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REVIEWS

A review of biology, ecology and prospect for aquaculture of *Parachanna obscura*

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Abstract *Parachanna obscura* is the most common African Channidae. Various studies are being conducted on its biology and ecology. It lives in fresh water in quiet and muddy areas. It has accessory respiratory organs allowing it to live in hypoxic environment. It has a varied diet and feeds on fish, remains of fish, insects, other invertebrates and plant detritus. It is a species with iteroparous asynchronous oogenesis which breeds throughout the year but much more during and just after the flood. It size at first maturity is 24.5 cm. Eggs and larvae of *P. obscura* are yellow and guarded by one or both parents. Hardiness, rapid growth, high tasty flesh and commercial value of this species represent significant aquaculture potentiality. Natural stocks of *P. obscura* are overexploited and are not sufficient to met local demands. Its extensive farming system has already started in some African countries. Successful farming of this species in intensive systems and semi—intensive can help not only to preserve and enhance natural stocks of *P. obscura* but also to continuously produce fingerlings remediation technologies for direct human consumption.

Keywords *Parachanna obscura* · Biology · Ecology · Aquaculture · Farming

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Introduction

Fish provides 22 % of the protein intake in sub-Saharan Africa (FAO 2006). However, this region, despite its enormous natural potentiality, provides only 0.16 % of world aquaculture production estimated at 59.4 million tonnes (FAO 2006). Most African countries rely on imports of fish to meet local demand for fish products. This situation created a real gap. In order to reduce imports and to better meet the needs of African fish consumers, fish production in this region should grow by 267 % compared to the situation of 2006 by 2020 (FAO 2006). The development of aquaculture through the farming of endemic species of African inland waters is necessary. Some neglected species like *Parachanna obscura* (Gunther 1861) which reveal interesting aquacultural potential have been identified.

Parachanna obscura is a hardy species that supports stressful conditions. This is the most widespread African Channidae (Bonou and Teugels 1985). The rapid growth (2 g/day) (Dabbadie 1996), and the

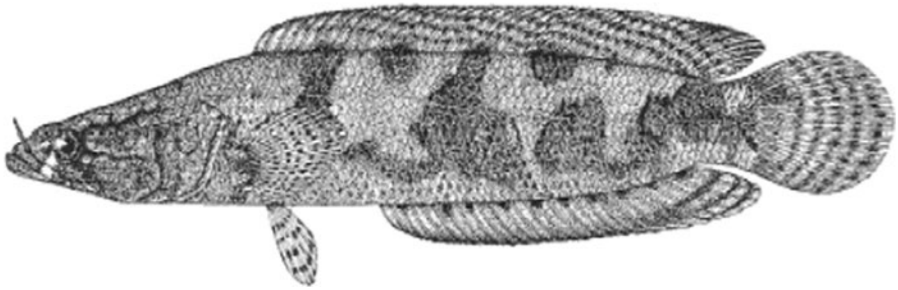

Fig. 1 Lateral view of *Parachanna obscura* (Bonou and Teugels 1985)

great economic value of *P. obscura* represent a great potential for African aquaculture (Micha 1974; Fagbenro 1989; Ng and Lim 1990; Akpocha and Victor 1992; Bolaji et al. 2011). It is a fish highly appreciated by the people of Africa because of its high gastronomic quality but its production by wild natural continental water can not meet local demands (O' Bryen and Lee 2007; Anonymous 2010). It was being cultured in extensive farming system in Ivory Cost (Lazard and Legendre 1994), Cameroon, Nigeria, Gabon and Democratic Republic of Congo (De Graaf 2004; FAO 2007; Bassey and Ajah 2010). In these culture conditions, it can reach 1 kg after 4–5 months (De Graaf et al. 1996; Bolaji et al. 2011). Therefore, domestication and intensive breeding of *P. obscura* are urgently required to kick-start its sustainability aquaculture. This option can help to preserve, to strengthen the natural stocks of *P. obscura* and to produce continually its juveniles for sale in the markets. Achieving this objective requires the mastery of biology, ecology and aquacultural potential of *P. obscura*. This article summarizes the results of the various studies on *P. obscura*.

Morphological characteristics

The Channidae are a family of freshwater fish commonly called "snakehead fish" or "snakehead" and met in Africa and Asia (Blanc 1963). However, African Channidae (Parachanna) is distinguished from Asian Channidae (Channa) by the absence of lamellae on the first epibranchial bone, and a hyomandibula that supports the suprabranchial organs. The genus Parachanna has four species: *P. fayumensis* (fossil); *P. insignis*, *P. africana* and *P. obscura* (Bonou and Teugels 1985; Murray 2006).

