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**Bibliographic synthesis on biology and ecology of *Hoplobatrachus occipitalis* (Günther, 1858)**

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**ABSTRACT**

*Hoplobatrachus occipitalis* is a frog belonging to Dicroglossidae family, the most spread in West Africa. This study aimed at performing a bibliographic synthesis on biology and ecology of this species in order to assess its potential in aquaculture. It lives along banks, rocky reservoirs and earthen ponds and prefers savannah areas. It feeds on coleopterans, caterpillars, spiders, vegetal fragments, fishes, crabs, ants, grasshoppers, locusts, dragonflies, frogs, mollusks, lizards, mice, butterflies, wasps and diptera larvae. The growth of *H. occipitalis* depends on the temperature and pH of the medium. A pH range 6.2 and 7 and temperature equal or upper, than 28 °C are suitable for its growth. *H. occipitalis* is an oviparous species. Its first sexual maturity height is 124.5 mm for females and 95 mm for males and it often reproduces during rainy season. The rapid growth, resistance and high nutritional quality of this species are some of its important potentialities for aquaculture. Natural reserves of *H. occipitalis* are overexploited and therefore no more able to satisfy the populations demand. A successful breeding of this species can help not only to preserve and strengthen the natural reserves but to produce regularly bulbous crowfoot for human consumption.

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**Keywords:** *Hoplobatrachus occipitalis*, biology, ecology, aquaculture potentialities.

**INTRODUCTION**

Worldwide fresh water aquaculture production reaches 47.1 million tons during 2015 owing to the rapid development of rearing technique of certain species such as Nile Tilapia (*Oreochromis niloticus*), *Clarias gariepinus*, some amphibians (frog, toad,

tritons and salamanders) and others (FAO, 2016).

In Africa, continental aquaculture produces 1.7 million tons during 2015 and is made of fishes, mollusks, crustacea and other aquatic animals including frog (FAO, 2016).

Frog is an amphibian that may be naturally found in tropical and subtropical

climate regions. Like every amphibian, it is a poikilotherm animal. Likewise, its growth is directly tied to the temperature. Another characteristic is the double respiratory system, either pulmonary or cutaneous (Morin, 2008).

Ecologically, these animals play an important role in food web and are indispensable to wetlands balance maintaining (Channing, 2001). Frogs are excellent bio-indicators of aquatic environment (Schjøtz, 1999; Rödel, 2000; Channing, 2001; Guerry and Hunter, 2002). Indeed, they consume harmful insects reducing therefore their population. By doing so, they enhance agricultural production and contribute to the fight against malaria vectors (Channing, 2001).

Economically, some edible frog species like *Hoplobatrachus occipitalis* constitute a source of animal genuine proteins and income to men (Neveu, 2004; Nzigidahera, 2006).

Several studies inform on the diet (Alfredo, 1996; Mady-Goma, 2012), the biology (Wells, 1977; Barbault, 1984; Heyer et al., 1994; Rödel, 2000; Morin, 2008; Tohé, 2009), the ecology (Rödel, 2000 ; Wildlife et al., 2007; Tohé, 2009), the parasitology (Akani et al., 2011; Aisien et al., 2014) and the sensitivity to heavy metals (James and Little, 2003 ; Ezemonye and Enuneku 2005; Sobha et al., 2007; Ezemonye and Enuneku, 2011; Idowu et al., 2014; Omonona et al., 2016) of *H. occipitalis*, but studies regarding frogs rearing especially *H. occipitalis* from larval stage to adult are scarce in West Africa. Besides, data on the feeding habit of this frog species are very important for the qualification of its growth performance and production cost reduction. *H. occipitalis* rearing in controlled medium can help promoting these species. In order to preserve and strengthen the natural stock. The rearing achievement of this frog species requires knowledge on its biology, ecology and aquaculture potential. This article summarizes some studies on *H. occipitalis*.

