale* sp. n. — паразитов рыб Средиземного и Чёрного морей. Вид из рода Gadimyxa впервые заре-гистрирован в Чёрном море.

Ключевые слова: миксоспоридии, Polysporoplasmidae fam. n., Gadi-myxidae fam. n., *Gadimyxa ovale* sp. n., рыбы, Средиземное море, Чёрное море.

Our investigations of myxosporean fauna of mullets (family Mugilidae) in the Black and Mediterranean seas showed that attribution of *Polysporoplasma mugilis* Sitja-Bobadilla et Alvarez-Pellitero, 1995 (Sitja-Bobadilla, Alvarez-Pellitero, 1995) to the family Sphaerosporidae Davis, 1917 was a mistake. The genus *Polysporoplasma* Sitja-Bobadilla et Alvarez-Pellitero, 1995 presented now by two species forms a new family Polysporoplasmidae fam. n.

Our study of myxosporeans from Mediterranean Sea burbot *Gaidropsarus mediterraneus* in the Black Sea revealed a new species — *Gadimyxa ovale* sp. n. Representative of this genus was found for the first time in the Black Sea.

Material and methods

Mullets were purchased in June 2004 and May 2005 at local fish markets from two localities in the Spanish Mediterranean, namely, from the Ebro River delta and Santa Pola Bay and in June 2004 from Yuzhnaya Bay of Sevastopol (the Black Sea, Ukraine; caught with a fishing rod). Myxosporeans of mullets were taken from alive or freshly frozen fish. Mediterranean Sea burbot *Gaidropsarus mediterraneus* (Linnaeus) was received from fishermen of the fishing brigade of the Institute of Biology of the Southern Seas of NASU, from Sevastopol bays of the Black Sea during October, November, and December of 2002–2004. Myxosporeans of the Mediterranean Sea burbot were taken only from alive fish. A total of 246 specimens belonging to three species of Mediterranean mullets were examined: thin-lip mullet *Liza ramada* (Risso, 1826) (207 specimens), golden grey mullet *Liza aurata* (Risso, 1810) (36 specimens) and thick-lip grey mullet *Chelon labrosus* (Risso, 1827) (3 specimens). Totally 9 specimens of *L. aurata* and 40 specimens of *G. mediterraneus* were examined from the Black Sea. All tissues and organs of fish were examined for myxosporean infections. The studies of spores and plasmodia were conducted either directly on alive material or

on gelatine-glycerine slides using the phase-contrast device (Donets, Shulman, 1973). Spores were photographed and measured on digital images. Descriptions of the spores were based on the guidelines of Lom and Dykova (1992) and Schulman et al. (1997) taking into account modern classification of Myxozoan parasites (Lom, Dykova, 2006).

POLYSPOROPLASMIDAE Yurakhno, **fam. n.**

Type genus: *Polysporoplasma* Sitja-Bobadilla et Alvarez-Pellitero, 1995

Myxosporeans of the order Bivalvulida Schulman, 1959, the suborder Variisporina Lom et Noble, 1984 with very big spores and polar capsules of spherical or subspherical shape. There are two polar capsules, equal in size, located on the anterior pole of the spore on the sides of sutural line. Sutural line is straight. The spores are characterized by very great thickness of valves, thickest at the anterior and posterior poles of the spore. There are two distinct bulges or horns (one on each valve) at the posterior pole of the spore in front view. Presence of several (from 4 to 12) uninucleate sporoplasms in a spore is the most prominent peculiarity of the family. Vegetative forms are twospore and polyspore plasmodia of round and oval form. One genus, *Polysporoplasma*, and two species, *P. sparis* Sitja-Bobadilla, Alvarez-Pellitero, 1995 and *P. mugilis* Sitja-Bobadilla, Alvarez-Pellitero, 1995 are known. Parasites on the sea fish kidneys.

Polysporoplasma mugilis Sitja-Bobadilla et Alvarez-Pellitero, 1995 (fig. 1, 2)

Hosts. In the Mediterranean Sea: thinlip grey mullet *Liza ramada* (Risso), golden grey mullet *L. aurata* (Risso), thicklip grey mullet *Chelon labrosus* Risso; in the Black Sea: *L. aurata* (Risso) (fam. Mugilidae).

