OSTEOLOGI IKAN KEURELING (*Tor tambroides*)

Ilham Zulfahmi, S.Kel, M.Si | Drh. Yusrizal Akmal, M.Si | Muliari, S.Kel, M.Si

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Indonesia merupakan negara dengan keanekaragaman ikan yang tinggi, salah satunya ikan yang berasal dari genus *Tor*. Terdapat 40 spesies ikan *Tor* di Asia, empat spesies diantaranya hidup di Indonesia yaitu *Tor tambroides*, *Tor douronensis*, *Tor tambra*, dan *Tor soro*. Saat ini kajian terhadap ikan dari genus ini masih terbatas pada bidang ekologi dan upaya domestikasi. Upaya untuk mengkaji lebih jauh terkait morfologi lebih khususnya osteologi ikan keureling masih belum banyak dilakukan.

Kajian morfologi skeleton ikan merupakan bagian penting dalam memahami sistematika ikan, diantaranya untuk mempelajari hubungan taksonomi dan filogenetik antar species ikan. Disamping itu, pengetahuan berkenaan dengan deskripsi morfologi skeleton suatu species ikan sangat dibutuhkan sebagai langkah preventif dalam menganalisis abnormalitas sistem skeleton.

Buku ini mengulas tentang klasifikasi dan ekologi ikan keureling, metode pembuatan preparat tulang ikan keureling, sistem osteologi ikan, morfologi tulang kepala ikan keureling, morfologi tulang belakang ikan keureling, dan morfologi tulang anggota gerak ikan keureling. Disamping itu, buku ini diharapkan dapat menghadirkan konsistensi dalam hal penyajian nomenklatur tulang penyusun rangka, mengidentifikasi perbedaan osteologi antar species ikan, dan memahami hubungan taksonomik dan filogenetik antarspecies ikan.

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PRAKATA

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OSTEOLOGI IKAN KEURELING (*Tor tambroides*)

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Banda Aceh, Februari 2019

Penulis

KATA PENGANTAR

EDITOR

Upaya penulis untuk menyusun buku dengan judul “Osteologi Ikan Keureuling (*Tor tambroides*)” merupakan suatu langkah yang sangat baik, terutama dalam memahami morfologi ikan keureuling. Kajian morfologi skeleton ikan keureuling ini merupakan gabungan antara studi literatur dan penelitian langsung terhadap osteologi ikan keureuling yang meliputi klasifikasi dan ekologi ikan keureling, metode pembuatan preparat tulang ikan keureling, sistem osteologi ikan, morfologi tulang kepala ikan keureling, morfologi tulang belakang ikan keureling, dan morfologi tulang anggota gerak ikan keureling.

Pemahaman terhadap osteologi ikan keureuling membuka peluang untuk melakukan kajian lebih lanjut terhadap morfologi secara keseluruhan yang mencakup sistem otot dan sistem organ lainnya.

Semoga buku ini memberikan manfaat yang sebesar-besarnya bagi para pembaca.

Bogor, 15 Februari 2019

Editor,

Dr. Drh. Heru Setijanto, PAVet (K)

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DAFTAR PUSTAKA

- Adriaens D, Aerts P, Verraes W. 2001. Ontogenetic shift in mouth opening mechanisms in a catfish (Clariidae, Siluriformes): a response to increasing functional demands. *Journal of Morphology*, 247(3): 197–216.
- Aerts P. 1991. Hyoid morphology and movements relative to abducting forces during feeding in *Astatotilapia elegans* (Teleostei, Cichlidae). *Journal of Morphology*, 208(3): 323–345.
- Aguilar-Medrano R, Frederich B, Balart EF, de Luna E. 2013. Diversification of the pectoral fin shape in damselfishes (Perciformes, Pomacentridae) of the Eastern Pacific. *Zoomorphology*, 132(2): 197–213.
- Aiello BR, Hardy AR, Cherian C, Olsen AM, Ahn SE, Hale ME, Westneat MW. 2018. The relationship between pectoral fin ray stiffness and swimming behavior in Labridae: insights into design, performance and ecology. *Journal of Experimental Biology*, 22(1): 1–10.
- Akmal Y, Zulfahmi I, Saifuddin F. 2018. Karakteristik Morfometrik dan Skeleton Ikan Keureling (*Tor tambroides* Bleeker 1854). *Jurnal Ilmiah Samudra Akuatika*, 2(1): 35–44.
- Al-Janabi MIG. 2017. A Comparison between *Tilapia zilli* (Gervais, 1748) (Perciformes: Cichlidae) and Common Carp *Cyprinus carpio* (Linnaeus, 1758) (Cypriniformes: Cyprinidae) by Staining Bone Technique. *International Journal of Current Microbiology and Applied Sciences*, 6(6): 459–467.
- Anderson PS, Westneat MW. 2007. Feeding mechanics and bite force modelling of the skull of *Dunkleosteus terrelli*, an ancient apex predator. *Biology Letters*, 3(1): 77–80.
- Antonucci F, Boglione C, Cerasari V, Caccia E, Costa C. 2011. External shape analyses in *Atherina boyeri* (Risso, 1810) from different environments. *Italian Journal of Zoology*, 79(1): 60–68.

