

Corona Virus Impact on Aquatic World: A Short Review

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Abstract

Coronavirus belongs to the family *Coronaviridae* which shares an evolutionary relationship to other member of this family impacting human and veterinary medicine. *Coronaviridae* belong to the order *Nidovirales* which is further divided into two different subfamilies i.e., *Coronavirinae* and *Torovirinae*. There are almost negligible coronaviruses isolated from aquatic organisms but it has effected many aquatic organisms mainly aquatic mammals which includes *beluga whale*, *Bottlenose dolphin* and *harbour seal*. The aquatic fish which is effected by the genus *Bafinivirus* under the same family *Coronaviridae* is *White bream (Blicca bjoerkna)*, *fathead minnow* and *Chinook salmon*. There are also several reports suggesting isolation of coronaviruses from *Carps*. All of these viruses are officially classified as Coronaviruses but some of them are not classified instead shares many similar features with these dreadful Coronaviruses. Current review comprises a detail insight about the history, root causes, mechanism of infection as well as transmission of *Corona viruses* to aquatic organisms. A futuristic prospect of this virus impacting the nature is facilitating the researchers to examine the genome of SARS-CoV-2 in comparison to the genome of aquatic *corona virus* to bring out the evolutionary virulence.

Keywords: Coronaviruses; *Coronaviridae*; *Nidovirales*; *Bafinivirus*; White bream; Bottle Nose

Introduction and Background

In the last few years, we have seen the existence of new viruses which has caused serious damage to global health. Recently numerous Coronaviruses isolates have been identified and accordingly their classifications have been revised. Coronaviruses are positive strand RNA viruses that originate from the family *Coronaviridae* (Order: *Nidovirales*) which consists of many genera and species and it infects three groups of vertebrates including mammals, birds and fishes [1] and they suffer respiratory, gastrointestinal, cardiovascular and neurological diseases. According to the International committee on taxonomy of viruses (ICTV),

Coronaviridae are divided into two subfamilies *Coronavirinae* and *Torovirinae*. The members of *Coronaviridae* infect three groups of vertebrates which includes mammals (genera *Alphacoronavirus*, *Betacoronavirus*, *Gammacoronavirus* and *Torovirus*), birds (genera *Gammacoronavirus* and *Deltacoronavirus*) and fish (genus *Bafinivirus*) [2].

The name *Coronaviridae*, is derived from the Latin term *Corona* as the name suggests it shows a crownlike structure presented from the prominent surface projections. The virus particles are enveloped and it can be spherical (*Coronavirinae*), kidney-shaped (*Torovirus*) or bacilliform (*Bafinivirus*). The viral envelope consists

a unit membrane which is having club-shaped projections of 12–24 nm in length and these projections bearing spike (S) glycoprotein trimers allows the virions to attach to specific receptors which are expressed on the plasma membrane of the host cell [3]. The major feature possessed by coronaviruses are formation of syncytia which are induced by S protein. Animal SARS-CoV could evolve to infect humans by a series of transmission events between animals and humans and among all the structural proteins of SARS-CoV this S protein is the main antigenic component that is mainly responsible for inducing host immune responses, neutralizing antibodies and protective immunity against virus infection [4]. The second type of surface projection of coronaviruses comprises a homodimeric hemagglutinin-esterase (HE) glycoprotein which helps in receptor binding. The other protein which plays a main role in viral budding is matrix (M) glycoprotein which is located on the cytoplasmic side of the viral envelope [5–7]. The non-glycosylated envelope E protein plays an important role in assembly of the virus as well as in morphogenesis because of its ion channel and membrane-permeabilizing activity but this E protein is not important for all corona viruses in spite of its loss may cause the inhibition of virus maturation. The major antigens which are expressed by coronaviruses are S and HE glycoproteins which induces the production of neutralizing antibodies and a cell-mediated immune response in the host [8,9]. The N protein which is responsible for genome encapsidation and packaging can also induce a protective immune response [4]. The closely related coronaviruses which show serological cross-reactivity are Human coronavirus 229E (HCoV 229E), Transmissible gastroenteritis virus (TGEV), Porcine respiratory coronavirus ISU-1 (PRCV ISU-1) and Feline infectious peritonitis virus WSU79-1146 (FIPV 79-1146) [10].

Review

Epidemiology

Aquatic mammals

In June 2000, twenty-one harbor seals were found dead on the beaches of Point Reyes near San Francisco, California. Sudden death of so many harbor seals, scientists sought to understand what killed these animals [11].

According to Schutze, *et al.* [12], aquatic Coronaviruses which are listed by officially by ICTV are Beluga whale Coronavirus SW1 and the White bream virus (WBV). The other unassigned member are harbor seal coronavirus and Bottle nose dolphin coronavirus.

Woo, *et al.* [13] suggested Beluga whale Coronavirus SW1 (BV-CoVSW1) and bottle nose dolphin coronavirus as a distinct species i.e. Cetacean coronavirus.

In 2008 and 2010 during marine surveillance study in Ocean park in Hongkong, a Coronavirus which was identified in Indo-pacific was from Bottle nose dolphin and even the coronavirus genome was detected in fecal samples from three apparently healthy animals.

Mihindukulasuriya, *et al.* [14] published first report about identification of the complete genome from a coronavirus isolated from a marine mammal which was Beluga whale which died from acute liver failure after suffering a short pulmonary disease and this was assigned as genus *Gammacoronavirus*.

Bossart and Schwatz in [15] reported the probable case of coronavirus infection in harbor seal. Three harbor seals (*Phoca Vitulina*) were affected by this virus in 1987. Two seals died without showing any clinical symptoms whereas the third one showed some symptoms such as severe diffuse pulmonary congestion and extensive broncho-alveolar hemorrhage. On the basis of antigenic cross reactivity this virus was confirmed as genus *Alphacoronavirus*, however the virus is still unassigned.

