# Ontogenesis of the asymmetric parapineal organ in the zebrafish epithalamus

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**Supplementary Table 1:** Presence/absence of parapineal organ at juvenile/adult stages in teleosts.

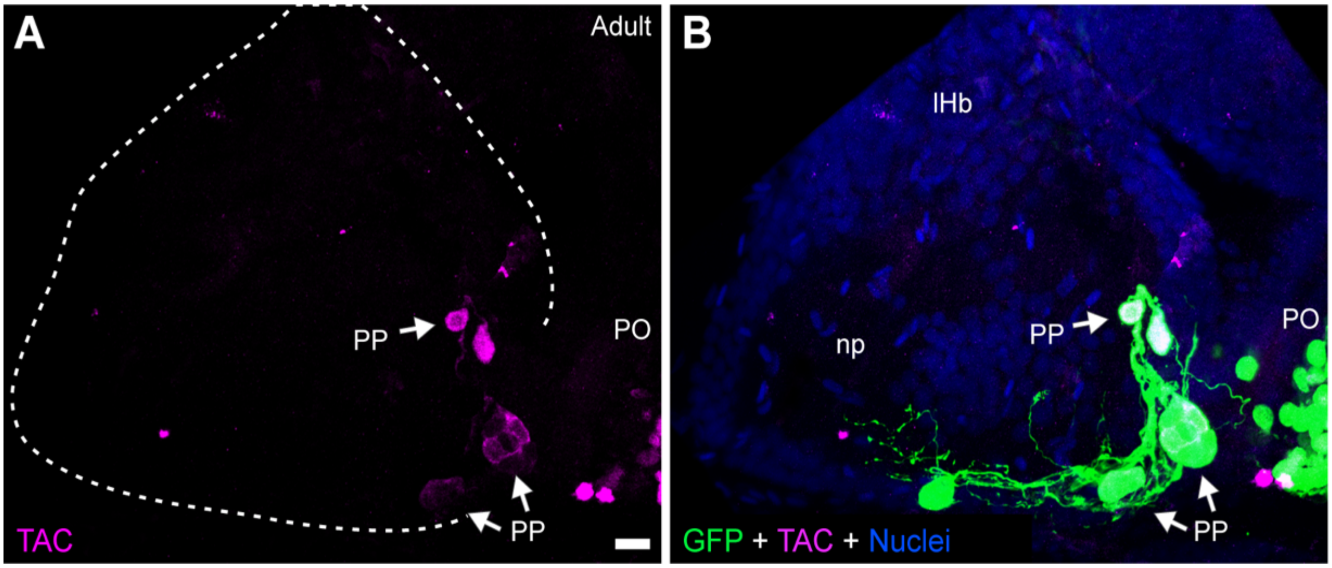
| **Teleost species / order** | **Presence of Parapineal Organ** | | | **Reference** |
|---|---|---|---|---|
| | Adult | Juvenile | Unknown age | |
| *Gnathonemus sp* / Osteoglossiformes | Yes | | | Borg, Ekstrom & Van Veen 1983. |
| *Anguilla anguilla* / Anguilliformes | Yes | | | Rudeberg 1971. |
| *Esox lucius* / Esociformes | Yes | | | Rudeberg 1969. |
| *Bathylagus wesethi* / Osmeriformes | No | | | McNulty 1976. |
| *Oncorhynchus mykiss* / Salmoniformes | Yes | | | Yañez 1996. |
| *Salmo gairdneri* / Salmoniformes | Yes | | | Rudeberg 1968. |
| *Salmo salar* / Salmoniformes | No | Yes | | Holmgren 1965. |
| *Salvelinus fontanalis* / Salmoniformes | No | Yes | | Hill 1894; Holmgren 1965. |
| *Salvelinus alpinus* / Salmoniformes | No | Yes | | Vigh-Teichmann 1991; Musæus 2009. |
| *Catla catla* / Cypriniformes | No | | | Dey 2003. |
| *Labeo bicolor* / Cypriniformes | Yes | | | Borg, Ekstrom & Van Veen 1983. |
| *Carassius auratus* / Cypriniformes | | | Yes | Borg, Ekstrom & Van Veen 1983. |
| *Cyprinus carpio* / Cypriniformes | | | Yes | Borg, Ekstrom & Van Veen 1983. |
| *Hypophthalamichthys molitrix* / Cypriniformes | | | Yes | Borg, Ekstrom & Van Veen 1983. |
| *Labeo umbratus* / Cypriniformes | Yes | | | Borg, Ekstrom & Van Veen 1983. |
| *Phoxinus phoxinus* / Cypriniformes | Yes | | | Vigh-Teichmann 1982. |
| *Alburnus tarichi* / Cypriniformes | No | | | Orgi & Oguz 2022. |
| *Gyrinocheilus aymoneri* / Cypriniformes | Yes | | | Borg, Ekstrom & Van Veen 1983. |
| *Nannostomus sp* / Cypriniformes | Yes | | | Borg, Ekstrom & Van Veen 1983. |
| *Acanthophthalmus sp* / Cypriniformes | | Yes | | Borg, Ekstrom & Van Veen 1983. |
| *Carnegiella sp* / Characiformes | No | | | Borg, Ekstrom & Van Veen 1983. |
| *Gasteropelecus sp* / Characiformes | No | | | Borg, Ekstrom & Van Veen 1983. |
| *Aphyocharax anisitsi* / Characiformes | Yes | | | Rincón-Camacho 2016. |
| *Paracheirodon axelrody* / Characiformes | Yes | | | Rincón-Camacho 2016. |
| *Gymnocorymbus ternetzi* / Characiformes | Yes | | | Borg, Ekstrom & Van Veen 1983. |
| *Corydora sp* / Siluriformes | Yes | | | Borg, Ekstrom & Van Veen 1983. |
| *Heteropneustes fossilis* / Siluriformes | | | Uncertain | Borg, Ekstrom & Van Veen 1983. |
| *Ictalurus nebulosus* / Siluriformes | | | Yes | Borg, Ekstrom & Van Veen 1983. |
| *Ceratoscopelus townsendi* / Myctophimorfes | No | | | McNulty & Nafpaktitis 1977. |
| *Diaphus theta* / Myctophimorfes | No | | | McNulty & Nafpaktitis 1977. |
| *Lampanyctus ritteri* / Myctophimorfes | No | | | McNulty & Nafpaktitis 1977. |