- Aspinall V, Cappello M. 2015. Introduction to Veterinary Anatomy and Physiology. Elsevier Health Sciences. 252 pp.
- Azhar, Dahelmi, Zakaria IJ, Sukendi. 2013. The Study of Garing Fish Physical Habitat (*Tor tambra* C.V.: Cyprinidae) in Anai River West Sumatera. *International Journal of Science and Research*, 4(3): 116–122.
- Bird NC, Hernandez LP. 2007. Morphological variation in the weberian apparatus of Cypriniformes. *Journal of Morphology*, 268(9): 739–757.
- Bogutskaya NG, Naseka AM, Golovanova IV. 2008. Descriptive osteology of *Gymnocorymbus ternetzi* (Teleostei: Characiformes: Characidae). *Zoosystematica Rossica*, 17(2): 111–128.
- Britz R, Conway KW. 2009. Osteology of Paedocypris, a miniature and highly developmentally Truncated Fish (Teleostei: Ostariophysi: Cyprinidae). *Journal of Morphology*, 270(4): 389–412.
- Cahu CL, Zambonito IJL, Takeuchi T. 2003. Nutritional components affecting skeletal development in fish larvae. *Aquaculture*, 227(1–4): 254–258.
- Cardeira J, Valles R, Dionisio G, Estevez A, Gisbert E, Pousao-Ferreira P, Cancela ML, Gavaia PJ. 2012. Osteology of the axial and appendicular skeletons of the meagre *Argyrosomus regius* (Sciaenidae) and early skeletal development at two rearing facilities. *Journal of Applied Ichthyology*, 28(12): 464–470.
- Carnevale G, Sorbini C, Landini W. 2003. *Oreochromis lorenzoi*, a new species of tilapiine cichlid from the late Miocene of central Italy. *Journal of Vertebrate Paleontology*, 23(3): 508–516.
- Carroll AM, Wainwright PC, Huskey SH, Collar DC, Turingan RG. 2004. Morphology predicts suction feeding performance in centrarchid fishes. *Journal of Experimental Biology*, 207(22): 3873–3881.
- Conway KW, Kubicek KM, Britz R. 2017. Morphological novelty and modest developmental truncation in Barboides, Africa's smallest vertebrates (Teleostei: Cyprinidae). *Journal of Morphology*, 278(6): 750–764.
- Cooper WJ, Westneat MW. 2009. Form and function of damselfish skulls: rapid and repeated evolution into a limited number of trophic niches. *BMC Evolutionary Biology*, 9(24): 1–17.