## MORPHOLOGY DESCRIPTION OF *H. OCCIPITALIS*

*H. occipitalis* is a large and flat ranidae with globular eyes which diameter ranges,

from 0.7 to 0.9 mm; several dorsal warts arranged longitudinally and a minuscule internal metatarsal tubercle. It has a complete strap between fingers and toes; a very verrucose skin though eyes and nostrils are dorsally positioned. The skin is very slippery due to numerous glands. Mussel-anal length of adult males varies from 52 to 104 mm and that of the biggest females measured in the national zoo area of Comoé was 65 mm. According to Loveridge (1955), mature female of *H. occipitalis* can weight 235 g with a mussel-anal length about 127 mm. However, Perret (1966) reported mussel-anal length varies from 52 to 110 mm in males and 110 to 135 mm in females. Males weight varies from 24 to 84 g and while females weigh from 20 to 132 g (Rödel, 2000). *H. occipitalis* specimens individuals have a large mouth. The side of inferior jaw carries three teeth. They pupil are oval and vertical. The eardrum is distinct and bordered by a bent supra-tympanic fold. Males have pairs of lateral vocal sack and large thenar tubercle; the skin surrounding vocal sacks in the throat is strongly folded. Posterior members are relatively short and muscled than anterior members. Stems are generally longer than thighs. There are many small tubercles on the posterior part of thighs (Rödel, 2000).

The body color of *H. occipitalis* is green-yellowish, olive or brown-dull; its back presents greenish or blackish spots which sometimes form lines. Black spots are also present on the superior lip; most of individuals have their throat and inferior lip white colored with rarely some black spots. The external parts of thighs are marbled. The belly is white with sometimes some black spots (Rödel, 2000); vocal sacks are grey, bluish (Burton, 1972) or cream colored (Loveridge, 1955).

## SYSTEMATICAL POSITION OF *HOPLOBATRACHUS OCCIPITALIS*

The species name has progressed as a function of time. Indeed, *Rana occipitalis* (Scortecci, 1936), *Rana tigrina occipitalis* (Dekeyser and Villiers, 1956), *Hoplobatrachus occipitalis* (Dubois, 1992) are synonym to *Hoplobatrachus occipitalis* (Günther, 1859). According to Frost et al. (2006), *Hoplobatrachus occipitalis* belongs to

Regnum of Animalia; Phylum of Chordata; Sub-phylum of Vertebrata; Class of Amphibia; Sub-class of Lissamphibia; Super-order of Salientia; Order of Anura; Familia of Dicroglossidae; Sub-familia of Dicroglossinae and Genus *Hoplobatrachus*.

## GEOGRAPHICAL DISTRIBUTION

*Hoplobatrachus occipitalis* distribution is mainly disjunctive including the Northern Africa (Morocco, Algeria and Libya) stock and a great part from sub-Saharan Africa. These populations can still be considered isolate with sub-populations in the South-West of Libyan Jamahiriya Arab, South-East of occidental Sahara and close to Mauritania, Mountains area of Niger and the Northern Mali. In sub-Saharan Africa, it is found on the Atlantic coast by the East, in Ethiopia, Chad, Sudan and Southern Angola and Mozambique. Other sub-Saharan African countries such as Northern Zambia, Western Congo, Senegal, Gambia, Bissau Guinea, Liberia, Sierra Leone, Guinea, Mali, Burkina Faso, Ivory Coast, Ghana, Togo, Benin, Niger, Nigeria, Cameroon, Equatorial Guinea (including Fernando Pó isle), Congo, Democratic Republic of Congo, Republic of Centrafrica, Uganda, Kenya, Tanzania, Rwanda and Burundi (Rödel, 2000). Research carried out by Frost (1985) confirm the existence of *H. occipitalis* in the area of Senegal to Ethiopia, from Northern to Southern Zambia, Angola and Southern Congo. According to Alfredo (1996), *H. occipitalis* is an Ethiopian species recorded in the North-West Africa, South-West Libya, Adrar Iforas (Mali), Adrar (Mauritania) and the rocky areas of Niger.

## ECOLOGY

*H. occipitalis* inhabits along river banks, rocky reservoirs and earthen ponds with a preference to savannah environments. This species may be found in some woody area (Poynton and Broadley, 1985) and in an eco-region with both savannah and forest: that is the case of Miombo forest of central Zambia (Gruschwitz et al., 1991). It also dwells into rocky reservoirs of rivers surrounding by primary forest where high water temperature (until 40 °C) is recorded

(Rödel, 2000; Wildlife et al., 2007). Its natural habitats are thus sub-tropical forests, dry savannah, wet savannah, tropical or sub-tropical prairie of dry plains, tropical or sub-tropical prairie of periodically flooded plain, rivers and intermittent rivers, fresh water lakes and intermittent fresh water lakes, fresh water swamp and intermittent fresh water swamp, fresh water sources, tillable grounds, pastures, rural gardens and ponds (Rödel, 2000).

