

PLANKTONIC CILIATES OF JUVENILE (FRY) FISHPONDS IN UZBEKISTAN

***I.M. Mirabdullayev**

Institute of zoology, Academy of Sciences of the Republic of Uzbekistan

**e-mail: imirabdullayev57@gmail.com*

Summary

A comprehensive study of planktonic ciliates was carried out in seven fry fishponds belonging to two fish farms located in the Tashkent region. During the investigation, a total of fifty-eight species of planktonic ciliates were identified, demonstrating a relatively high diversity of protozoan communities in the examined aquaculture ecosystems. The dynamics of species composition, abundance, and biomass of ciliates were analyzed throughout different stages of pond development and fish cultivation. Most ciliate species were characterized by short-term and relatively narrow periods of active development, usually lasting from three to seven days. In several cases, significant fluctuations in abundance were observed even within a single day, indicating the instability and rapid transformation of planktonic communities in fry ponds. Such abrupt changes in population density were likely associated with intensive processes of excystment and encystment, as well as with changing environmental conditions, including water temperature, oxygen concentration, and availability of organic matter and bacterial food resources.

The study revealed that during the first week after filling the ponds with water, the planktonic community was dominated mainly by ciliate species typical of temporary or ephemeral water bodies. These pioneer species rapidly colonized newly formed aquatic habitats and played an important role in the initial stages of ecological succession. As the ponds matured, gradual changes in the taxonomic composition and structure of the ciliate community were observed, reflecting the succession processes occurring in aquaculture reservoirs. The obtained results indicate that planktonic ciliates can serve as valuable bioindicators of ecological conditions and trophic status

in fishpond ecosystems. In addition, ciliates represent an important component of the natural food base for fish fry, participating actively in nutrient cycling and energy transfer within aquatic food webs.

Keywords: *zooplankton, ciliates, biomass, fry fishpond, succession, protozoa, aquaculture, plankton dynamics, ecological succession, fish farming*

Introduction. Ciliates (Ciliophora) are an important component of aquatic ecosystems. Ciliates are the main food for juveniles of all fish species. The absence or deficiency of ciliates (and also rotifers and nauplia) results in developmental delay and significant mortality of juvenile fish. In turn, ciliates consume significant part of the production of phytoplankton and bacterioplankton, thus connecting the chain between the higher and lower trophic levels of the ecosystems. Consuming oxygen, releasing carbon dioxide and metabolic products, ciliates affect the hydrochemical regime of water bodies, and, even more importantly, actively participate in the cycle of substances in aquatic ecosystems, thus stimulating the development of phyto- and bacterioplankton.

Ciliates, along with phyto- and bacterioplankton, are an essential link in the food chain of water bodies. By consuming phytoplankton, bacteria and detritus, ciliates are a powerful factor in the transformation of organic matter. The processes of self-purification and formation of water quality largely depend on zooplankton, most of which are sedimentators. Observations of ciliates constitute a necessary link in the system of environmental monitoring and forecasting the consequences of anthropogenic impact [1, 2]. The species diversity and quantitative development of ciliates depends on many abiotic and biotic factors.

Their impact on zooplankton can be direct (one-sided or complex) and indirect.

In general, the patterns of the succession of zooplankton (metazoan and protozoan) as well as phytoplankton and zoobenthos in juvenile (fry) and spawning fishponds have not been studied and are unknown [3].

Material and methods. In Uzbekistan juvenile fishponds are relatively small ponds (100-5000 m²) in which fish larvae grow up for 2-3 weeks. Empty juvenile ponds are flooded with water from channels and larvae are launched into them after 1-2 days.

Research carried out in the Tashkent Region on 1 juvenile pond in the Scientific base of the Uzbek Institute of Fishery and 6 juvenile ponds of the "Balykchi" Fishery Farm. The depth of the ponds is 0.8-1.0 m; the area is 0.3-0.5 ha. In the ponds, the larvae of the silver carp *Hypophthalmichthys molitrix* were grown in second half of May and first half of June.

