

SOME ADAPTATIONS OF PRICKLEBACKS (FAM. STICHAEIDAE) TO REPRODUCTION IN PETER THE GREAT BAY (THE SEA OF JAPAN).

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Fishes of the family Stichaeidae are widely distributed in waters of the North Pacific. The Sea of Japan is home to up to 38 species of this family, of which 24 species have been recorded from Peter the Great Bay. Members of the family Stichaeidae inhabit mostly shallow waters, the intertidal and subtidal zones, but some species are found also on the continental slope. Larvae of pricklebacks are pelagic, show pronounced phototaxis and, thus, can concentrate near a light source, which allows catching them with the use of illumination equipment in the dark. These species can disperse quite widely through pelagic larvae despite the sedentary life of their adults. The duration of the pelagic stage can range from 2–3 weeks to several months, depending on the species and habitat conditions. As our study shows, this characteristic is quite variable in some species.

Our ichthyoplankton survey in Zhitkov Bay, Russky Island, in the period from March to December 2017–2020 with the use of fish-luring systems, light traps, surface hauls of a IKS-80 plankton net, and also diving operations in the period 2019–2020, made it possible to study the dynamics of the planktonic stage of development in 17 identified stichaeid fish species. The timing of spawning and hatching were determined for some of them.

It has been found that some pricklebacks in the waters of Peter the Great Bay, which is characterized by a wide variety of habitat conditions, show a spawning strategy and timing of early development that are not typical for them in other parts of the range, and can be conditionally divided into three groups: (1) species spawning in autumn, hatching in autumn–winter, and having a prolonged planktonic stage of development; (2) species spawning in autumn or winter, hatching in late winter and early spring, and having a planktonic stage from 1 to 3 months; (3) species spawning in spring, hatching from April to June, and having a planktonic stage lasting from 2 weeks to 1 month (Table).



Fig. 1. The typical representative of Stichaeidae fish in Peter the Great Bay - *Chirolophis japonicus*.
Фото А.В. Ратникова

Table. Specifics of spawning ecology and early development of Stichaeidae fish in Peter the Great Bay.

species/spawning ecology	spawning	hatching	the time of occurrence in plankton near Russky Island				the data for the north of Japanese Islands or from the Peter the Great Bay		
			2017	2018	2019'	2020'	spawning	hatching	in the plankton
<i>Ascoldia variegata</i>	fall - winter	March	March - April						
<i>Chirolophis japonicus</i>	fall	November - December	March - May	April - May	November - May	January - May	November - December	February - March	March - June
<i>Chirolophis saitone</i>	fall	October - November	March - May	April - May	October - May	October - May	November - December?	February - March?	March - May?
<i>Lumpenus sagitta</i>	fall - winter?	February - March	March - May	April - May	March - May	February - May	winter - spring?		March - June*
<i>Ernogrammus hexagrammus</i>	spring**	May***	June			May - June	spring	April - May	May - June
<i>Opisthocentrus tenuis</i>	fall?	March	March - May	April - May	March - May	March - April	December - January	February - March	March - April
<i>Opisthocentrus ocellatus</i>	fall	March	March - May	April - May	March - May	March - May	December - January	February - March	March - June
<i>Opisthocentrus zonope</i>	November - December?***	April?	April - May			May	October - December	February - March	March-April
<i>Stichaeus grigorjewi</i>	May	May - June	May - June	May - June	May - June	June	May	May - June	April-Jule*
<i>Stichaeus nozawae</i>	April - May	May		May - June	May - June	June	winter?	January? - March	January - March?, March - Jule*
<i>Stichaeus fuscus</i>	April - May	April - May				May - June			
<i>Pholidapus dybowskii</i>	fall	March - April***	April - May		May	May	winter?	April?	April - June, August*
<i>Alectrias benjamini</i>	April - May	May - June	May		May - June		winter?	March?	March - May
<i>Alectrias cirratus</i>	November	April	April - May	April - May	May	April - May	fall	April - May	
<i>Stichaeus ochriamkini</i>	fall - winter	April	April - June	April - May	May - June	April - May	September - October		
<i>Stichaeopsis epallax</i>	spring	May	May - June	May - June	May - June	May			March - Jule*
<i>Stichaeopsis nana</i>	spring **	May**	May				spring	April - May	May - June*

