World Organisation for Animal Health
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INFECTION WITH TILAPIA LAKE VIRUS (TiLV) – A NOVEL ORTHOMYXO-LIKE VIRUS

PATHOGEN INFORMATION

1. CAUSATIVE AGENT

1.1. Pathogen type

Virus.

1.2. Disease name and synonyms

Infection with tilapia lake virus (TiLV).

1.3. Pathogen common names and synonyms

Tilapia lake virus (TiLV) has been classified by the ICTV as *Tilapia tilapinevirus* (ICTV, 2018).

1.4. Taxonomic affiliation

TiLV was tentatively assigned to the Orthomyxoviridae (Bacharach *et al.*, 2016). However, it has now been classified within a new family, Amnooniviridae which is related to the Orthomyxoviridae (ICTV, 2018).

1.5. Authority (first scientific description, reference)

The virus was first described by Eyngor *et al.* (2014).

1.6. Pathogen environment (fresh, brackish, marine waters)

Fresh and brackish water.

2. MODES OF TRANSMISSION

2.1. Routes of transmission (horizontal, vertical, indirect)

Co-habitation studies have demonstrated that direct horizontal transmission is an important route of transmission. Detection of the virus in the gonads of breeders and detection of virus in fry at 2, 5- and 10-days post-hatching suggest possible vertical transmission of TiLV (Yamkasem *et al.,* 2019). The biophysical characteristics of the virus are not well characterised, so it is difficult to determine the significance of indirect transmission by fomites.

2.2. Reservoir

Infected populations of fish, both farmed and wild, are the only established reservoirs of infection. The original source of TiLV is not known.

2.3 Risk factors (temperature, salinity, etc.)

Disease has been associated with transfer between ponds and thus may be associated with stress (Ferguson *et al.*, 2014; Dong *et al,* 2017). No other factors (temperature, salinity, etc.) have been identified as potential risk factors.

3. HOST RANGE

3.1. Susceptible species

Mortalities attributed to infection with TiLV have been observed in wild tilapia *Sarotherodon (Tilapia) galilaeus*, farmed tilapia *Oreochromis niloticus* and commercial hybrid tilapia (*O. niloticus* X *O. aureus*) (Bacharach *et al.*, 2016; Ferguson *et al.*, 2014; Eyngor *et al.*, 2014). Experimental infections with TiLV by injection and co-habitation resulted in mortalities in the giant gourami *(Osphronemus goramy)* (Jaemwimol *et al.*, 2018). Eight additional warm water fish species were found not to be susceptible in the study.

3.2. Affected life stage

In the outbreaks reported by Ferguson *et al.* (2014) and Dong *et al.* (2017) fingerlings were mainly affected. Dong *et al.* (2017) reported approximately 90% mortality in red tilapia fingerlings within one months of stocking into cages. Mortality just over 9% in medium to large sized Nile tilapia was noted by Fathi *et al.* (2017). Other reports have not commented on different levels of mortality by life stage (Eyngor *et al.*, 2014).

3.3. Additional comments

There is some evidence that certain genetic strains of tilapia are resistant. Ferguson *et al.* (2014) noted that one strain of tilapia (genetically male tilapia) incurred a significantly lower level of mortality (10-20%) compared with other strains.

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There is preliminary evidence to suggest that frozen tilapia fillets pose a lower risk of TiLV transmission due to lowered viral viability post freezing (Thammatorn *et al.,* 2019).

4. GEOGRAPHICAL DISTRIBUTION

Infection with TiLV has been reported in Bangladesh, Chinese Taipei, Colombia, Ecuador, Egypt, India, Indonesia, Israel, Malaysia, Mexico, Peru, Philippines, Tanzania, Thailand, Uganda and the United States of America (Ahasan *et al*., 2020; Amal *et al*., 2018; Bacharach *et al*., 2016; Behera *et al*., 2018; Chaput *et al*., 2020; Dong *et al*., 2017; Fathi *et al*., 2017; Ferguson *et al*., 2014; Koesharyani *et al*., 2018; Mugimba, 2018; OIE, 2018a; OIE, 2018b; OIE, 2018c; Tsofack *et al*., 2016).