- Dawnay N, Ogden R, McEwing R, Carvalho GR, Thorpe RS. 2007. Validation of the carcoding gene COI for use in forensic genetic species identification. *Forensic Science International*, 173(1): 1–6.
- De Iuliis G, Pulerà D. 2011. *The dissection of vertebrates, Second Edition A Laboratory Manual*. Academic Press. 79–82 pp.
- Deschamps MH, Sire JY. 2010. Histomorphometrical studies of vertebral bone condition in farmed rainbow trout, *Oncorhynchus mykiss*. *Journal of Applied Ichthyology*, 26(2): 377–380.
- Dierickx K, Wouters, W, Van Neer W .2017. Comparative osteological study of three species of distinct genera of *Haplotilapiini* (Cichlidae). *Cybiurn*, 41(3): 223–235.
- Diogo R, Bills R. 2006. Osteology and myology of the cephalic region and pectoral girdle of the South African cat fish *Austroglanis gilli*, with comments on the autapomorphies and phylogenetic relationships of the *Austroglanididae* (Teleostei: Siluriformes). *Animal Biology*, 56(1): 39–62.
- Diogo R, Oliveira C, Chardon M. 2000. On the anatomy and function of the cephalic structures in *Phractura* (Siluriformes: Amphiliidae), with comments on some striking homoplasies occurring between the Doumeinae and some loricaroid catfishes. *Belgian Journal of Zoology*, 130(2): 117–130.
- Diogo R. 2008. The Origin of Higher Clades, Osteology, Myology, Phylogeny and Evolution of Bony Fishes and the Rise of Tetrapods. Science Publishers. USA. 396 pp.
- Drucker EG, Jensen JS. 1991. Functional analysis of a specialized prey processing behavior: winnowing by surfperches (Teleostei: Embiotocidae). *Journal of Morphology*. 210: 267–287.
- Drucker EG, Lauder GV. 2000. A hydrodynamic analysis of fish swimming speed: wake structure and locomotor force in slow and fast labriform swimmers. *Journal of Experimental Biology*, 203(1): 2379–2393.
- Drucker EG, Lauder GV. 2001. Locomotor function of the dorsal fin in teleost fishes: experimental analysis of wake forces in sunfish. *Journal of Experimental Biology*, 204(17): 2943–2958.

- Eagderi S, Adriaens D. 2010. Head morphology of the duckbill eel, *Hoplunnis punctata* (Regan, 1915; Nettastomatidae: Anguilliformes) in relation to jaw elongation. *Zoology*, 113(3): 148–157.
- Eagderi S, Adriaens D. 2014. Cephalic morphology of *Ariosoma gilberti* (Bathymyrinae: Congridae). *Iranian Journal of Ichthyology* 1(1): 39–50.
- Enghoff IB. 1991. Mesolithic eel-fishing at Bjornsholm, Denmark, spiced with exotic species. *Journal of Danish Archaeology*, 10(1): 105–118.
- Ferry-Graham LA, Lauder GV. 2001. Aquatic prey capture in ray-finned fishes: a century of progress and new directions. *Journal of Morphology*, 248 (2): 99–119.
- Flammang BE, Lauder GV. 2013. Pectoral fins aid in navigation of a complex environment by bluegill sunfish under sensory deprivation conditions. *The Journal of Experimental Biology*, 216: 3084–3089.
- Flammang BE, Lauder GV. 2016. Functional morphology and hydrodynamics of backward swimming in bluegill sunfish, *Lepomis macrochirus*. *Zoology*, 119(5): 414–420.
- Fugi R, Agostinho AA, Hahn NS 2001. Trophic morphology of five benthic-feeding fish species of a tropical floodplain. *Revista brasileira de biologia*, 61(1): 27–33.
- Gidmark NJ, Staab KL, Brainerd EL, Hernandez LP. 2012. Flexibility in starting posture drives flexibility in kinematic behavior of the kinethmoid-mediated premaxillary protrusion mechanism in a cyprinid fish, *Cyprinus carpio*. *Journal of Experimental Biology*, 215(13): 2262–2272.
- Hardjamulia AN, Suhendra, Wahyudi E. 1995. Perkembangan Oosit Dan Ovari Ikan Semah (*Tor douronensis*) Di Sungai Selabung, Danau Ranau, Sumatera Selatan. *Jurnal Penelitian Perikanan Indonesia*, 1(3): 36–46.
- Haryono, Subagja J. 2008. Populasi dan habitat ikan tambra, *Tor tambroides* (Bleeker, 1854) di perairan kawasan Pegunungan Muller Kalimantan Tengah. *Biodiversitas*, 9(4): 306–309.
- Haryono. 2006. Aspek biologi ikan tambra (*Tor tambroides*) yang eksotik dan langka sebagai dasar domestikasi. *Biodiversitas*, 7: 195–198.

