Pharmaceutical and Clinical Journal of Nusantara (PCJN)
Volume 1, N0. 01 (2022), Page 21 - 31
https://nusantarascientificjournal.com/index.php/pcjn/article/view/3

Analysis of Embryo Development and Early Performance of Larvae of *Barbonymus schwanenfeldii*: A Systematic Review

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Abstract

Tengadak fish is a freshwater fish that can be found in rivers, lakes and canals and ditches. One of the important phases in fish development is the embryo. Embryo development (embryogenesis) is more in the process of formation and development of the embryo, not only the increase in the number and mass of embryonic blastomer cells but also the activity of blastomeric cells.The purpose of this study was to analyze the stages of embryonic development and early larval performance in Tengadak fish (*Barbonymus schwanenfeldii*). This study used systematic literature review using data from PubMed, NCBI, Google Scholar databases using keywords, namely, "embryo, performance, Tengadak fish (*Barbonymus schwanenfeldii*)". Approximately, 350 articles were obtained for the keywords "embryo, performance, Tengadak fish (*Barbonymus schwanenfeldii*)". All articles were selected based on inclusion criteria and exclusion and obtained as many as 27 articles that meet the inclusion criteria From the results of research conducted, it can be concluded that this research has sequentially described the embryonic development and early performance of the larvae of the *Barbonymus schwanenfeldii*. Need research on the other animal for future research.

Keywords: *Analysis, Embryo development, form of larvae, Tegadak fish*

Abstrak

Ikan Tengadak merupakan ikan air tawar yang dapat ditemukan di sungai, danau dan kanal serta parit. Salah satu fase penting dalam perkembangan ikan adalah embrio. Perkembangan embrio (embriogenesis) lebih pada proses pembentukan dan perkembangan embrio, tidak hanya peningkatan jumlah dan massa sel blastomer embrio tetapi juga aktivitas sel blastomer. perkembangan embrionik dan penampilan larva awal pada ikan Tengadak (Barbonymus schwanenfeldii). Penelitian ini menggunakan sistematik literature review dengan menggunakan data dari database PubMed, NCBI, Google Scholar dengan menggunakan kata kunci yaitu, "embrio, performance, ikan Tengadak (Barbonymus schwanenfeldii)". Didapatkan sekitar 350 artikel untuk kata kunci "embrio, performance, ikan Tengadak (Barbonymus schwanenfeldii)". Semua artikel diseleksi berdasarkan kriteria inklusi dan eksklusi dan diperoleh sebanyak 27 artikel yang memenuhi kriteria inklusi Dari hasil penelitian yang dilakukan, dapat disimpulkan bahwa penelitian ini secara berurutan menggambarkan perkembangan embrio dan performa awal larva larva Barbonymus schwanenfeldii. Perlu penelitian pada hewan lain untuk penelitian selanjutnya.

Kata kunci: Analisis, bentuk larva, ikan tengadak, perkembangan embrio

Received: *November 2022* ***Accepted:*** *November 2022*

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https://nusantarascientificjournal.com/index.php/pcjn/article/view/3

INTRODUCTION

Fish is one of the sources of animal protein that is very popular with the public in general. Currently, the demand for public consumption of fish is quite high, given the increasing public awareness of the importance of consuming fish [1]. This goes in reverse with fish stocks, especially cultivated products, so there is a need for development in terms of fish cultivation by utilizing the potential of local fish as aquaculture commodities [2].

As consumption fish, the existence of local fish in nature is threatened due to overfishing. Indonesian-specific local fish that are marketed today are generally caught from fresh waters, be it lakes or rivers [3]. Tegadak fish is one of the local fish that must be prioritized in the development of fish farming commodities in Indonesia. Bearing in mind that the stilt fish is a fish native to Indonesian waters which has economic value, its growth weight can reach 1 kg/head. Tegadak fish is a freshwater fish that can be found in rivers, lakes and canals and ditches. This fish is an omnivore whose main food is phytoplankton, zooplankton, aquatic invertebrates and detritus [4]

One of the important phases in fish development is the embryo. This information on embryonic development is a key step in improving the quality and survival of larvae [5]. Embryo development (embryogenesis) is part of the study of progressive changes in the structure and function of the body in living things, this is more in the process of formation and development of the embryo, not only the increase in the number and mass of embryonic blastomer cells but also the activity of blastomeric cells [6]. The purpose of this study was to analyze the stages of embryonic development and early larval performance in Tengadak fish (*Barbonymus schwanenfeldii*).

METHODOLOGY

A literature search was carried out systematically through the PubMed, NCBI, Google Scholar databases using keywords, namely "embryo, performance, Tengadak fish (*Barbonymus schwanenfeldii*)". Based on these keywords, the articles obtained were first selected by setting several inclusion criteria including journals are not paid / free articles, research results focus on "embryo, performance, Tengadak fish (*Barbonymus schwanenfeldii*)" [7]. Articles that do not meet the inclusion criteria are eliminated and articles that meet the criteria will be analyzed to obtain data.