5. CLINICAL SIGNS AND CASE DESCRIPTION

5.1. Host tissues and infected organs

The main organs where pathology is observed are the eyes, brain and liver (Eyngor *et al*., 2014).

5.2. Gross observations and macroscopic lesions

Gross lesions included ocular alterations, including opacity of the lens and in advanced cases ruptured lens. Other lesions included skin erosions, haemorrhages in the leptomeninges and congestion of the spleen (Eyngor *et al*., 2014).

5.3. Microscopic lesions and tissue abnormality

Histologic lesions have been observed in the brain, eye and liver (Eyngor *et al*., 2014). Lesions in the brain included oedema, focal haemorrhages in the leptomeninges, and capillary congestion in both the white and grey matter and neural degeneration. Foci of gliosis and occasional perivascular cuffs of lymphocytes have been detected. Ocular lesions included ruptured lenticular capsule and cataractous changes. Foci of hepatocellular swelling were observed. The spleen was hyperplastic, with proliferating lymphocytes. Melanomacrophage centres (MMCs) were increased in size and number in both the liver and the spleen. Transmission electron microscopy confirmed the presence of an orthomyxo-like virus within diseased hepatocytes and thus confirmed earlier reports of syncytial hepatitis (del-Pozo *et al*., 2016).

5.4. WOAH status

Infection with TiLV has been defined as an emerging disease by WOAH and Members must report it in accordance with Article 1.1.4. of the *Aquatic Code*. The 2022 OIE General Assembly agreed to include TiLV in Chapter 1.3. Diseases listed by the OIE of the *Aquatic Code*.

6. SOCIAL AND ECONOMIC SIGNIFICANCE

Tilapines, comprising more than 100 species, are the second most import group of farmed fish worldwide after carp. Global production is estimated at 4.5 million metric tons with a current value in excess of U.S.$7.5 billion (FAO, 2014). In some regions they are ecologically important (algae and mosquito control and habitat maintenance for shrimp farming) and an important wild capture species. Introduction of the virus has been shown to cause significant mortality (up to 90%) and thus result in serious economic losses to both farmers and fishers (Eyngor *et al*., 2014; Dong *et al*., 2017).

7. ZOONOTIC IMPORTANCE

None

8. DIAGNOSTIC METHODS

8.1. Definition of suspect cases

High levels of mortality in tilapine species, associated with ocular alterations (opacity of the lens or more severe pathology), should be considered suspicious of TiLV. Skin erosions, haemorrhages in the leptomeninges and moderate congestion of the spleen and kidney may be observed on post-mortem.

8.2. Presumptive test methods

TiLV can be cultured in primary tilapia brain cells or in an E-11 cell line, inducing a cytopathic effect at 3-10 days (Eyngor *et al*., 2014; Liamnimitr *et al*., 2017). Tsofack *et al.* (2016) describe optimal conditions for culturing TiLV.

8.3. Confirmatory test methods

Four PCR assays allow for reliable detection and diagnosis of infection with TiLV (OIE, 2021). Two real-time probe-based PCR assays (Cefas RT-qPCR and Hong RT-qPCR assays) had the highest sensitivity, repeatability and robustness of the assays evaluated and are the recommended assays for detecting TiLV (OIE, 2021).

9. CONTROL METHODS

Restrictions on the movement of live tilapines from farms and fisheries where the virus is known to occur will limit the spread of the disease. Generic biosecurity measures to minimise fomite spread via equipment, vehicles or staff (i.e. cleaning and disinfection) should also be implemented. Common disinfectants are effective against TiLV provided usage conditions are adhered to (Jaemwimol *et al*., 2019). Appropriate disinfection protocols should be incorporated into biosecurity procedures.