- Herbing IHV, Miyake T, Hall BK, Boutilier RG. 1996. Ontogeny of feeding and respiration in larval Atlantic cod *Gadus morhua* (Teleostei, Gadiformes): I. Morphology. *Journal of morphology*, 227(1): 15–35.
- Hernandez LP, Bird NC, Staab KL. 2007. Using zebrafish to investigate cypriniform evolutionary novelties: functional development and evolutionary diversification of the kinethmoid. *Journal of Experimental Zoology*. 308B: 625–641.
- Hilton EJ, Kley NJ. 2005. Osteology of the Quillfish, *Ptilichthys goodei* (Perciformes: Zoarcoidei: Ptilichthyidae). *Copeia*, 2005(3): 571–585.
- Hilton EJ, Stevenson DE. 2013. Osteology of the Prowfish, *Zaprora silenus* (Cottiformes: Zoarcoidei: Zaproridae). *Journal of Morphology*, 274(10): 1143–1163.
- Hilton EJ. 2002. Comparative osteology and phylogenetic systematics of fossil and living bony-tongue fishes (Actinopterygii, Teleostei, Osteoglossomorpha). *Zoological Journal of the Linnean Society*, 137(1): 1–100.
- Hilton EJ. 2011. *The Skeleton Bony Fish Skeleton*. Elsevier Inc. All rights reserved, Virginia Institute of Marine Science, Gloucester Point, VA, USA. 434–436 pp.
- Hossain MY, Ohtomi J, Ahmed ZF. 2009. Morphometric, Meristic Characteristics and Conservation of the Threatened Fish, *Puntius sarana* (Hamilton, 1822) (Cyprinidae) in the Ganges River, Northwestern Bangladesh. *Turkish Journal of Fisheries and Aquatic Sciences*, 9: 223–225.
- Howes GJ. 1982. Anatomy and evolution of the jaws in the semiplotine carps with a review of the genus Cyprinion Heckel, 1843 (Teleostei: Cyprinidae). *Bulletin of the British Museum (Natural History)*, *Zoology*, 42(4): 299–335.
- IUCN. 1990. *IUCN red list of threatened animal*. IUCN, Gland and Cambrige.
- Jalili P, Eagderi S, Nasri M, Mousavi-Sabet H. 2015a. Descriptive osteology study of *Alburnus amirkabiri* (Cypriniformes: Cyprinidae), a newly described species from namak lake basin, central of Iran. *Bulletin of the Iraq Natural History Museum*, 13(4): 51–62.

- Jalili P, Eagderi S, Nikmehr N, Keivany Y. 2015b. Descriptive osteology of *Barbus cyri* (Teleostei: Cyprinidae) from southern Caspian Sea basin. *Iranian Journal of Ichthyology*, 2(2): 105–112.
- Kammerer CF, Grande L, Westneat MW. 2006. Comparative and developmental functional morphology of the jaws of living and fossil gars (Actinopterygii: Lepisosteidae). *Journal of morphology*, 267(9): 1017–1031.
- Katwate U, Paingankar MS, Jadhav S, Dahanukar N. 2013. Phylogenetic position and osteology of *Pethia setnai* (Chhapgar & Sane, 1992), an endemic barb (Teleostei: Cyprinidae) of the Western Ghats, India, with notes on its distribution and threats. *Journal of Threatened Taxa*, 5(17): 5214–5227.
- Keivany Y. 2014. Comparative osteology of the suspensorial and opercular series in representatives of the eurypterygian fishes. *Iranian Journal of Ichthyology*, 1(2): 73–89.
- Khayra A, Muchlisin ZA, Sarong MA. 2016. Morfometrik lima species ikan yang dominan tertangkap di Danau Aneuk Laot, Kota Sabang. *Depik*, 5 (2): 57–66.
- Klingenberg CP, Barluenga M, Meyer A. 2003. Body shape variation in cichlid fishes of the *Amphilophus citrinellus* species complex. *Biological Journal of the Linnean Society*, 80(3): 397–408.
- Konow N, Sanford CP. 2008. Biomechanics of a convergently derived prey-processing mechanism in fishes: evidence from comparative tongue bite apparatus morphology and raking kinematics. *Journal of Experimental Biology*, 211(21): 3378–3391.
- Kottelat M, Whitten AJ, Kartikasari SN, Wirjoatmodjo S. 1993. *Freshwater Fishes of Western Indonesia and Sulawesi*. Periplus, Singapore.
- Koumoundouros G, Divanach P, Kentouri M. 2000. Development of the skull in *Dentex dentex* (Osteichthyes: Sparidae). *Marine Biology*, 136(1): 175–184.
- Lall SP, Lewis-McCrea LM. 2007. Role of nutrients in skeletal metabolism and pathology in fish: an overview. *Aquaculture*, 267(1): 3–19.