Site: kidneys.

Locality and time of revealing. Mediterranean Sea: Spain, river Ebro Delta, June 2004: in 2 of 37 (prevalence — 5 %) of studied *L. ramada* with general length (L) 41–42.5 cm; in 1 of 36 (3 %) of studied *L. aurata* with length 32.5 cm; May 2005: in 2 of 109 (2 %) of studied *L. ramada* with length 39.2–39.8 cm, and in 1 of 3 *C. labrosus*; Santa Pola — in 3 of 61 (prevalence — 8 %) *L. ramada* with length 34–35 cm; Black Sea: Sevastopol, Yuzhnaya bay, June 2004: in 1 of 9 of studied *L. aurata* with length 21.7 cm.

The size of *P. mugilis* spores from fresh smears of *L. ramada* kidney appeared to be a bit differing from that in the first description. The length of spores was 18.0*–22.0, width of spores 16.0–19.5, thickness of spores 16.5, diameter of polar capsules 5.5–6.0. Polar thread formed 4 spires.

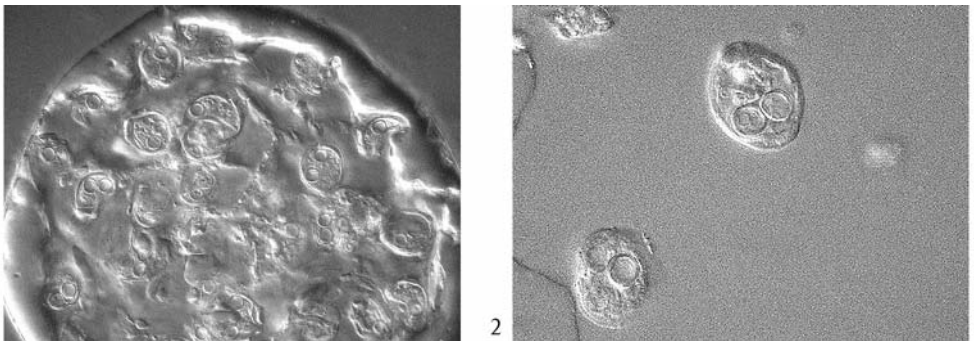

Fig. 1–2: 1 — Plasmodium of *Polysporoplasma mugilis* with spores. 2 — Spores of *Polysporoplasma mugilis*.
Рис. 1–2: 1 — Плазмодий *Polysporoplasma mugilis* со спорами. 2 — Споры *Polysporoplasma mugilis*.

* All measurements in micrometers (μm) unless otherwise indicated.

Liza ramada and *C. labrosus* are found to be new hosts for *P. mugilis* in the Mediterranean Sea. In the Black sea, *P. mugilis* is a new species for the local fauna (Ovcharenko, Jurakhno, 2006; Ovcharenko et al., 2007; Yurakhno, 2008; Yurakhno, Ovcharenko, 2008).

GADIMYXIDAE Yurakhno, **fam. n.**

Type genus: *Gadimyxa* Køie, Karlsbakk et Nylund, 2007

Myxosporeans of the order Bivalvilida, the suborder Variisporina, with spores of semicircular or oval, transversally elongated shape, sometimes (sub) spherical. Anterior spore pole is often flattened. Valves are smooth, without protrusions, non-engraved. The sutural line is thin, strait or weakly curved. It is characteristic, that when seen from the front the line goes over the anterior and posterior spore poles horizontally, but not vertically, as in the representatives of *Leptotheca* Thélohan, 1895 (Thélohan, 1895) and *Ceratomyxa* Thélohan, 1892 (Thélohan, 1892), in which the spore shape is similar to that in *Gadimyxa* (Køie et al, 2007). Presence of the spindle-shaped bulge surrounding polar capsules and located along the sutural line is another peculiarity of the family representatives. This bulge is not always seen on the spores from the fresh smears. Two polar capsules of rounded shape and not of big size are located at the anterior spore pole and open near the sutural line. There is one sporoplasm, it has two nuclei and distributed all over the spore plane under the polar capsules. Vegetative forms are rounded, oval or elongated two-spore, coarse-grained plasmodia, sometimes with one end sharpened, with well seen pseudopodia. Parasites of the sea fish urinary bladder. The family contains one genus *Gadimyxa* and four species — *G. atlantica* Køie, Karlsbakk et Nylund, 2007, *G. sphaerica* Køie, Karlsbakk et Nylund, 2007, *G. arctica* Køie, Karlsbakk et Nylund, 2007 (Køie et al., 2007) and *G. ovale* sp. n. Diagnosis of the genus *Gadimyxa* corresponds to the diagnosis of the family.