According to Alfredo (1996), in Northern Africa, *H. occipitalis* dwells in oasis, in mountain regions where it lives in wells and cisterns. It is active the day and inactive at night and during the winter.

Besides, the life cycle of frogs includes two distinct stages: aquatic stage and terrestrial stage. The last one requires consumption of high proteins value feed for their growth (Olvera-Novoa et al., 2007).

Nevertheless, they have a rapid growth in hot climates and low in temperate climates due to their poikilotherm characteristic. Therefore, they hibernate and their activity is limited to the mid of year in temperate climate (Morin, 2008). Especially, temperature is important for the growth of *H. occipitalis* since values upper than 28 °C enable its normal growth but at values lower than 25 °C, the growth is slowed down. Furthermore, a pH ranged between 6.2 and 7 does not influence the growth of *H. occipitalis* (Nzigidahera, 2006). It is important to notice that a period of two years is necessary for them to reach sexual maturity and more for commercial height (Morin, 2008).

## FOOD HABIT

Generally, frogs are recognized like electrical diet animals (Perret, 1966). They are live prey predators. *H. occipitalis* essentially feeds on coleopterans, caterpillars, spiders, vegetal fragment, fishes, crabs, ants, grasshoppers, locusts, dragonflies, frogs, mollusks, lizards, mice, butterflies, wasps (Mady-Goma, 2012). According to Alfredo (1996), it feeds on coleopterans, orthopterans, toads (de Xeros Bufo) and their tadpoles and individuals from their own species. Rödel (2000) reported that *H. occipitalis* larvae are carnivorous though preys are larvae from other frog species, mosquito larvae and other

aquatic species larvae. An observation of their stomach content showed Coleopterans, Diptera, Lepidoptera, Hymenoptera, Orthopterans, mollusks, soft substances and vegetal fragments (Nzigidahera, 2006). Lescure (1971) showed that *H. occipitalis* diet includes essentially Coleopterans, spiders and Orthopterans. These predators select their prey according to its speed, movement and size. The important proportion of Coleopterans in the frog diet indicates its ability to live nearby rivers (Inger and Marx, 1961; Rödel, 1995). Observations made by Loveridge (1942) showed *H. occipitalis* feeds on other frog species. Also, Noble (1924) reported this frog feeds on its fellows. According to Kühn et al. (1987), all ranidae, insects and fishes are considered as prey of *H. occipitalis* which lives in water during the day. It leaves the water for hunting at night but in full moon period it stays in water. In Northern Africa, *H. occipitalis* is active in the day and at night but inactive during the winter (Alfredo, 1996). Spieler and Linsenmair (1998) confirmed this species is active at night and stay hidden from the sun rise to sunset.

Moreover, food conditions of frog are not well defined. Carnivorous fish rations are used in frog rearing farm (Casali et al., 2005).

## REPRODUCTION

Reproduction is an important factor to the success of intensive production of animal. Moreover, frogs reproduce only during hot temperature period. In temperate climates, frogs reproduce only during the summer (Morin, 2008).

However, the reproduction of *H. occipitalis* occurs in the rainy season under sub-tropical climate (Rödel, 2000). Males are small and possess vocal sacks which are powerful resonator (Perret, 1966). The first maturity height is 124.5 mm for females and 95 mm for males (Tohé et al., 2016). The least height of first maturity for females is 122 mm and 68 mm for males. All individuals reach sexual maturity at 130 mm for females and 120 mm for males (Tohé et al., 2016). Their croaking is especially tied in reproduction (Wells, 1977; Heyer et al., 1994). Females of *H. occipitalis* show an annual variation in their reproduction capacity even in constant

environmental conditions (photoperiod, temperature, precipitations, humidity) (Kühn et al., 1987). This is especially favoured in ponds near rivers filled up by the first rain (van den Elzen and Kreulen, 1979). Thus males floating at water surface attract females by their croaking. Spawn often happens in the water and eggs quantity may range between 800 and 1500 (Barbault, 1984; Rödel, 2000).

