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Ultraviolet radiation-A (366 nm) induced morphological and histological malformations during embryogenesis of *Clarias gariepinus* (Burchell, 1822)

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ABSTRACT

Exposure to ultraviolet radiation has been associated with variety effects in many organisms ranging from molecular and tissue damage to population level effects. The exposure of embryos of the catfish, *Clarias gariepinus* (Burchell, 1822) to 366 nm UVA at different doses 15, 30 and 60 min resulted in the hatching time delayed to 29 h-post-fertilization stage (29 h-PFS) in comparison with normal hatching time of 22 h-PFS at 29 °C. In embryos exposed to 15 min/UVA, 30 min/UVA and 60 min/UVA the total percentage of hatched embryos/fertilized eggs were 90%, 89% and 85%, respectively, while in control was 95% at 29 h-PFS. The total percentage of mortality/ hatched embryos were (1–14)%, (2–22)%, (2–23)% and (3–40)% for control, 15 min, 30 min and 60 min groups, respectively, at 40 h-PFS. Also as a result some morphological malformations; (yolk sac oedema, body curvature, fin blistering, and dwarfism) were revealed. These destructive effects were also confirmed by histopathological changes in gills, eyes, intestinal tract, spinal cord, notochord, liver, skin and kidney. The results confirm that exposure to UVA caused an exposure time-dependent delay in hatching rate and reduced the percentage of the hatched embryos but the mortality rate increased with increase of the exposure time to UVA.

1. Introduction

Ultraviolet radiation (UVR) is naturally stressor to most forms of life. Recent changes in UVR exposure at both global and local level regarding the potentially damaging effects of this stressor [1]. Ozone depletion, as a consequence of human activity, is the primary cause of a change in the dose of UVR received by aquatic and terrestrial species [2,3]. Plus ozone depletion, global climate changes, particularly global warming and acidification, decreases the amount of dissolved carbon which in turn increases UVR penetration into aquatic ecosystem [4]. Exposure to UVR has been associated with variety effects in many organisms ranging from molecular and tissue damage to population level effects [5]. Also, UVR radiation may have negative effects on the aquatic ecosystems resulting in decreased biomass productivity including fish yields [6]. UVR comprises three distinct spectra according to wavelength; UVA (315–400 nm), UVB (280–315), and UVC (100–280 nm). UVA, wavelength (315–400 nm) is only slightly affected by ozone levels [7]. Ultraviolet radiation-A (315–400 nm) is scattered rapidly in water with biologically useful amounts to at least 100 m depth in clear aquatic environments [8]. Most UVA radiation is able to reach the earth's surface and can contribute to tanning, skin aging, eye damage, and immune suppression [9].

African catfish *Clarias gariepinus* is distributed throughout Africa [10]. In the northern and central part of Africa it has been described as *Clarias lazera*, in the eastern part as *Clarias senegalensis*, in the western part as *Clarias mossambica*, and in the southern part as *C. gariepinus* [11]. This species was introduced into Europe, Asia and Latin America in 1970, and has become one of the most important farmed catfish in the world [12–14]. Moreover, the African catfish has been used in fundamental researches [14], since it has a will documented biology, short period of development, transparent egg and is easy to reproduce all year round [15,14]. Furthermore, natural populations of *C. gariepinus* form a stable diet for many farmers throughout the African continent [14]. The economic importance of this species has increased tremendously in recent years as a result of its extensive use in aquaculture [11]. This fish is suitable for embryological studies since its spawning can be induced by hormones injection [16,17,13,18] followed by artificial fertilization.

Embryos and early larval stages have been shown to be especially sensitive indicators of aquatic stress [19,20]. Generally, developing fish embryos or larvae are considered the most sensitive stages in the life [14] being particularly sensitive to all kind of low-level environmental stressors [14]. The present study focuses on UVA toxicity in different developmental stages of *C. gariepinus* considering different biomarkers comprising changes in the developmental hatching rate, morphological and histological changes.

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2. Materials and methods

2.1. Gamete collection

Mature African catfish, *C. gariepinus* (weight of 900–1500 g) were collected from the River Nile at Assuit, Egypt and transported to the Fish Lab., Zoology Department, Assuit University. The criteria applied for the selection of spawners were those described by De Graaf and Janssen [11]. The catfish specimens were kept in 100-L glass tanks to be acclimatized for two-weeks period at 27–29 °C, pH = 7.56, dissolved oxygen 88–94% saturation. The photoperiod was 12-h light to 12-h dark cycle and the catfish