| | | | | |
|---|---|---|---|---|
| *Parvilux ingens* / Myctophimorfes | No | | | McNulty & Nafpaktitis 1977. |
| *Stenobrachius leucopsaurus* / Myctophimorfes | No | | | McNulty & Nafpaktitis 1977. |
| *Symbolophorus californiensis* / Myctophimorfes | No | | | McNulty & Nafpaktitis 1977. |
| *Tarletonbeania crenularis* / Myctophimorfes | No | | | McNulty & Nafpaktitis 1977. |
| *Triphotorus mexicanus* / Myctophimorfes | No | | | McNulty 1976. |
| *Gadus morhua* / Gadiformes | Yes | | | Borg, Ekstrom & Van Veen 1983. |
| *Zoarces viviparous* / Gadiformes | Yes | | | Borg, Ekstrom & Van Veen 1983. |
| *Nezumia liolepis* / Gadiformes | No | | | McNulty 1976. |
| *Xenentodon cancila* / Beloniformes | No | | | Shrivastava 1972. |
| *Oryzias latipes* / Beloniformes | No | Yes | | Ishikawa 2015. |
| *Poecilia latipinna* / Cyprinodontiformes | No | No | | Borg, Ekstrom & Van Veen 1983. |
| *Poecilia reticulate* / Cyprinodontiformes | No | No | | Borg, Ekstrom & Van Veen 1983. |
| *Xiphophorus helleri* / Cyprinodontiformes | No | No | | Borg, Ekstrom & Van Veen 1983. |
| *Epiplatys sp* / Cyprinodontiformes | No | No | | Borg, Ekstrom & Van Veen 1983. |
| *Nothobranchius rachovi* / Cyprinodontiformes | No | No | | Borg, Ekstrom & Van Veen 1983. |
| *Spinachia spinachia* / Gasteroiformes | | Yes | | Borg, Ekstrom & Van Veen 1983. |
| *Gasterosteus aculeatus* / Gasteroiformes | Yes | | | Van veen 1980. |
| *Nerophys ophidion* / Gasteroiformes | Yes | | | Borg, Ekstrom & Van Veen 1983. |
| *Helostoma temmincki* / Perciformes | Yes | | | Borg, Ekstrom & Van Veen 1983. |
| *Dicentrarchus labrax* / Perciformes | Yes | | | Herrera-Perez 2011. |
| *Trachurus japonicas* / Perciformes | | | Yes | Ueck 1979. |
| *Chanda ranga* / Perciformes | Yes | | | Borg, Ekstrom & Van Veen 1983. |
| *Cichlasoma cyanoguttatum* / Perciformes | Yes | | | Borg, Ekstrom & Van Veen 1983. |
| *Cichlasoma dimerus* / Perciformes | Yes | | | Birba et al 2014. |
| *Pelmatochromis kribensis* / Perciformes | Yes | | | Borg, Ekstrom & Van Veen 1983. |
| *Monodactylus argentus* / Perciformes | | Yes | | Borg, Ekstrom & Van Veen 1983. |
| *Perca fluvialis* / Perciformes | Yes | | | Borg, Ekstrom & Van Veen 1983. |
| *Stizostedion lucioperca* / Perciformes | | | Yes | Vigh-Teichmann 1990. |
| *Badis badis* / Perciformes | Yes | | | Borg, Ekstrom & Van Veen 1983. |
| *Typhlogobius californiensis* / Perciformes | No | | | McNulty 1978. |
| *Helicolenus hilgendorfi* / Scorpaeniformes | Yes | | | Ueck & Kobayashi 1979. |
| *Monopterus chuchia* / Scorpaeniformes | | | Yes | Sastry & Sathyanesan 1981. |
| *Platichthys flesus* / Pleuronectiformes | | Yes | | Borg, Ekstrom & Van Veen 1983. |
| *Solea senegalensis* / Pleuronectiformes | Yes | | | Confente 2018. |