Gadimyxa ovale Yurakhno, sp. n. (figs 3, 4)

Host: Mediterranean Sea burbot *Gaidropsarus mediterraneus* (Linnaeus) (fam. Gadidae).

Site: urinary bladder.

Locality and time of revealing: Black sea, Sevastopol (Karantinnaya Bay — November 2002: in 2 of 6 studied fishes; October 2004: in 3 of 11, November 2004: in 2 of 5, December 2004: in 1 of 2. Martynova Bay — December 2002: in 3 of 3. Alexandrovskaya Bay — October 2003: in 4 of 13 studied fishes).

Syntypes: slides N 1, 9, 30, 32, BAS 6, BAS 5.

Syntypes of *Gadimyxa ovale* sp. n. are deposited in the collection of the Department of Ecological Parasitology of IBSS, NAS of Ukraine (Sevastopol).

Vegetative forms: rounded, oval and wide–oval bisporous plasmodia, sometimes with one sharpened end, with coarse-grained endoplasma, with many well seen pseudopodia, 0.5– 2.0 long. Size of plasmodia 10.5 × 12.5, 9.7 × 17.0, 27.0 × 34.0.

Spores are elongated, oval, smooth. Polar capsules are rounded, small, situated at front spore pole and opening near the sutural line. Sutural line is thin, slightly curved. The line observed from the front is situated horizontally, over the anterior and posterior spore poles. Sporoplasm is distributed all over the spore plane under the polar capsules. Measurements of the spores are given in table 1.

The general length (L) of infected fish was 20.0–27.5 cm. Single specimens were observed in the smears.

Differential diagnosis. *Gadimyxa ovale* sp. n. is similar to the three other species of the genus *Gadimyxa* (Køie et al., 2007) from Gadiidae fish — Atlantic cod *Gadus morhua* L. (Gadidae) from the Øresund, Denmark, western Norway (*G. atlanti-*