Pharmaceutical and Clinical Journal of Nusantara (PCJN)
Volume 1, N0. 01 (2022), Page 21 - 31
https://nusantarascientificjournal.com/index.php/pcjn/article/view/3

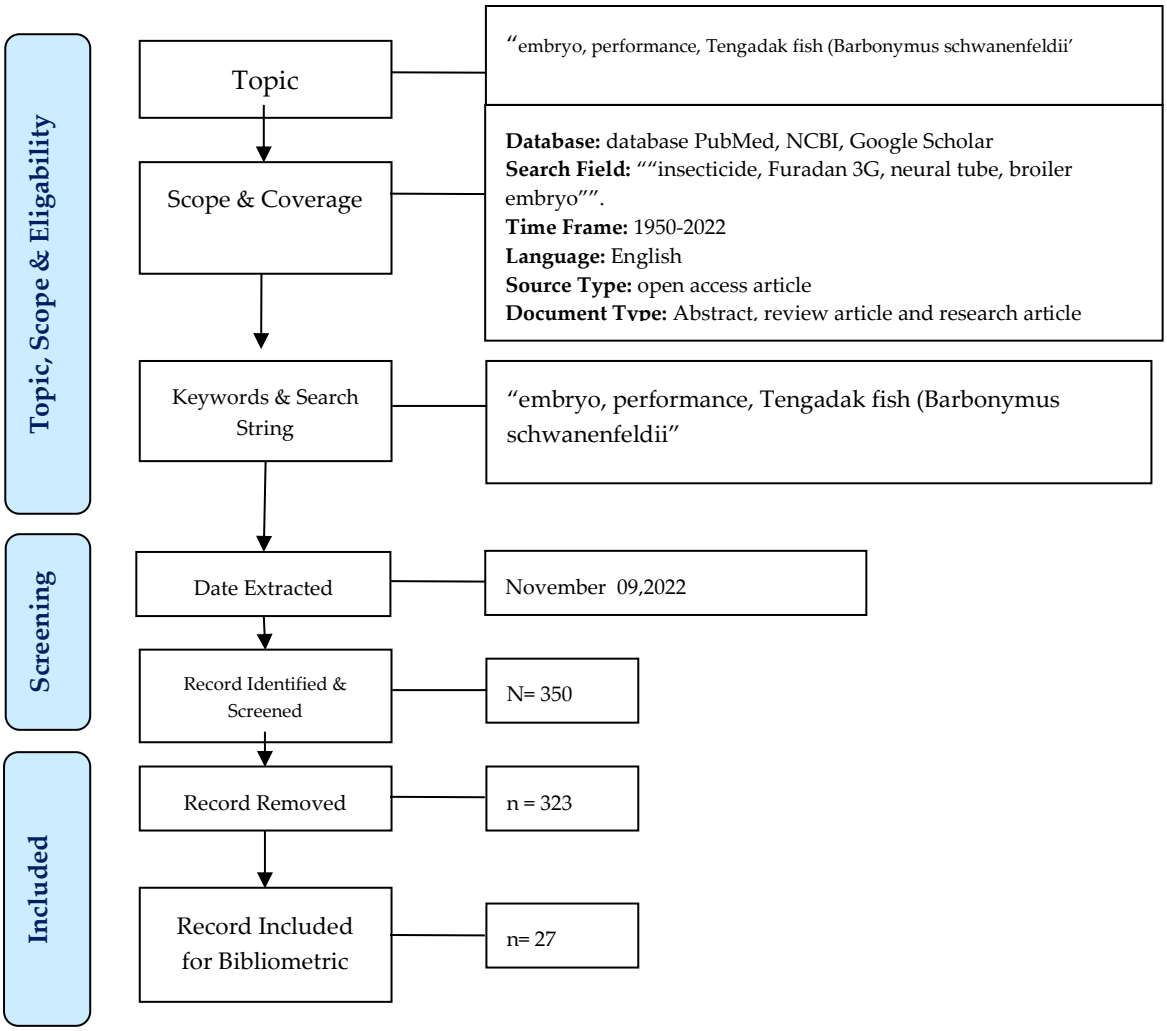


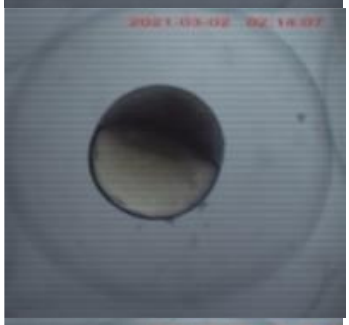
Figure 1. Flow diagram of the search strategy

RESULT AND DISCUSSION

Based on the search results in the PubMed, NCBI, Google Scholar databases using predetermined keywords, 350 articles were obtained for the keywords embryo, performance, Tengadak fish (*Barbonymus schwanenfeldii*). All articles were re-selected based on inclusion criteria and exclusion and obtained as many as 27 articles that meet the inclusion criteria.