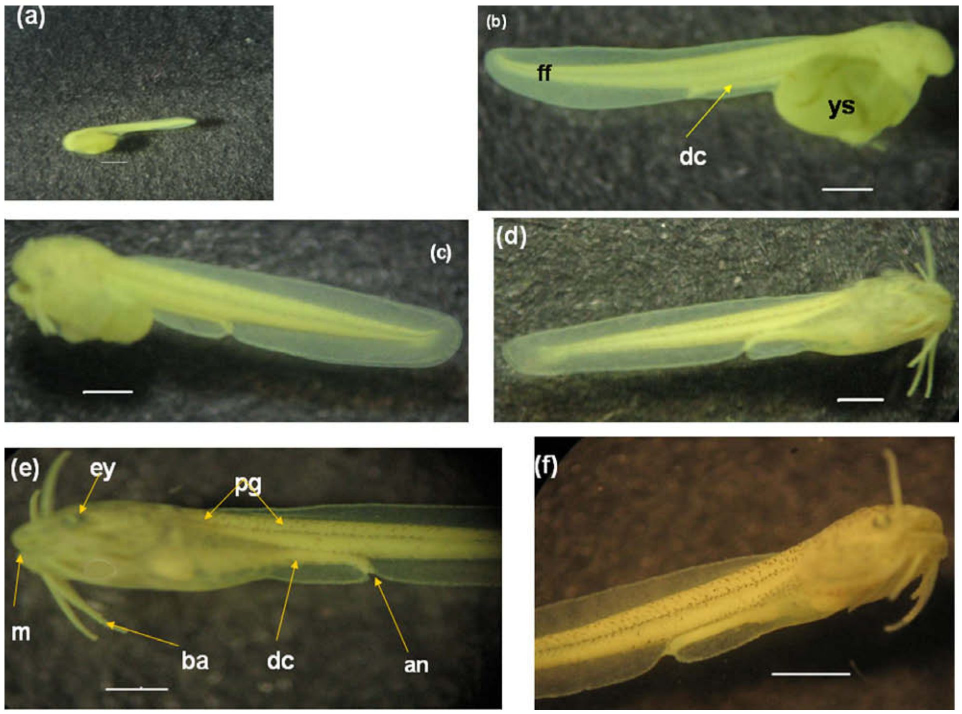

Fig. 1. Developmental embryonal stages of *Clarias gariepinus* showing (a) 24 h-PFS, (b) 48 h-PFS, (c) 72 h-PFS, (d) 84 h-PFS, (e) 96 h-PFS and (f) 120 h-PFS. ys = yolk sac, ff = fin fold, dc = digestive canal, ba = barbels, m = mouth, ey = eye, pg = pigments, an = anus, PFS = post-fertilization stage and scale bar = 1 mm.

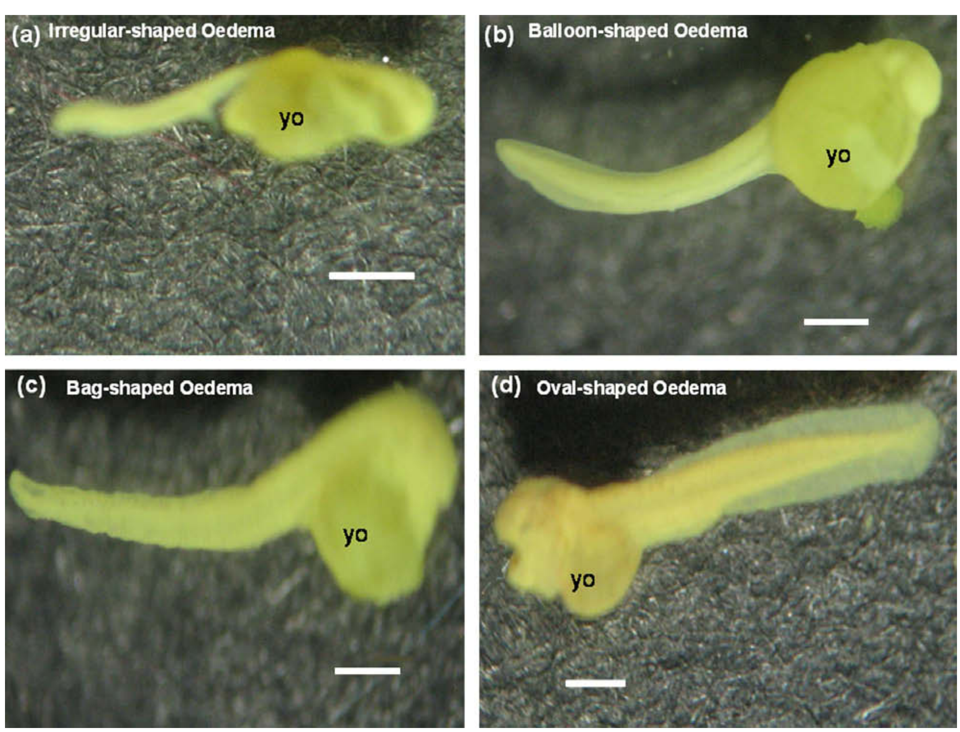

Fig. 2. Yolk sac oedema in the embryos of *Clarias gariepinus* after exposure to UVA showing (a) irregular-shaped oedema (24 h-PFS exposed for 60 min), (b) balloon-shaped oedema (48 h-PFS exposed for 60 min), (c) bag-shaped oedema (48 h-PFS exposed for 60 min) and (d) oval-shaped oedema (72 h-PFS exposed for 60 min). yo = yolk sac oedema, PFS = post-fertilization stage and scale bar = 1 mm.