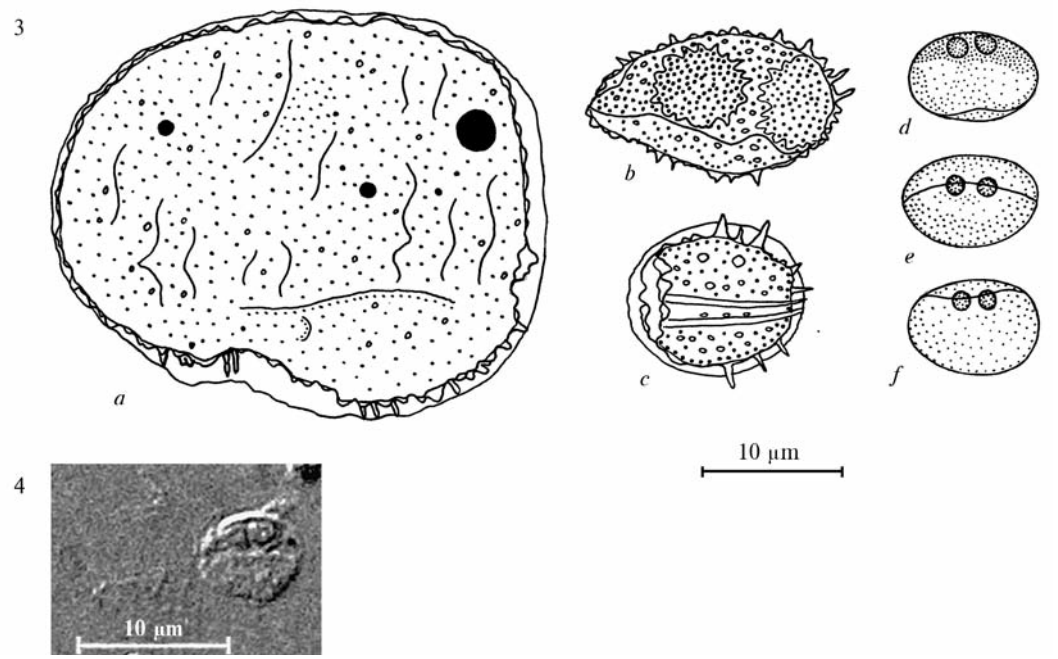

Fig. 3–4. 3 — Plasmodia and spores of *Gadimyxa ovale* sp. n.: *a*, *b*, *c* — plasmodia with different forms and sizes; *d*, *e*, *f* — spores. 4 — Spore of *Gadimyxa ovale* sp. n.

Рис. 3–4. 3 — Плазмодии и споры *Gadimyxa ovale* sp. n.: *a*, *b*, *c* — плазмодии разных форм и размеров; *d*, *e*, *f* — споры. 4 — Спора *Gadimyxa ovale* sp. n.

ca and *G. sphaerica*) and *Arctogadus glacialis* (Peters) from Greenlandic seas (*G. arctica*). *G. ovale* sp. n. vegetative stages have rounded or oval and wide–oval shape, whereas other species of this genus have elongated or spherical shape. The spores of *G. ovale* sp. n. differ by their shape and size from those of *G. atlantica, G. sphaerica* and *G. arctica*. Semicircular shape of the spores occurs rarely, spherical shape was not found. Length of the spores of *G. ovale* sp. n. is larger than in *G. atlantica* and smaller than in *G. sphaerica* and *G. arctica*. Spores of *Gadimyxa ovale* sp. n. are wider and with thicker valves than in *G. sphaerica*, with considerably smaller polar capsule diameter than in other *Gadimyxa* species.

Discussion

Very large size of *Polysporoplasma mugilis* spores and polar capsules, very great thickness of its valves, thickest at the anterior and posterior poles of the spore, two well seen bulges or horns at the posterior pole of the spore in front view, several (from 4 to 12) uninucleate sporoplasms in the spore, very big size and unusual form of vegetative stages are the evidence of this genus uniqueness, in contrast to other representatives of Sphaerosporidae; this set of features supports the existence of a separate myxosporean family Polysporoplasmidae.

Table 1. The size of *Gadimyxa ovale* sp. n. spores on the fresh and fixed preparations
Таблица 1. Размеры спор *Gadimyxa ovale* sp. n. на свежих и фиксированных мазках

Size of spores and polar capsules	Fresh smears	Gelatine-glycerine preparations
Length of spores	5.3–6.5	5.4–6.6
Width of spores	8.7–9.2	6.5–8.4
Thickness of spores	6.0	
Diameter of polar capsules	1.2	1.2–1.3 (1.5)

Differences in *Gadimyxa ovale* sp. n. size and the shape of the spores in comparison with other species of this genus prove the validity of this new species. Attribution of *G. ovale* sp. n. and other *Gadimyxa* spp. to the family Parvicapsulidae we consider to be erroneous, as the shape of typical representatives of this family differs completely from that characteristic for *Gadimyxa* genus. We presume it was the molecular studies that demonstrated the affinities between *Parvicapula* and *Gadimyxa* inhabiting the same organ — the urinary bladder. Similar situation occurred in the case of *Pseudokudoa trifolia* Holzer, Blasco-Costa, Sarabeev, Ovcharenko et Balbuena, 2006 (Holzer et al., 2006): the molecular-biological data have shown very high similarity of this species to *Kudoa unicapsula* Yurakhno, Ovcharenko, Holzer, Sarabeev et Balbuena, 2007 (Yurakhno et al., 2007), which is completely different morphologically, but occurs in the same organs — intestine mesenterium and pyloric appendage of the same hosts, *Liza ramada* and *L. aurata* (Yurakhno, 2007).

Donets Z. S., Shulman S. S. About methods of Myxosporidia (Protozoa, Cnidosporidia) studied // Parasitology. — 1973. — **7**, fasc. 2. — P. 191–193.