Samples were taken using a plastic tube (length 1 m, inner diameter 2.5 cm). The tube was lowered into the water vertically from the surface to the bottom layers, as a result of which the water column was "cut out". Then the tube was closed at the bottom and removed from the water. H. Utermöhl [4] used a similar method to study the zooplankton of ponds. Samples were collected in 7 points in each pond and combined in one integral sample. Samples were taken every 1-2 days.

Ciliates were counted no later than 30 minutes after sampling. Ciliates were counted as follows. Water was poured into a Petri dish up to a depth of 5 mm. By lowering the tube of the MBS-7 stereomicroscope, I counted the ciliates that fell into the field of view. Thus, we counted all the ciliates in a given volume of water (depending on the chosen magnification of the stereomicroscope). 10 fields of view were viewed in each dish and then the water was replaced. This procedure was repeated 5 times. Large (*Condylostoma vorticella*, *Hypotrichidium spp.* etc.) and medium-sized (*Paramaecium spp.*, *Prorodon spp.* etc.) ciliates were counted at $\times 16$ magnification, in the case of their mass development, and small ciliates (*Halteria spp.*, *Urotricha spp.* etc.) – at $\times 32$ magnification. With the mass development

of small forms, they were counted at a magnification of $\times 56$. Thus, at a magnification of $\times 16$, 24 ml of water were counted, at $\times 32$ - 6 ml, and at $\times 56$ - 2 ml. The number of specimens of mass species calculated in this way reached, as a rule, from several tens to many tens of specimens. Sorokin and Jevanese [5] used a similar method for quantifying planktonic ciliates.

Rotifers and crustaceans were found in the samples along with ciliates. They were fixed with formaldehyde, identified and counted (although for metazoic plankton this is certainly not the optimal method).

Argyrophylic structures were revealed using dry [6] and wet [7] methods. In the latter case, fixation with 4% formaldehyde was used. After fixation, formaldehyde was washed out in 5 changes of distilled water. Then a drop with infusoria was mixed on a heated slide with 2 drops of heated gelatin (gelatin - 10 g, NaCl - 0.05 g, distilled water - 100 ml). The mixture was quickly smeared on slide. The slide was transferred to a humid chamber and placed in a refrigerator. After a few minutes, a few drops of cold 3% AgNO₃ solution were applied to the surface of the preparation and left in the refrigerator for several hours. This was followed by washing with distilled water in 3-4 shifts and placing the slide in 70% alcohol. Further procedures can be carried out at room temperature. The preparations were dehydrated in alcohol and xylene and embedded in canadian balm or synthetic medium. Silver reduction can be carried out at any stage starting from 96% alcohol. For this, it was just used daylight. Material stored in formalin for several weeks was suitable for impregnation by argentum.

The maximum daytime water temperatures in the ponds were 25-28 °C.

Results and discussion. Fifty-eight species of planktonic ciliates were recorded in 7 fry ponds of two fish farms in Tashkent region (table 1, fig. 1).

The lists of ciliate species in the studied ponds were similar. The most noticeable species in quantitative development were found in all ponds. However, the temporal and quantitative indicators of development in different ponds varied markedly.

Planktonic and other organisms quickly appear and develop in ponds flooded with water. They enter the pond with water, from the air and soil (cysts and other resting stages). The ecological succession of the zooplankton community occurs in the ponds – various types of ciliates appear, develop, reach a certain number and drop out of the plankton in a certain order.

Most species were characterized by relatively narrow (3-7 days) periods of development (Figs 2-3). In some cases, the number per day changed several times. This was especially true for small species. The abrupt changes in numbers were probably caused by ex- and encysting processes. The first species of ciliates (*Halteria oviformis*) appeared already in the first 1-2 days after the

beginning of filling the ponds with water and reached a significant development in 1-3 days. After that, the species disappeared from the plankton, passing apparently into a dormant state – cysts (this has been shown in laboratory experiments in petri dishes). The maximum biomass of ciliates fell on days 3-6. A week later, a group of species characteristic of temporary (ephemeral, rain pools) water bodies (*Actinobolina vorax*, *Spathidium lieberkühni*, *Tillina magna*, *Furgassonia viridis*, *Nassula* sp., *Disematostoma colpidioides*, *Astylozoon faurei*, *Hastatella radians*, *Metastrombidium nigrum*, *Hypotrichidium conicum*, *H. faurei*, *Hypotrichidium* sp., *Psilotricha succisa*, *Spiratella plancticola*) [8, 9], encysting disappeared from plankton.