- Lauder G V. 2000. Function of the caudal fin during locomotion in fishes: kinematics, flow visualization, and evolutionary patterns. *Integrative and Comparative Biology*, 40(1):101–122.
- Lauder GV, Madden PGA. 2007. Fish locomotion: kinematics and hydrodynamics of flexible foil-like fins. *Experiments in Fluids*, 43(5): 641–653.
- Lauder, GV, Madden PG, Mittal R, Dong H, Bozkurttas M. 2006. Locomotion with flexible propulsors: I. Experimental analysis of pectoral fin swimming in sunfish. *Bioinspiration & Biomimetics*, 1(4): S25–S34.
- Leprevost A, Sire JY. 2014. Architecture, mineralization and development of the axial skeleton in Acipenseriformes, and occurrences of axial anomalies in rearing conditions; can current knowledge in teleost fish help?. *Journal of Applied Ichthyology*, 30(4): 767–776.
- Liem K, Bemis W, Walker WF, Grande L. 2001. Chapter 8: The postcranial skeleton: The axial skeleton. In: Lewis T (ed). *Functional Anatomy of the Vertebrates: An Evolutionary Perspective*. Emily Barrosse. Orlando. 269–293 pp.
- Löffler J, Ott A, Ahnelt H, Keckeis H. 2008. Early development of the skull of *Sander lucioperca* (L.) (Teleostei: Percidae) relating to growth and mortality. *Journal of Fish Biology*, 72(1): 233–258.
- Löw P, Molnár K, Kriska G. 2016. *Atlas of Animal Anatomy and Histology*. Springer, 413 pp.
- Mafakheri P, Eagderi S, Farahmand H, Mousavi-Sabet H. 2014. Osteological structure of *Kiabi loach*, *Oxyzomacheilus kiabii* (Actinopterygii: Nemacheilidae). *Iranian Journal of Ichthyology*, 1(3): 197–205.
- Mattox GMT, Britz B, Piza MT. 2016. Osteology of *Priocharax* and remarkable developmental truncation in a miniature Amazonian Fish (Teleostei: Characiformes: Characidae). *Journal of Morphology*, 277(1): 65–85.
- Muchlisin ZA, Batubara AS, Siti-azizah MN, Adlim M, Hendri A, NurFadli, Muhammadar AA, Sugianto S. 2015. Feeding habit and length weight relationship of keureling fish, *Tor tambra* Valenciennes, 1842 (Cyprinidae) from the western region of Aceh Province, Indonesia. *Biodiversitas*, 16(1): 89–94.

- Murray AM. 2004. Osteology and morphology of the characiform fish *Alestes stuhlmannii* (Alestidae) from the Rufiji River basin, East Africa. *Journal of fish biology*, 65(5): 1412–1430.
- Nasri M, Eagderi S, Farahmand H. 2016. Descriptive and comparative osteology of Bighead Lotak, *Cyprinion milesi* (Cyprinidae: Cypriniformes) from southeastern Iran. *vertebrate-zoology*, 66(3): 251–260.
- Nasri M, Keivany Y, Dorafshan S. 2013. Comparative osteology of lotaks, *Cyprinion kais* and *C. macrostomum* (Cypriniformes, Cyprinidae), from Godarkhosh River, western Iran. *Journal of Ichthyology*, 53(6): 455–463.
- Ng HH, Rachmatika I. 2005. *Glyptothorax exodon*, A New Species of Rheophilic Catfish from Borneo (Teleostei: Sisoridae). *The Raffles Bulletin of Zoology*, 53(2): 251–255.
- Nikmehr N, Eagderi S, Jalili P. 2016. Osteological description of *Barbus lacerta* Heckel, 1843 (Cyprinidae) from Tigris basin of Iran. *Journal of Entomology and Zoology Studies*, 4(4): 473–477.
- Ogale SN. 2002. Mahseer breeding and conservation and possibilities of commercial culture, the Indian experience. In: Petr T, Swar SB (eds.). Cold Water Fisheries in the trans-Himalayan Countries. FAO Fisheries Technical Paper. Rome.
- Ogino Y, Katoh H, Yamada G. 2004. Androgen dependent development of a modified anal fin, gonopodium, as a model to understand the mechanism of secondary sexual character expression in vertebrates. *Federation of European Biochemical Societies Letters*, 574: 119–126.
- Ostrander GK, Hopkins J. 2000. The laboratory fish. San Diego: Academic press. 79–91 pp.
- Payne SL, Holliday CM, Vickaryous MK. 2011. An osteological and histological investigation of cranial joints in geckos. The Anatomical Record: *Advances in Integrative Anatomy and Evolutionary Biology*, 294(3): 399–405.
- Pohlmann K, Atema J, Breithaupt T. 2004. The importance of the lateral line in nocturnal predation of piscivorous catfish. *Journal of Experimental Biology*, 207:2971–2978.