' - yearround observations from March 2018 to December 2020

* - the data for the Peter the Great Bay

** - the coincidence with published data on spawning

*** - the hatching match

**** - the coincidence in terms of plankton

the original data that differed from published are highlighted in color

The same species exposed to milder hydrological conditions, e.g., off southern Hokkaido Island or northern Honshu Island, where water temperatures in winter do not fall below 1–2°C, spawn typically at a later time (winter–spring) but at a similar temperature. Their larvae hatch earlier in winter and spring and more rapidly complete the planktonic stage of development at higher temperatures.

Typical representatives of group 1 in Peter the Great Bay are two species of the genus *Chirolophis* (Fig. 1). Species of the genera *Opistocentrus* and *Lumpenus*, and also the species *Alectrias cirratus* and *Stichaeus ohriamkini* (Fig. 2), can be attributed to group 2. Group 3 includes representatives of the genus *Stichaeus* (except *S. ohriamkini*), *Stihaeopsis*, *Ernogrammus* and also the *A. benjmini*.

Thus, due to the ecological plasticity (a shift in the spawning period, a change in the duration of incubation and the timing of the pelagic stage), species of this family not only can spawn under optimal temperature conditions (Fig. 3), but also either survive the adverse winter period at the stage of egg, or use for early stages of development favorable feeding conditions in the second half of the autumn. For some species that have small eggs and spawn in rapidly warming shallow water, it became more advantageous to use the period of sharp spring warming with the subsequent peak in abundance of forage plankton for breeding. Due to these factors, the time of incubation and, accordingly, the protection of offspring, as well as the time of the planktonic larvae stage, are significantly reduced.



Fig. 2. The typical representative of Stichaeidae fish in Peter the Great Bay - *Stichaeus ochriamkini*.
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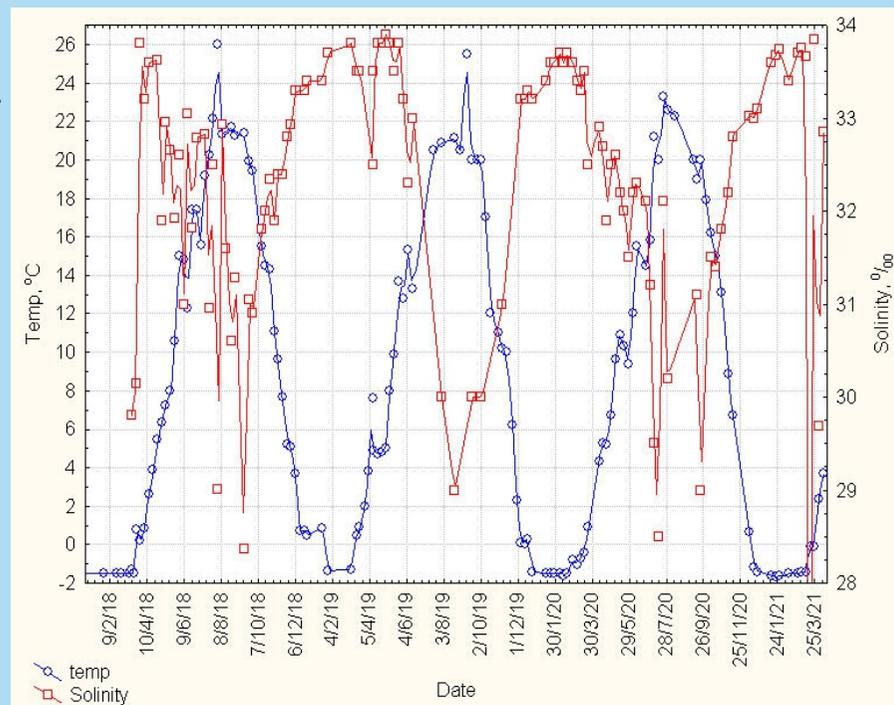


Fig. 3. Changes in water temperature and salinity indicators in Zhitzkov Bay, Russky Island, during period from December 2018 to March 2021.