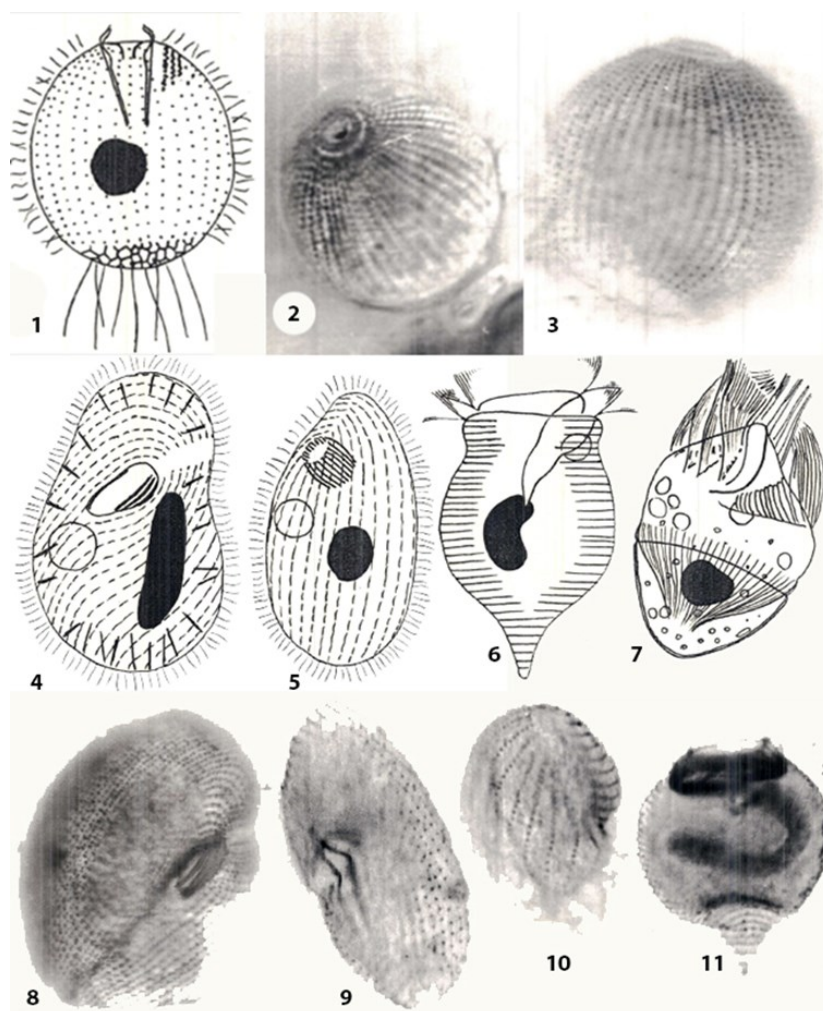


Fig. 1. 1-3: *Urotricha puytoraci*; 4,8: *Disematostoma colpidioides*; 5: *Furgassonia viridis*; 6, 11: *Astylozoon faurei*; 7: *Limnostrombidium viride*; 8-9: *Colpididium viridis*