Gaevskaya A. V., Kovaleva A. A., Schulman S. S. New genus Neoparvicapsula and the state of Parvicapsulidae in Myxosporidia system // Zool. Journ. — 1982. — **61**, fasc. 5. — P. 774–777.

Holzer A. S., Blasco-Costa I., Sarabeev V. L. et al. Kudoa trifolia sp.n. — molecular phylogeny suggests a new spore morphology and unusual tissue location for a well-known genus // J. Fish Dis. — 2006. — **29. —** P. 743–755.

Køie M., Karlsbakk E., Nylund A. A new genus Gadimyxa with three new species (Myxozoa, Parvicapsulidae) parasitic in marine fish (Gadidae) and the two-host life cycle of Gadimyxa atlantica n. sp. // J. Parasitol. — 2007. — **93,** N 6. — P. 1459–1467.

Lom J., Dykova I. Protozoan parasites of fishes. Developments in Aquaculture and Fisheries sciences. — Amsterdam ; London ; New York ; Tokyo : Elsevier, 1992. — P. 160–235.

Lom J., Dykova I. Myxozoan genera: definition and notes on taxonomy, life-cycle terminology and pathogenic species // Folia parasitologica. — 2006. — **53. —** P. 1–36.

Schulman S. S., Donets Z. S., Kovaleva A. A. Class of myxosporeans (Myxosporea) of the world fauna. — St. Petersburg : Nauka, 1997. — 567 p. — Vol. 1. — Russian : *Шульман С. С., Донец З. С., Ковалева А. А.* Класс миксоспоридий мировой фауны.

Sitja-Bobadilla A., Alvarez-Pellitero P. Light and electron microscopic description of Polysporoplasma n. g. (Myxosporea: Bivalvulida), Polysporoplasma sparis n. sp. from Sparus aurata (L.), and Polysporoplasma mugilis n. sp. from Liza aurata L. // Europ. J. Protistol. — 1995. — **31**. — P. 77–89.

Ovcharenko M., Jurakhno V. Nowe dane o mikropasożytach ryb z rodziny cefalowatych (Mugilidae) // XX Zjazd Hydrobiologów Polskich (5–8 września 2006, Toruń, Polska). — Toruń, 2006. — P. 160.

Ovcharenko M., Yurakhno V., Tytar V. Review of microparasites of mullets in the Mediterranean basin and the Sea of Japan // Revista Română de Parasitoilogie. — 2007. — Suppl. **17**. — P. 142–143.

Thélohan P. Observation sur les myxosporidies et éssai de classification de ces organismes // Bull. Soc. Philom. — 1892. — **4. —** P. 165 –178.

Thélohan P. Recherches sur les Myxosporidies // Bull. Sci. Fr. Belg. — 1895. — **26. —** P. 100–394.

Yurakhno V. M. About validity of Kudoa trifolia Holzer et al., 2006 (Myxosporea: Multivalvulida) // Parassitologia. — 2007. — Vol. 49, Suppl. 2. — P. 172. — (7th International Symposium on Fish Parasites, Viterbo, Italy, 24–28 September 2007).

Yurakhno V. M. The results of the Black sea fish myxosporeans biodiversity studies // Importance and perspectives of the stationary investigations for preservation of biodiversity: Materials of the international scientific conference, devoted to the 50-th anniversary of functioning stationary "Pozhizhevska" (Lvov; Pozhizhevska, September 23–27, 2008). — Lvov, 2008. — P. 455.

Yurakhno V. M., Ovcharenko N. A. Myxosporeans of mullets in the World Ocean // Materials of the IV All-Russia Meeting of the Parasitological society under Russian Academy of Sciences, which took place on October 20–25, 2008, in Zoological institute of the Russian Academy of Sciences in St.Petersburg: "Parasitology in XXI century — problems, methods, solutions". — Vol. 3 / Ed. K. V. Galaktionov, A. A. Dobrovolsky. — St.Petersburg: Lema, 2008. — P. 231–234.

Yurakhno V. M., Ovcharenko M. O., Holzer A. S. et al. Kudoa unicapsula n. sp. (Myxosporea: Kudoidae) a parasite of the Mediterranean mullets Liza ramada and L. aurata (Teleostei: Mugilidae) // Parasitol. Res. — 2007. — **101,** N 6. — P. 1671–1680.