Eggs are laid individually or in small group forming sticking frost on rocks or stones at the water bottom. The sticking frosts are covered by algae and detritus making eggs are less visible. Eggs diameter averages 5 mm at pharyngula stage and 3.2 mm at neurula stage (Rödel, 2000). According to Tohé et al. (2016), mature eggs size is 2.74 mm.

A study led by Zug (1987), show eggs measured 1.6 mm to 1.8 mm and possess black and white poles. Parker (1936) described clutch as a huge floating egg mass. However, these authors have made confusion between *Hoplobatrachus occipitalis* eggs and those from other species (probably *Phrynomantis microps*).

## PARASITE FAUNA OF HOPLOBATRACHUS OCCIPITALIS

Parasites are the most recorded pathogens in aquaculture. Parasitological studies are so very important for the development of fish breeding potential in fresh water habitats. Some studies showed *Hoplobatrachus occipitalis* may be infested in different organs by several parasites (Table 1).

## HEMATOLOGY AND SENSITIVITY TO HEAVY METALS

Cadmium is a heavy metal without any biological function. It is very toxic to both aquatic and terrestrial organisms. It was introduced in aquatic environment mainly by human activities including mine exploitation, fertilizers using and industrial discharges (Volgiatzis and Loumbourdis, 1997; James and Little, 2003; Ezemonye and Enuneku, 2005). Adult frogs can absorb cadmium by skin or by oral way by consuming water and by respiration (Ezemonye and Enuneku, 2011). Then, it can pass through many tissues particularly liver, kidneys, gonads, placenta,

brain, bones and blood (Sobha et al., 2007; Omonona et al., 2016).

Furthermore *H. occipitalis* accumulates highly zinc, following successively by iron, copper, Nickel and lead (Idowu et al., 2014).

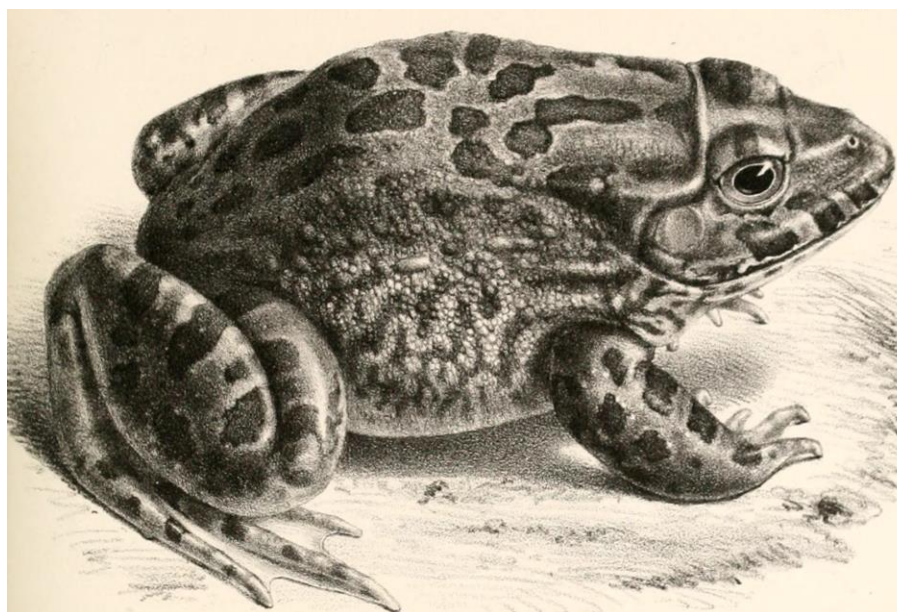
#### PROSPECTIVE FOR AQUACULTURE

Frogs constitute an important animal proteins source in Africa (Onadeko et al., 2011). Populations of Nigeria, Côte d'Ivoire, Benin and Burkina Faso include increasingly frog meat in their menu: either grilled or boiled. Fishermen obtained 20 dollars for a thousand of dried frog. Most of them were adapted to this activity because it is more profitable than fish (DDC, 2010). The extent of this activity constitutes a threat to ecosystems. *H. occipitalis* is more appreciated by consumers but its tadpoles are useful because for example, they consume mosquito larvae (DDC, 2010). Biologist required frogs rearing farm in order to preserve wild populations (DDC, 2010).