Currently, no published methods have been shown to be effective in limiting the impact of an outbreak on an infected farm. It has been suggested that breeding for resistance or the development of a vaccine may offer the long-term prospects for managing the disease (Ferguson *et al*., 2014). A breeding programme would need to select

and test a range of different strains of tilapia with a view to finding those least susceptible.

10. TRANSMISSION RISK

As TiLV has been horizontally transmitted through cohabitation, disease transmission is likely with movement of live aquatic animals. There is limited information about TiLV biophysical properties, and the risks associated with aquatic animal products. However, it may be assumed that it will share properties of other aquatic orthomyxoviruses, such as infectious salmon anaemia virus. Current evidence suggests that the eye, brain and liver are likely to contain highest concentrations of TiLV and thus solid and liquid waste is likely to be contaminated. However, it is possible that the pathogenic agent may also be found in musculature of infected fish. TiLV has been detected by real-time RT-PCR and virus isolation in mucous but not faeces (Liamnimitr *et al*., 2017).

11. ADDITIONAL USEFUL INFORMATION

- CGIAR Research Program on Fish Agri-food Systems (2017). Tilapia Lake Virus (TiLV): What to know and to? Factsheet: FISH-2017-03
- Tang, K.F.J., Bondad-Reantaso, M.G., Surachetpong, W., Dong, H.T., Fejzic, N., Wang, Q., Wajsbrot, N. & Hao, B. 2021. Tilapia lake virus disease strategy manual. FAO Fisheries and Aquaculture Circular No. 1220. Rome, FAO. https://doi.org/10.4060/cb7293en
- Food and Agriculture Organization of the United Nations (FAO)/GIEWS Special Alert nr. 338. (2017). Outbreaks of Tilapia lake virus (TiLV) threaten the livelihoods and food security of millions of people dependent on tilapia farming. http://www.fao.org/3/a-i7326e.pdf
- Network of Aquaculture Centres in Asia-Pacific (NACA). (2017). Urgent update on possible wordlwide spread of tilapia lake virus. https://enaca.org/?id=870&title=urgent-update-on-possible-worldwide-spread-of-tilapia-lake-virus-tilv