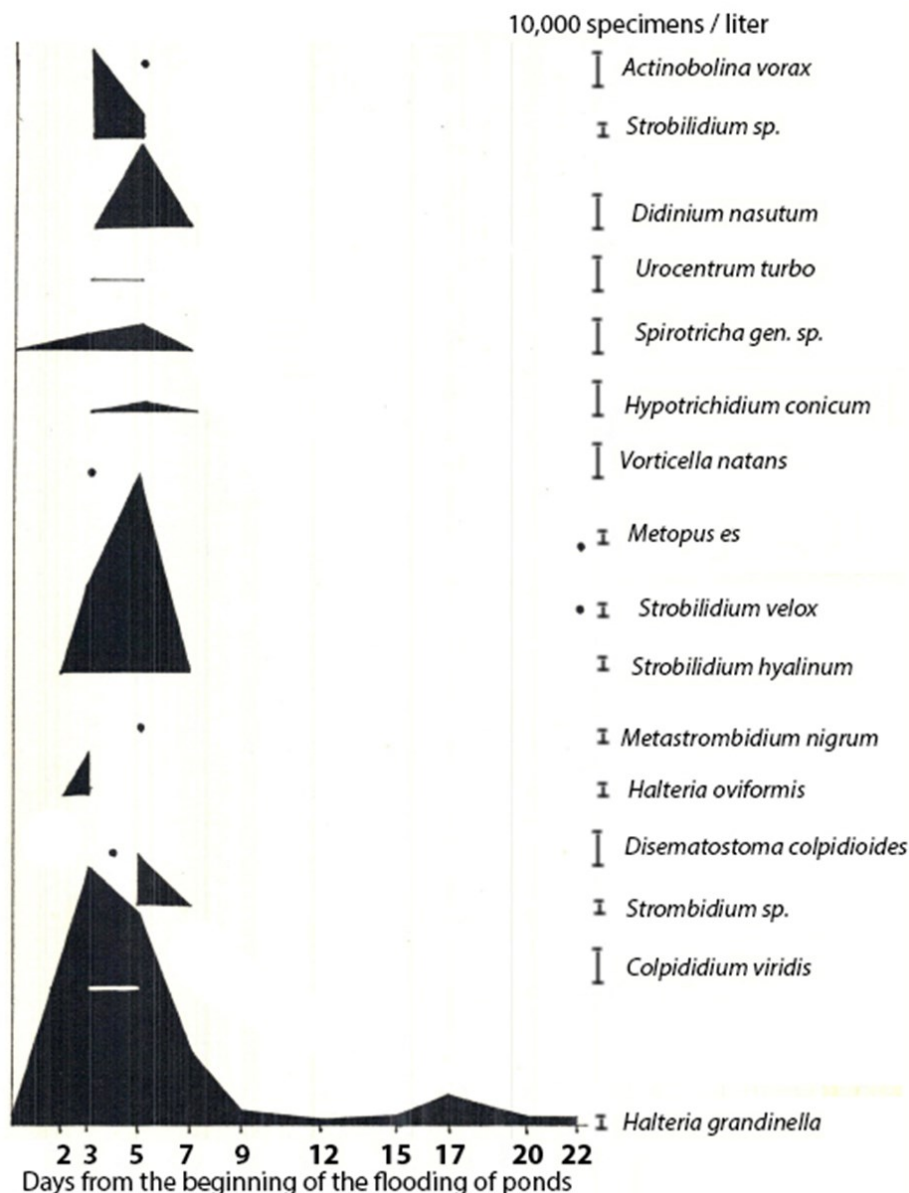


Fig. 2. Dynamics of the total biomass of ciliates in the juvenile pond № 1 of the Fish Farm "Balykchi"

The dynamics of quantitative indicators of the development of ciliates also had a regular character. So, the maximum of total biomass of ciliates fell, as a rule, on 3-7 days from the beginning of flooding the ponds with water. Further the biomass sharply decreased (Fig. 4).

In the course of studies of ciliates, some information was obtained on the development of metazoan plankton. In particular,

it was shown that after the maximum biomass of ciliates, the maximum development of rotifers (15 spp. recorded) was observed, then cladocerans (5 spp.), then copepods.

In other studies, ciliate and metazoan plankton of rearing ponds (where the fish are raised for 2-3 years) were studied [10, 11]. In these ponds, sharp changes in the composition, abundance, and total biomass of ciliates were also noted.