**Supplementary Table 2:** Neurochemical markers analysed in the parapineal of zebrafish at larval and adult stages.

| **Neurochemical Marker** | **7dpf** | **Adult** |
|---|---|---|
| Serotonin (5HT) | + | + |
| Substance P (SP) | + | + |
| Tachykinin (TAC: SP precursor) | + | + |
| Neuropeptide Y (NPY) | - | - |
| Gad 65/67 (GABA) | - | - |
| Choline acetyltransferase (ChAT) | - | - |
| Tyrosine Hydroxylase (TH) | - | - |

## Supplementary Figure 1



**Supplementary Figure 1: Parapineal cells show immunoreactivity against tachykinin, the precursor of substance P.** Immunofluorescence against tachykinin (Tac) in adult Tg(*foxd3::GFP*) zebrafish. Images correspond to confocal z-stack maximum projections showing the fluorescence signal corresponding to Tac (magenta in **A**), or the merge fluorescence signals that also include the GFP of the pineal complex (green) and the DAPI/Hoechst nuclear staining that provides the left habenula tissue context (blue) (**B**). White arrows indicate Tac-immunoreactive parapineal cell bodies. Abbreviations: PO (pineal organ at the level of the stalk), PP (parapineal). Adult samples (n=2). Scale bar, 10µm.

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