- Rachmatika I. 1987. Ekologi ikan kekhel, *Glyptothorax platipogon* (BLGR) di Sungai Cisadane. *Zoo Indonesia*, 7: 1–6.
- Rahardjo MF. 1985. Iktiologi Sebagai Pedoman Kerja Praktikum. IPB, Bogor.
- Rojo AL. 1991. Dictionary of Evolutionary Fish Osteology. Boca Raton, Florida. CRC Press. 273 pp.
- Rupawan AK, Gaffar, Husnah. 1999. Beberapa Sifat Biologi dan Ekologi Ikan Samah (*Tor douronensis*) di Danau Kerinci dan Sungai Merangin, Jambi. *Jurnal Penelitian Perikanan Indonesia*, 5(4): 1–5.
- Saanin H. 1984. *Taksonomi dan Kunci Identifikasi Ikan*. Bina Cipta. Jakarta. 520 hal.
- Saka, Ş, Çoban D, Kamacı HO, Süzer C, Fırat K. 2008. Early development of cephalic skeleton in hatchery-reared gilthead seabream, *Sparus aurata*. *Turkish Journal of Fisheries and Aquatic Sciences*, 8(2): 341–345.
- Sanger TJ, Mc Cune AR. 2002. Comparative osteology of the *Danio* (Cyprinidae: Ostariophysi) axial skeleton with comments on *Danio* relationships based on molecules and morphology. *Zoological Journal of the Linnean Society*, 135(4): 529–546.
- Sarkar SK, De SK. 2011. Functional morphoanatomy of olfactory sensory epithelial cells of *Pseudapocryptes lanceolatus* (Bloch and Schneider). *International Journal of Science and Nature*, 2(2): 1–6.
- Schindler I, Schmidt J. 2006. Review of the mouthbrooding Betta (Teleostei, Osphronemidae) from Thailand, with descriptions of two new species. *Zeitschrift für Fischkunde*, (8): 47–69.
- Schmitz L, Wainwright PC. 2011. Ecomorphology of the eyes and skull in zooplanktivorous labrid fishes. *Coral Reefs*, 30(2): 415–428.
- Schnell NK, Hilton EJ. 2014. Osteology and ontogeny of the Wrymouths, Genus *Cryptacanthodes* (Cottiformes: Zoarcoidei: Cryptacanthodidae). *Journal of Morphology*, 276(6): 185–208.

- Singh AK. 2007. Biological and reproductive diversity in revere as well ss lacustrine golden mahser, *Tor putitora* (Hamilton 1822) in central Malayas, India. In: Siraj SS, Christianus A, Kiat NC, De Silva SS. (eds.). Mahser, the biology, culture and conservation. Proceeding of the International Symposium on the Mahseer. Malaysian Fisheries Society. Kuala Lumpur, Malaysia.
- Skonberg DI, Yogev L, Hardy RW, Dong FM. 1997. Metabolic response to dietary phosphorus intake in rainbow trout (*Oncorhynchus mykiss*). *Aquaculture*, 157(1): 11–24.
- Staab KL, Hernandez LP. 2010. Development of the Cypriniform protrusible jaw complex in *Danio rerio*: constructional insights for evolution. *J. Morphol.* 271: 814–825.
- Standen EM, Lauder GV. 2007. Hydrodynamic function of dorsal and anal fins in brook trout (*Salvelinus fontinalis*). *Journal of Experimental Biology*, 210(1): 325–339.
- Standen EM. 2008. Pelvic fin locomotor function in fishes: three-dimensional kinematics in rainbow trout (*Oncorhynchus mykiss*). *The Journal of Experimental Biology*, 211: 2931–2942.
- Standen EM. 2011. Buoyancy, Locomotion, and Movement in Fishes, Paired Fin Swimming. Elsevier Inc, McGill University, Canada. 564 pp.
- Stiassny ML. 2000. *The laboratory fish*, Chapter 6 – Skeletal system. Academic Press. 109–118 pp.
- Susanto G N, Utari FR. 2016. Struktur Skeleton Sirip Kaudal Kompleks *Periophthalmus gracilis*. *Biogenesis*, 4(1): 29–33.
- Takeuchi H, Hosoya K. 2011. Osteology of *Ischikauia steenackeri* (Teleostei: Cypriniformes) with comments on its systematic position. *Ichthyological Research*, 58(1): 10–18.
- Tanaka M, Münsterberg A, Anderson WG, Prescott AR, Hazon N, Tickle C. 2002. Fin development in a cartilaginous fish and the origin of vertebrate limbs. *Nature*, 416(6880): 527–531.
- Taylor WR, Van Dyke CC .1985. Revised procedures for staining and clearing small fishes and other vertebrates for bone and cartilage study. *Cybbium*, 9(2): 107–119.