REFERENCES

- AHASAN, M. S., KELEHER, W., GIRAY, C., PERRY, B., SURACHETPONG, W., NICHOLSON, P., AL-HUSSINEE, L., SUBRAMANIAM, K. AND WALTZEK, T. B. (2020). Genomic characterization of tilapia lake virus isolates recovered from moribund Nile Tilapia (Oreochromis niloticus) on a farm in the United States. *Microbiology Resource Announcements*, **9(4)**, e01368-19. https://doi.org/10.1128/mra.01368 -19
- AMAL, M.N.A., KOH, C.B., NURLIYANA, M., SUHAIBA, M., NOR-AMALINA, Z., SANTHA, S., DIYANI-NADHIRAH, K.P., YUSOF, M.T., INA-SALWANY, M.Y. & ZAMRI-SAAD, M. (2018). A case of natural co-infection of Tilapia Lake Virus and Aeromonas veronii in a Malaysian red hybrid tilapia (*Oreochromis niloticus* x *O. mossambicus*) farm experiencing high mortality. *Aquaculture*, **485**, 12-16.
- BACHARACH, E., MISHRA, N., BRIESE, T., ZODY, M. C., KEMBOU TSOFACK, J. E., ZAMOSTIANO, R., BERKOWITZ, A., NG, J., NITIDO, A., CORVELO, A., TOUSSAINT, N.C., NIELSEN, S.C.A., HORNIG, M., DEL POZO, J., BLOOM, T., FERGUSON, H., ELDAR, A. & LIPKIN, W. I. (2016). Characterization of a Novel Orthomyxo-like Virus Causing Mass Die-Offs of Tilapia. *mBio*, **7(2)**, e00431–16. http://doi.org/10.1128/mBio.00431-16
- BEHERA, B.K., PRADHAN, P.K., SWAMINATHAN, T.T., SOOD, N., PRASENJIT PARIA, ABHISCHEK DAS, VERMA, D.K., KUMAR, R., YADAV, M.K., DEV, A.K., PARIDA, P.K., DAS, B.K., LAL, K.K. & JENA, J.K. (2018) Emergence of Tilapia Lake Virus associated with mortalities of framed Nile Tilapia *Oreochromis niloticus* (Linneaus 1758) in India. *Aquaculture*, **484**, 168-174.
- CHAPUT, D. L., BASS, D., ALAM, M. M., AL HASAN, N., STENTIFORD, G. D., VAN AERLE, R., MOORE, K., BIGNELL, J.P., MAHFUJUL HAQUE, M., TYLER, C. R. (2020). The segment matters: Probable reassortment of tilapia lake virus (TILV) complicates phylogenetic analysis and inference of geographical origin of new isolate from Bangladesh. *Viruses*, **12(3),** 258. HTTPS://DOI.ORG/10.3390/V12030258
- DEL-POZO, J., MISHRA, N., KABUUSU, R., CHEETHAM, S., ELDAR, A., BACHARACH, E., LIPKIN, W.I., & FERGUSON, H. W. (2016). Syncytial Hepatitis of Tilapia (*Oreochromis niloticus L.*) is Associated With Orthomyxovirus-Like Virions in Hepatocytes. *Veterinary Pathology*, **54(1)**, 164-170. https://doi.org/10.1177/0300985816658100
- DONG, H.T., SIRIROOB, S., MEEMETTA, W., SANTIMANAWONG, W., GANGNONNGIW, W., PIRARAT, N., KHUNRAE, P., RATTANAROJPONG, T., VANICHVIRIYAKIT, R. & SENAPIN, S. (2017), Emergence of tilapia lake virus in Thailand and an alternative semi-nested RT-PCR for detection. *Aquaculture*, **176**, 111-118.
- EYNGOR, M., ZAMOSTIANO, R., TSOFACK, J. E. K., BERKOWITZ, A., BERCOVIER, H., TINMAN, S., LEV, M., HURYITZ, A., GALEOTTI, M. & ELDAR, A. (2014). Identification of a novel RNA virus lethal to tilapia. *Journal of Clinical Microbiology*, **52(12)**, 4137-4146. https://doi.org/10.1128/JCM.00827-14
- FAO (2014). The state of world fisheries and aquaculture. Food and Agriculture Oraganization of the United Nations (**Vol. 2014**). https://doi.org/92-5-105177-1
- FATHI, M., DICKSON, C., DICKSON, M., LESCHEN, W., BAILY, J., MUIR, F., ULRICH, K., & WEIDMANN, M. (2017). Identification of Tilapia Lake Virus in Egypt in Nile tilapia affected by 'summer mortality' syndrome. *Aquaculture*, **472**, 430-432.
- FERGUSON, H. W., KABUUSU, R., BELTRAN, S., REYES, E., LINCE, J. A., & DEL POZO, J. (2014). Syncytial hepatitis of farmed tilapia, *Oreochromis niloticus* (L.): A case report. *Journal of Fish Diseases*, **37(6)**, 583–589. https://doi.org/10.1111/jfd.12142