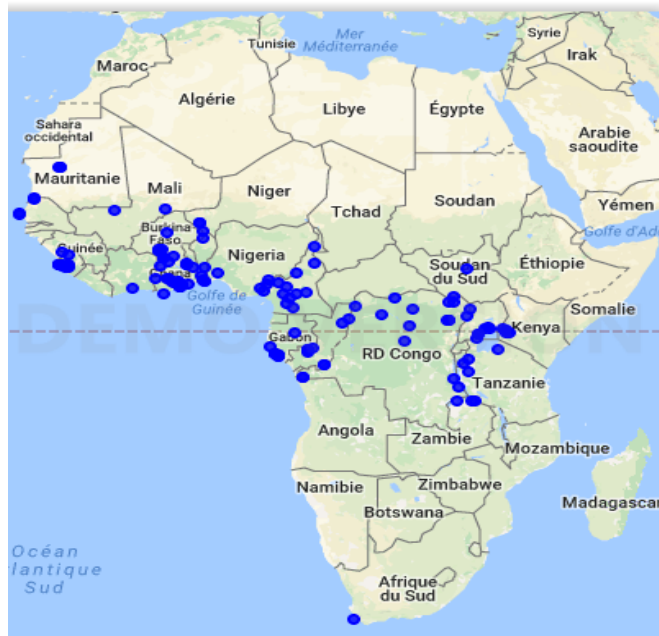
According to Nzigidahera (2006), exploitation of edible frogs constitutes a

source of income. For instance, peasants sell edible frogs *Hoplobatrachus* and *Ptychadena* to big hotels and restaurants in Bujumbura (Nzigidahera, 2006). Therefore, *H. occipitalis* is the most sold because it is easy to harvest and has a big thigh with an important economical value.

A survey made by "Fondation Droit Animal", Sciences and Ethic (LFDA) during the first months of years 2008 and 2009 in three countries (Nigeria, Benin and Burkina Faso) by questioning villagers, commercials, hunters, dealers and customer-consumers showed that among the 25 species considered, *H. occipitalis* is the most consumed in both Burkina Faso and Nigeria following by *Pyxicephalus edulis*, *Ptychadena bibroni*, *Ptychadena oxyrinchus* and *Ptychadena trinodis* (LFDA, 2011). Frogs sale concerns mainly human consumption. However, certain species are used in traditional medicine, especially toads or frogs resembling to toads (LFDA, 2011).



**Figure 1:** Specimen of *Hoplobatrachus occipitalis* (Günther, 1858).



• Residence zone of the species

**Figure 2:** Distribution of *Hoplobatrachus occipitalis* in Africa (Cartographical Data©2017 Google. INEGI).

**Table 1:** Parasites of *Hoplobatrachus occipitalis* and infested organs.

Parasites (Species)	Phylum	Organs
<i>Microfilariae Folleyellides sp</i> (Aisien et al., 2014)	Nematoda	Blood
<i>Aplectana acuminata</i> (Akani et al., 2011)	Nematoda	Bowel
<i>Oxyuris sp.</i> (Akani et al., 2011)	Nematoda	Bowel and Colon
<i>Eurytrema sp.</i> (Akani et al., 2011)	Nematoda	Stomach, Bowel and colon
<i>Diphyllobothrium sp.</i> (Akani et al., 2011)	Cestoda	Bowel
<i>Eimeria terraepokotorum</i> (Miloslav et al., 2006)	coccida	Bowel

## CONCLUSION

In summary, we can say that *H. occipitalis* is a very robust species that deserves to be reared because it is an important source of animal genuine protein for humans. Also, in the major hotels of most of African countries, *H. occipitalis* is the best-selling species because it is easy to harvest and has a fairly large thigh with a significant economic value.

## COMPETING INTERESTS

The authors declare that there is no competing interests.

## AUTHORS' CONTRIBUTIONS

All authors have made adequate effort on all parts of the work necessary for the development of this manuscript according to his expertise. All authors read and approved the final manuscript.

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