- Teletchea F. 2016. Molecular identification methods of fish species: reassessment and possible applications. *Reviews in Fish Biology and Fisheries*, 19 (1): 263–293.
- Tomita T, Toda M, Yamamoto Y, Sato K, Uchida S, Nakaya K. 2013. A novel pharyngeal expansion mechanism in the yellow-spotted fanray, *Platyrrhina tangi* (Elasmobranchii: Batoidea), with special reference to the function of the fifth ceratobranchial cartilage in batoids. *Zoomorphology*, 132(3): 317–324.
- Van Wassenbergh S, De Rechter D. 2011. Piscivorous cyprinid fish modulates suction feeding kinematics to capture elusive prey. *Zoology*, 114(1): 46–52.
- Voskoboinikova OS, Grechanov IG. 2002. Development of the skeleton during the ontogenesis of the River Perch *Perca fluviatilis*. *Journal of Ichthyology*, 42(4): 322–333.
- Wainwright PC, Bellwood DR, Westneat MW, Grubich JR, Hoey AS. 2004. A functional morphospace for the skull of labrid fishes: patterns of diversity in a complex biomechanical system. *Biological Journal of the Linnean Society*, 82(1): 1–25.
- Walker JA, Westneat MW. 2002. Performance limits of labriform propulsion and correlates with fin shape and motion. *The Journal of Experimental Biology*, 205: 177–187.
- Walter BE. 2013. Cranial skeletogenesis and osteology of the red eye tetra *Moenkhausia sanctaefilomenae*. *Journal of Fish Biology*, 82: 69–95.
- Webb PW. 1975. Hydrodynamics and energetics of fish propulsion. *Bulletin Fish Research*, (190): 1–159.
- Westneat MW. 2003. A biomechanical model for analysis of muscle force, power output and lower jaw motion in fishes. *Journal of Theoretical Biology*, 223(3): 269–281.
- Wilga CD. 2010. Hyoid and pharyngeal arch function during ventilation and feeding in elasmobranchs: conservation and modification in function. *Journal of Applied Ichthyology*, 26(2): 162–166.
- Witten PE, Obach A, Huysseune A, Baeverfjord G. 2006. Vertebrae fusion in Atlantic salmon (*Salmo salar*): development, aggravation and pathways of containment. *Aquaculture*, 258(1-4): 164–172.

- Yamanoue Y, Setiamarga DHE, Matsuura K. 2010. Pelvic fins in teleosts: structure, function and evolution. *Journal of Fish Biology*, 77(6): 1173–1208.
- Zhang X, Shimoda K, Ura K, Adachi S, Takagi Y. 2012. Developmental structure of the vertebral column, fins, scutes and scales in bester sturgeon, a hybrid of beluga *Huso huso* and sterlet *Acipenser ruthenus*. *Journal of Fish Biology*, 81(6): 1985–2004.
- Zulfahmi I dan Akmal Y. 2018. Anatomi Morfologi Skeleton Ikan Keureling (*Tor tambroides* Valenciennes 1842). Penelitian Dosen Pemula. Universitas Islam Negeri Ar – Raniry. Banda Aceh.