Fish (*Bafinivirus*)

Coronaviruses in fish was assigned as genus *Bafinivirus* under the family *Coronaviridae*.

Granzow, *et al.* [16] isolated White bream virus from a healthy white bream (*B. Bjoerkna* L) in Germany during monitoring of pathogen in wild fresh water fish. Other WBV isolates from cyprinids was Gold fish, Tench and Grass carp [17].

In 2014 Lord, *et al.* [18] isolated a *bafinivirus* from Chinook Salmon which was the first report of Coronavirus in *Salmonidae*. This virus was related to white bream virus and FHMV (Fathead Minnow Virus) according to the amino acid alignment however the virus is still unassigned member of the *Nidovirales*.

In 2002, Fathead minnow virus was isolated from Moribund fathead minnows on a Baitfish farm in Central Arkansas in 1997 [19]. According to Batts, *et al.* [20]. FHMNV is closest relative of WBV (white bream virus), however FHMNV is still the unassigned member of the *Nidovirales*.

Ahne., *et al.* [21] isolated an unknown virus from a healthy grass carp (*C. idella*) and the isolate was named as CIVH 33/86 (*Ctenopharyngodon idella virus hungary*). This virus was finally confirmed as genus *torovirus* from the family *Coronaviridae*.

Miyazaki., *et al.* [22] published an another accepted Coronavirus which was named as Carp viremia-associated ana-aki-byo, caused a high mortality in Colored Carp (*C. Carpio*) in 1997 and 1998 in Japan.

Sano., *et al.* [13] isolated a coronavirus from common carp that died after suffering an acute infection.

What are coronaviruses in aquatic organisms

According to Schutze., *et al.* 2016. Coronaviruses belong to the family *Coronaviridae* and in aquatic organism it infects the aquatic species coming under the genus *alphacoronavirus*, *betacoronavirus*, *gammacoronavirus* and *deltacoronavirus* under the subfamily *coronavirinae* as well as the species of the genus *torovirus* and *bafinivirus* from the subfamily *Torovirinae*. *Beluga whale coronavirus* and *dolphin coronavirus* are in the genus *gammacoronavirus* whereas *harbor seal corona virus* belong to the genus *alpha coronavirus* and white bream, fathead minnow and chinook salmon belong to the genus *bafinivirus*. They are classified according to ICTV and among all these virus only two are assigned mainly *Beluga whale coronavirus* in aquatic mammals and white bream in aquatic fishes [12]. There are no reports for delta and beta coronavirus in aquatic organisms.

What are clinical symptoms exhibited by coronavirus in aquatic organisms:

Alphacoronavirus

According to Bossart and Schwartz in 1987 three harbor seals (*Phoca vitulina*) housed at the Miami Seaquarium were infected by Coronavirus and showed symptoms of acute necrotizing enteritis. Two of the seals died without showing any clinical signs and the third one displayed marked leukocytosis, dehydration, hypernatremia and hyperchloremia. Extensive focal bronchoalveolar hemorrhage and edema with severe diffuse pulmonary congestion were revealed by pathological sections from all the three harbor seals. There was detection of moderate-to-severe lymphoid depletion in the spleen, visceral and in peripheral lymphnodes. Coronavirus-specific antigens were detected in the intestinal mucosa. According to the antigenic cross-reactivity, the coronavirus infecting

the harbor seals most probably belonged to the genus *Alphacoronavirus* and all *alphacoronaviruses* including *Canine coronavirus* yielded positive results by Immunofluorescence staining.

Gammacoronavirus

Beluga whale exhibited acute liver failure and died after suffering a short generalized pulmonary disease. According to histological examination acute hepatic necrosis was confirmed and a great number of round viral particles was observed in the cytoplasm of hepatic cells during electronic microscopic examination [12]. Bottlenose Dolphin showed no clinical symptoms except the viral genome was detected during infectious stage and in fecal sample from the healthy animals.

Bafinivirus

Effected fish exhibited hemorrhage of the skin and eyes, as well as hepatic, splenic and renal lesions including White Bream, carp and gold fish. In 2009 Fichtner., *et al.* suggested that Other WBV-like pathogens were isolated from tench and carp after clinical events and fatalities in Germany in 2007 and clinical signs shown such as exhaustion, reduced food intake, increased mucus production, pseudofeces and petechiae.

Transmission

According to current report Schutze., *et al.* 2016, at present there are no information is available regarding the ecology, route of infection, cell tropism, mode of transmission or vectors of coronaviruses that infect aquatic organisms but the principle features of the viral infection cycle are as reviewed by de Vries., *et al.* (1997) and Ruch and Machamer [24]. Virus replication takes place entirely within the cytoplasm of the infected cell.

Treatment

As per current report there are no treatments yet and still the information about the disease is lacking.

Discussion and Conclusion

This review suggest that coronaviruses are prevalent in cypriids, salmonids, beluga whale and dolphin too. The first outbreak of coronavirus infecting humans was in 2003 and then recently in 2019 in China and before the outbreak of coronavirus in humans it was seen in fishes as well as in aquatic mammals including blue whale (1987) and in 2001 there were 21 harbor seals died in California [11]. So this study can help in the identification of root of the

coronavirus outbreak as still there are no reports for the source of this coronavirus which has recently emerged in 2019 and still is the major cause of death to humans as well as to some animals. It is hoped that this review will enable the discovery and identification of source of coronaviruses and facilitate further research into their molecular biology, phylogeny and evolution [25-34].

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