Pharmaceutical and Clinical Journal of Nusantara (PCJN)
Volume 1, N0. 01 (2022), Page 21 - 31
https://nusantarascientificjournal.com/index.php/pcjn/article/view/3

Table 1. Embryo development of the scorpion fish (*Barbonymus schwanenfeldii*)

Development Phase	Minute-	Embryo Development	Description
Division	10		Within the cell, a small space is formed called the segmentation cavity.
	30		Oil droplets have accumulated at the vegetal pole
Morula	50		There is division to produce cells with double the number until many cells are formed. Phase 2 cell division-34 cells
Blastula	80		The formation of a group arrangement that looks denser than the yolk. Final division phase 64 cells
	100		An empty cavity or layer of the area will form the main organ

Gastrula	120		The final blastula phase occurs when the yolk is invaded and enters the gastrula phase producing a germinal ring.
	150		The blastoderm covers almost the entire yolk sac and the germination ring is thicker. Move 50% Epiboly
	240		The cell begins to close the yolk completely. movement 90% Epiboly
Segmentasi	300		The final phase of the gastrula begins to form a tail bud
	360		The head and tail can be distinguished and 6 somites are formed

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https://nusantarascientificjournal.com/index.php/pcjn/article/view/3

	420		The eyes are getting rounder, and the heart and blood vessels have not yet formed. Formed 10 Somites
	480		The eyes are getting rounder, the body size is getting bigger. Formed 20 Somites
Hatching	640		The embryo hatches and a transparent segmented larva appears.

Table 2. Initial performance of the scorpion fish larvae (*Barbonymus schwanenfeldii*)

Parameter	Measurement Data
Egg yolk diameter	39.42 ± 4.41 µm
Initial length of larva	18.46 ± 1.32 µm
Abnormality	5.71 ± 2.5 %

Embryogenesis is the whole process that includes the process of developing fish eggs after fertilization (fertilization) to organogenesis before the fish eggs hatch (Raharjo et al. 2011). The development and embryogenesis of squirrel fish in general can go through several phases, including: single cell, blastomere, blastula, gastrula, neurula, and organogenesis. The development of the fish embryos begins with the rapid division of the zygote into small cell units that divide into 2 cells, 4 cells, 8 cells, 16 cells, until the final morula phase [8].

The cleavage phase occurs every 10 minutes. The results of observations in the cleavage phase of the catfish embryo occurred during 30 minutes after egg fertilization, this result was

faster when compared to other freshwater fish. In the cleavage phase, the embryo of Torfish species lasts for 10 hours. Furthermore, the process of embryo development in Oryzias woworae species occurs for 1 hour 20 minutes [9]. While the results of observations on the cleavage phase of the embryo in Tawes fish lasted for 2 hours 24 minutes after fertilization (Naskuroh et al. 2018). Each type of fish in the embryonic development phase is very dependent on environmental conditions, especially water temperature [10].

According to Wahyuningtias et al. (2015) at a good environmental temperature embryonic development, egg hatching, and early survival of fish larvae can take place normally. At high temperatures it will accelerate metabolism, so that embryonic development will be faster, and can inhibit the hatching process or cause death in larvae [11]. A good temperature for hatchery of freshwater fish ranges from 25-31 C

Furthermore, the fish eggs enter the morula phase. The morula phase is the end of the cleavage phase which will then be followed by the stage of embryo organ formation (Budianita et al. 2019). In this phase, a group arrangement that is denser than the yolk sac begins to form (Gusrina 2014). The morula phase ends when it has produced a blastomere. The blastomeres then condense into small blastodic cells forming two layers of cells and at the end of the division two groups will be produced [12].

After going through the morula phase, the egg develops into the blastula phase. The blastula phase begins with more and more blastomeric cells in the fluid-filled cavity as blastocoels. The blastula phase occurs between 80 and 100 minutes after fertilization [13]. During the blastula stage, the blastomere divides several times to form blastomeres of smaller size. At the end of the blastula phase, the blastoderm cells consist of neural, epidermal, notochordal, mesodermal, and endodermal [14].