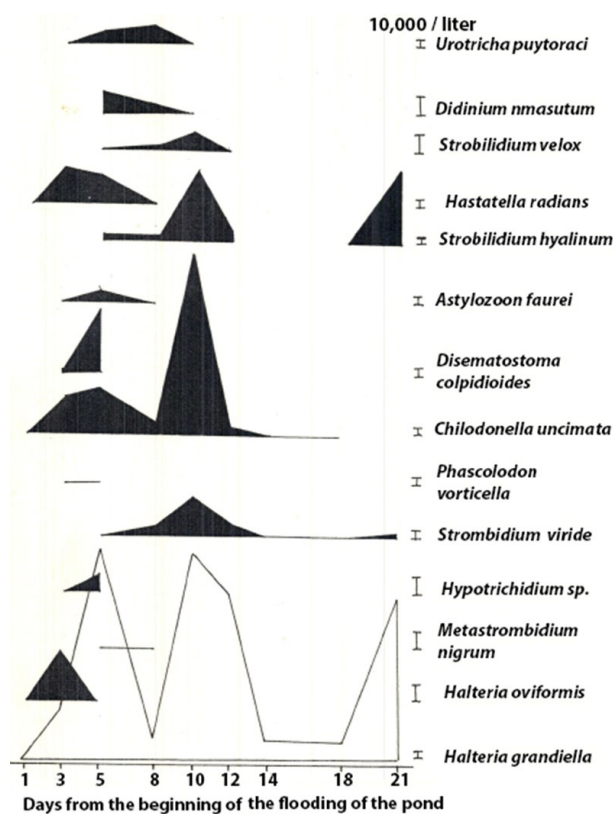


Fig. 3. Dynamics of the number of certain species of ciliates in the juvenile pond № 1 of the Uzbek Institute of Fishery

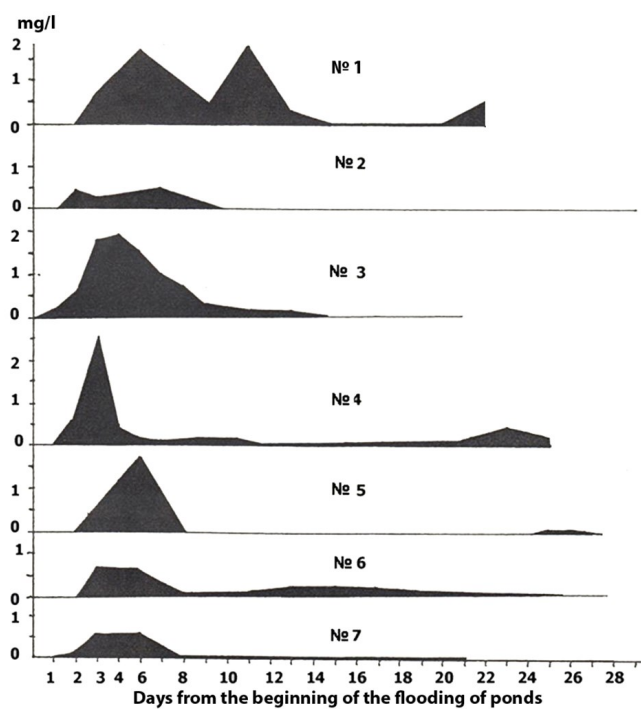


Fig. 4. Dynamics of the total biomass of ciliates in juvenile ponds (№ 1: Uzbek Institute of Fishery; № 2-7: Fish Farm "Balykchi")

Table 1. Species composition of planktonic ciliates of fry fishponds of the Fish Farm “Balykchi” (FFB) and the Uzbek Institute of Fishery (UIF)