- JAEMWIMOL, P., SIRIKANCHANA, K., TATTIYAPONG, P., MONGKOLSUK, S. & SURACHETPONG, W. (2019). Virucidal effects of common disinfectants against tilapia lake virus. *Journal of Fish Diseases*, **42(10)**, 1383–1389. https ://doi.org/10.1111/jfd.13060
- JAEMWIMOL, P., RAWIWAN, P., TATTIYAPONG, P., SAENGNUAL P., KAMLANGEE, A. AND SURACHETPONG, W. (2018) Susceptibility of important warm water fih species to tilapia lake virus (TilV) infection. *Aquaculture,* **497**, 462-468
- KOESHARYANI, I., GARDENIA, L., WIDOWATI, Z., KHUMAIRA, K., & RUSTIANTI, D. (2018). Studi kasus infeksi tilapia lake virus (TiLV) pada ikan nila (*Oreochromis niloticus*). *Jurnal Riset Akuakultur*, **13(1),** 85–92. https://doi.org/10.15578/ jra.13.1.2018.85-92
- LIAMNIMITR, P., THAMMATORN, W., U-THOOMPORM, S., TATTIYAPONG, P & SURACHETPONG, W. (2018) Non-lethal sampling for Tilapia Lake Virus detection by RT-qPCR and cell culture. *Aquaculture,* **486**, 75-80.
- MUGIMBA, K. K., CHENGULA, A.A. & WAMALA, S., (2018). Detection of tilapia lake virus (TiLV) infection by PCR in farmed and wild Nile tilapia (*Oreochromis niloticus*) from Lake Victoria. *Journal of Fish Diseases*, **41(8)**, 1181–1189. https://doi.org/10.1111/jfd.12790
- OIE. (2021). Report of the virutal meeting of the OIE *ad hoc* Group on Infection with tilapia lake virus: September 2019- September 2021. https://www.oie.int/app/uploads/2021/12/a-ahg-infection-with-tilapia-lake-sept-2019-sept-2021.pdf
- OIE. (2016). *Aquatic Animal Health Code* (19th ed.). Paris: OIE. Retrieved from http://www.oie.int/international-standard-setting/aquatic-code/access-online/
- OIE. (2017). Disease notification report 25278, 23/11/2017. Retreived from https://www.oie.int/wahis_2/public/wahid.php/Reviewreport/Review?page_refer=MapFullEventReport&reportid=25278
- OIE. (2018a). Immediate notification. Tilapia lake virus, USA. Retrieved from https://wahis.oie.int/#/report-info?reportId=12868
- OIE. (2018b). Immediate notification. Tilapia lake virus, Mexico. Retrieved from https://wahis.oie.int/#/report-info?reportId=11470
- OIE. (2018c). Follow up report 1. Tilapia lake virus, Malaysia. Retrieved from : https://wahis.oie.int/#/report-info?reportId=27838
- TATTIYAPONG, P., SIRIKANCHANA, K. & SURACHETPONG, W. (2017), Development and validation of a reverse transcription quantitative polymerase chain reaction for tilapia lake virus detection in clinical samples and experimentally challenged fish. *Journal of Fish Diseases*, **41**, 255-261.
- THAMMATORN, W., RAWIWAN, P. & SURACHETPONG, W. (2019). Minimal risk of tilapia lake virus transmission via frozen tilapia fillets. *Journal of Fish Diseases*, **42(1)**, 3-9. https://doi.org/10.1111/jfd.12924
- TSOFACK, J. E. K., ZAMOSTIANO, R. WATTED, S., BERKOWITZ, E., MISHRA, N., BRIESE, T., LIPKIN, W.I., KABUUSU, R.M., FERGUSON, H., DEL POZO, J., ELDAR, A., & BACHARACH, E. (2016) Detection of Tilapia Lake Virus (TiLV) in Clinical Samples by Culturing and Nested RT-PCR. *Journal of Clinical Microbiology*, **55(3)**, 759-767.
- THAMMATORN, W., RAWIWAN, P. & SURACHETPONG, W. (2019). Minimal risk of tilapia lake virus transmission via frozen tilapia fillets. *Journal of Fish Diseases*, **42(1)**, 3-9. https://doi.org/10.1111/jfd.12924
- WAIYAMITRA, P., TATTIYAPONG, P., SIRIKANCHANA, K., MONGOLDUK, S., NICHOLSON, P., & SURACHETPONG, W. (2018) A TaqMan RT-qPCR assays for tilapia lake virus (TiLV) detection in tilapia. *Aquaculture*, **497**, 184-188
- YAMKASEM, J., TATTIYAPONG, P., KAMLANGDEE, A. & SURACHETPONG, W. (2019). Evidence of potential vertical transmission of tilapia lake virus. *Journal of Fish Diseases*, **42(9)**, 1293–1300. https ://doi.org/10.1111/jfd.13050