The gastrula stage in fish begins with the movement of the epiboly which reaches 50% of the viteline vesicle. The blastoderm covers most of the yolk sac and the thicker posterior germ ring is called the embryonic shield [15]. In this phase, the curves of the body become more noticeable and visible, occurring in the 120-150 minute period after conception . Epiboly movement reaching 90% occurs at 240 minutes after fertilization and the last phase of the gastrula is marked by the appearance of a tail bud (Ath-Thar 2014). In this phase, the head will protrude at the animal pole and the tail will appear at the vegetal pole [16].

After the gastrula phase, the segmentation phase begins with the formation of the head, tail, and the appearance of 6 somites (body segments) (Budianita et al. 2019). This phase occurs at 300 minutes after fertilization. This segmentation process

lasts longer when compared to other phases. According to Nurjanah (2014) in the segmentation process successively will form organs including nerves, notochord, eyes, bone segments (somites), Kuffer cavity, olfactory sac, kidney cavity, intestines, subnotchord bone, lateral line, heart, aorta, gills, infundibulum, and fin folds.

In the next phase, it is marked by the eyes getting rounder, the body size getting bigger, and the formation of 10-20 somites occurring in 360-420 minutes (Ath-Thar 2014). At 480 minutes, the embryo resembles a larva with the eyes getting thicker and black pigment dots appear on the edges of the eyes (Budianita et al. 2019). In the segmentation phase, there is a differentiation process in the embryo, body organs such as eyes, head, tail, segments, heart, body, egg yolk, crystalline, and melanophores will be more clearly visible. In addition, this phase shows the movement of the embryo. The movement of the embryo is caused by the increasing length of the tail and starting to separate from the yolk sac and the heart has begun to be active [17].

The hatching time of fish eggs in each fish species will vary (Budianita et al. 2019). The results of the research by Cahyanti et al. (2020) stated that the Tor douronensis species hatched at 100 hours after fertilization. Meanwhile, the Tor soro species hatched 120 hours after fertilization and the Tor tambroides species hatched 140 hours after fertilization. According to Poto (2019), hatching can occur due to mechanical work, namely the embryo often changes its position due to lack of space in its shell or because the embryo is longer than its shell environment and enzymatic work, namely enzymes and other chemical elements released by the endodermal glands in the pharyngeal area of the embryo. In addition, hatching can also be caused by movements due to an increase in temperature, light intensity or absorption of oxygen pressure (Huwoyon et al. 2010).

Agatha et al. (2021) stated that fertilized eggs will develop and hatch normally if supported by good environmental conditions, including sufficient oxygen, appropriate temperature and clean water free of microorganisms. Embryos have a temperature tolerance limit in the process of development (Yuliani et al. 2020). In general, mackerel fish can live well at a temperature of 28-30 oC (Kusmini et al. 2018). This is in line with the research results of Prakoso et al. (2010) stated that the water temperature is quite low, namely 20-24°C, the growth of albino and black-tailed mackerel fish becomes slower.

After the complete embryonic development phase, the eggs will hatch into larvae. The development of fish larval organs has a main and specific character of larval development. The larvae develop to resemble adults (juveniles). In the early stages of larval development the eyespots are visible but not functioning, the mouth has not

opened, the digestive tract is in the form of a short alimentary canal, and the fins are new in the form of a caudal fin and a newly fused anal fin and a preanal fin on the abdomen in front of the anus [18]. Larvae rely on egg yolks as an energy source (endogenous energy). Larvae that carry food reserves for the development of body organs are called endogenous feeding [19].

The critical phase in the development of the squid embryo occurs in the pre-hatching phase and the hatching phase into larvae. According to Herjayanto et al. (2017) fertilized eggs can fail to hatch due to abnormal sperm cells and environmental factors that are not suitable for embryo development such as unsuitable temperature. Abnormalities that occur in each species of fish larvae cause the organs of the fish body to not develop properly [20].

During the larval observation period, it was found that there were abnormalities in the larvae of the cockroach fish. The results of the observation of the abnormality of the mackerel larvae with an incubation temperature of 28 oC showed an abnormality value of 16%. The results of Lestari's research (2016) on hormonal induction to improve the reproductive performance of squirrel fishshowed an abnormality value of 7.79-9.49%. Abnormalities in fish larvae occur due to a deviation process during embryogenesis or defective larvae after hatching . This statement is reinforced by Effendi (2004) which states that weak embryos that hatch successfully have the opportunity to become abnormal larvae. Defective fish larvae can be caused by the outermost layer of the egg (chorion) which has hardened so that the embryo will be difficult to come out. After the chorion can be broken, the embryo will come out in a deformed body state.

CONCLUSION

Based on the search results in the PubMed, NCBI, Google Scholar databases using predetermined keywords, 350 articles were obtained and 27 articles met the inclusion criteria. From the results of research conducted, it can be concluded that this research has sequentially described the embryonic development and early performance of the larvae of the *Barbonymus schwanenfeldii*. Need research on the other animal for future research.

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