Taxa	FFB	UIF
SUBPHYLUM POSTCILIODESMATOPHORA Gerassimova & Seravin, 1976		
CLASS <u>HETEROTRICHEA</u> Stein 1859		
<i>Blepharisma</i> sp.	-	+
<i>Bursaria truncatella</i> O.F. Müller, 1773	+	+
<i>Caenamorpha medusula</i> Perty, 1852	+	-
<i>Condylostoma vorticella</i> Ehrenberg, 1833	++	++
Heterotricha (?) <i>gen. sp.</i>	++	++
SUBPHYLUM INTRAMACRONUCLEATA Lynn, 1996		
CLASS <u>PROSTOMATEA</u> Schewiakoff, 1896		
<i>Coleps hirtus</i> Nitsch, 1827	+	+
<i>Holophrya nigrificans</i> Lauterborn, 1894	+	+
<i>Urotricha farcta</i> Claparede et Lachman, 1858	++	++
<i>U. puytoraci</i> Dragesco et al., 1974	++	++
CLASS <u>COLPODEA</u> Small & Lynn, 1981		
<i>Tillina magna</i> Gruber, 1880	+	+
CLASS <u>NASSOPHOREA</u> Small & Lynn, 1981		
<i>Colpodidium viridis</i> (Mirabdullayev, 1986)	+	+
<i>Furgasonia viridis</i> (Dingfelder, 1962)	++	++
<i>Nassula</i> sp.	+	+
CLASS <u>LITOSTOMATEA</u> Small & Lynn, 1981		
<i>Actinobolina vorax</i> (Wenrich, 1929)	++	++
<i>Didinium balbiani</i> Fabre-Domerque, 1888	++	++
<i>D. nasutum</i> O.F. Müller, 1773	++	++
<i>Pseudomonilicaryon anser</i> (O.F. Müller, 1773)	+	+
<i>Enchelys</i> sp.	+	+
<i>Paradileptus conicus</i> Wenrich, 1929	+	+
<i>Pelagodileptus trachelioides</i> (Zacharas, 1894)	++	++
<i>Spathidium lieberkühni</i> (Bütschli, 1889)	+	+
CLASS <u>ARMOPHOREA</u> Linn, 2004		
<i>Metopus es</i> Claparède & Lachmann, 1858	+	-
CLASS <u>OLIGOHYMENOPHOREA</u> de Puytorac et al., 1974		
<i>Astylozoon faurei</i> Kahl, 1935	++	++
<i>Cyclidium</i> sp.	+	+
<i>Disematostoma colpidioides</i> (Gelei, 1954)	++	++
<i>Frontonia</i> sp.	+	+
<i>Glaucoma</i> sp.	+	+

Table 1 (continued)

<i>Hastatella radians</i> Erlanger, 1890	+	+
<i>Paramaecium aurelia</i> Ehrenberg, 1838	+	+
<i>P. caudatum</i> O.F. Müller, 1773	+	+
<i>Pelagovorticella natans</i> (Fauré-Fremiet, 1920)	+	+
<i>Trichodina</i> sp.	+	-
<i>Urocentrum turbo</i> (O.F. Müller, 1786)	-	+
<i>V. campanula</i> Ehrenberg, 1831	++	+
CLASS SPIROTRICHEA Bütschli 1889		
<i>Aspidisca</i> sp.	+	-
<i>Euplotes patella</i> (O.F. Müller, 1773)	+	+
<i>Hypotrichidium conicum</i> Ilowaisky, 1921	++	++
<i>H. faurei</i> Tuffrou, 1972	+	+
<i>Hypotrichidium</i> sp.	++	++
<i>Psilotricha succusa</i> (O.F. Müller)	+	-
<i>Spiretella plancticola</i> (Gelei, 1933)	++	++
<i>Strongilidium</i> sp.	-	+
<i>Halteria grandinella</i> (O.F. Müller, 1786)	++	++
<i>H. oviformis</i> Gelei, 1950	++	++
<i>Limnostrombidium viride</i> (Stein, 1867)	++	++
<i>Metastrombidium nigrum</i> Mirabdullaev, 1985	++	++
<i>Strombidium</i> sp.	++	++
<i>Strobilidium gyrans</i> Stokes, 1887	+	-
<i>S. hyalinus</i> Mirabdullaev, 1985	++	++
<i>Strobilidium velox</i> Faure-Fremiet, 1924	++	+
<i>Strobilidium</i> sp.	+	+
<i>Tintinnidium fluviatile</i> Stein, 1863	+	+
<i>Tintinnopsis pusillum</i> Entz, 1909	+	+
CLASS PHYLLOPHARYNGEA de Puytorac et al., 1974		
<i>Chilodonella uncinata</i> (Ehrenberg, 1838)	+	+
<i>Phascolodon vorticella</i> Stein, 1859	++	++
<i>Trithigmostoma cucullulus</i> Jankowski, 1967	+	+

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ЎЗБЕКСТАНДАҒЫ БАЛЫҚ АУЛАУ ТОҒАНДАРЫНЫҢ ПЛАНКТОНДЫҚ КІРПІКШЕЛІ БАЛЫҚТАР

И.М. Мирабдуллаев

Ўзбекистан Республикасы Ғылым академиясының Зоология институты

*e-mail: imirabdullayev57@gmail.com

Аңдатпа

Ташкент облысындағы екі балық шаруашылығына қарасты жеті шабақ өсіру тоғанында планктондық кірпікшелілердің түрлік құрамы мен даму динамикасына зерттеу жүргізілді. Зерттеу нәтижесінде планктондық кірпікшелілердің жалпы саны елу сегіз түрді құрайтыны анықталды. Аталған микроорганизмдер су экожүйелерінің маңызды компоненті болып табылады және балық шабақтарының табиғи қоректік базасын қалыптастыруда ерекше рөл атқарады. Зерттеу барысында кірпікшелілердің түрлік құрамы, саны, биомассасы және олардың сукцессиялық өзгерістері бақыланды.

Көптеген түрлер салыстырмалы түрде қысқа мерзімде, яғни 3–7 күн аралығында белсенді дамумен сипатталды. Кейбір жағдайларда кірпікшелілер санының тәулігіне бірнеше рет өзгеруі байқалды. Мұндай күрт ауытқулар қоршаған орта жағдайларының өзгеруіне, соның ішінде су температурасына, еріген оттегі мөлшеріне, органикалық заттардың жиналуына және қоректік ресурстардың қолжетімділігіне байланысты болуы мүмкін. Сонымен қатар санының кенеттен өзгеруі кірпікшелілердің эксцистация және энцистация үдерістерімен де түсіндіріледі.

Тоғандарды сумен толтырғаннан кейінгі алғашқы аптада уақытша немесе эфемерлік су қоймаларына тән кірпікшелілер түрлері басым дамығаны анықталды.

Бұл түрлер жаңа қалыптасқан су ортасына тез бейімделіп, алғашқы сукцессиялық кезеңде жетекші орын алды. Кейінгі кезеңдерде планктондық қауымдастықтың құрылымы біртіндеп өзгеріп, экожүйедегі табиғи сукцессиялық процестердің жүруі байқалды.

Түйінді сөздер: зоопланктон, кірпікшелілер, биомасса, балық аулау тоған, сукцессия, аквамадениет, планктон динамикасы, экологиялық мониторинг.

**ПЛАНКТОННЫЕ ИНFUZОРИИ
МАЛЬКОВЫХ РЫБОВОДНЫХ
ПРУДОВ УЗБЕКИСТАНА**

И.М. Мирабдуллаев

Институт зоологии Академии наук Республики Узбекистан

**e-mail: imirabdullayev57@gmail.com*

Аннотация

В семи прудах для выращивания мальков двух рыбоводных хозяйств Ташкентской области было исследовано видовое разнообразие и динамика развития планктонных инфузорий. В результате исследований зарегистрировано пятьдесят восемь видов инфузорий, входящих в состав зоопланктонного сообщества данных водоёмов. Планктонные инфузории играют важную роль в функционировании водных экосистем, участвуют в процессах круговорота веществ и формировании естественной кормовой базы для молоди рыб.

Для большинства видов были харак-

терны относительно короткие периоды массового развития продолжительностью 3–7 дней. В отдельных случаях численность инфузорий изменялась несколько раз в течение суток, что свидетельствует о высокой динамичности планктонного сообщества. Резкие колебания численности, вероятно, были связаны с процессами эксцистирования и инцистирования, а также с изменениями экологических условий среды.

Установлено, что в первую неделю после заполнения прудов водой преимущественно развивались виды инфузорий, характерные для временных (эфемерных) водоёмов. В дальнейшем происходили изменения видового состава и структуры сообщества, отражающие процессы экологической сукцессии в рыбоводных прудах. Полученные данные свидетельствуют о возможности использования инфузорий в качестве биоиндикаторов экологического состояния прудовых экосистем.

Ключевые слова: зоопланктон, инфузории, биомасса, пруд для мальков, сукцессия, аквакультура.

Conflict of interest. The authors declare no conflict of interest.