Parachanna obscura has an elongated body, fusiform, subcylindrical, covered with cycloid scales of medium size (Fig. 1). The head is depressed anteriorly, relatively long and covered with cycloid scales larger than those on the body and symmetrical on the top. The relatively large and lateral eyes allow it to quickly locate prey. Two nostrils are on either side of the muzzle. One pair of nostrils is anterior and tubulated. The mouth is large and protractile. The lower jaw is slightly longer than the upper jaw and bears 4–6 well—developed canines. Lateral line is single, typically complete with 65–78 scales. The dorsal and anal fins are elongated. They have soft fin rays in alls fins and do not touch the caudal ones. The dorsal fin starting above pectoral fins and has 39–45 spiny rays while the anal has 26–32. The caudal fin is slightly rounded and has 14 spiny rays. The pelvis fin are abdominally positioned, spineless, soft and near to the pectorals (Teugels and Daget 1984; Bonou and Teugels 1985; Fapohunda and Godstates 2007).

Juveniles and adults of *P. obscura* are colored black or blackish olive on the dorsal side and flanks. 5–8 dark spots more or less rounded or geometric can be found along the flanks. The ventral side has ochre marbling colouration. A few dark spots that tend to connect to those sides are present on the back, on either side of the ridge. The head bears a lateral dark band that is enlarged behind the eye and extends to the posterior edge of the opercula. Small dark maculae forming more or less distinct oblique bands are on the fins. A small black and rounded spot is at the base of the caudal fin. The fry are generally with ochre base body colouration with black side in the middle of the flank, from the tip of the snout to the tip of the caudal fin (Bonou and Teugels 1985). *P. obscura* larvae are yellow (Gosse 1963).

Taxonomy

Ophioceplalus obscurus (Senna 1924), *Channa obscura* (Myers and Shapovalov 1931) or *Parophiocephalus obscurus* (Berg 1940) are synonymous for *Parachanna obscura* (Gunther 1861). According to Teugels and Daget (1984), Bonou and Teugels (1985), Paugy and Levêque (2006a, b) and Teugels (2007), *P. obscura* belongs in the Kingdom: Animalia; the Phylum: Chordata; the Subphylum of: Craniata (Vertebrata); the Super-class: Gnatostoma (presence of jaw); the Class: Osteichthyes (Bony fish); the Subclass: Actinopterygii (presence of dorsal, anal and gular plate); the Infra-class: Neopterygii; the Division of Halecostomi; the Subdivision: Teleostei; the Infra-division: Euteleostei; the Super order: Acanthopterygii (no the Weberian apparatus); the Order: Perciformes; Suborder: Channoidei; Family: Channidae; Genus: Channa and Parachanna.

Geographical distribution

Parachanna obscura is the most common species among African Channidae (Fig. 2). It is present in most coastal basins. It is present in Gambia, Sierra Leone, Senegal, Guinea, Mali, Ivory Coast and Cameroon (Bonou and Teugels 1985; Koné et al. 2003). It also occurs in the Sudan (Bailey 1994), Ethiopia (Golubtsov et al. 1995), Chad, Congo and Democratic Republic of Congo (Mamonekene and Teugels 1993), Gabon and Central African Republic (Micha 1974), Niger (Moussa 2004), Burkina Faso (Blanc and Daget 1957), Ghana (Dankwa et al. 1999; Ansah 2010), Togo (Daget 1950) and Benin (Lalèyè et al. 1997, 2004; Murai et al. 2003; Amoussou 2010).

Habitat

Parachanna obscura is benthopelagic and potamodromous fish thriving in harsh environment (Riede 2004). Most studies (Gosse 1963; Bailey 1994; Riede 2004; Levêque 2006; Adeosun et al. 2011) showed that *P. obscura* lives in freshwater, in the creeks of swamps, ponds, streams, rivers, lakes, lagoons, marshes and floodplains. In flowing waters, *P. obscura* preferred calm and muddy areas, marginal vegetation to muddy (Teugels et al. 1992). It is held in the aquatic vegetation and often remains motionless as if asleep, hence the name of "sleeping fish" (Bonou and Teugels 1985).

Physico-chemical requirements

Parachanna obscura is a species strictly tropical species that can support water temperature range between 25 and 28° C and prefers slightly acidic pH (6.5–7.5) (Riehl and Baensch 1991). It has adaptations to life in hypoxic environments. Indeed, the studies of Gras (1961), Daget and Iltis (1965), Fagade and Olaniyan (1974), Liem (1980), Vierke (1978), Pinter (1986) and Lee and Ng (1991) on the requirements of dissolved oxygen of Channidae have shown that they can live in water with low dissolved oxygen and high ammonia levels. Snakeheads possess a cavity above the gill chamber, which functions as an accessory respiratory organ. This organ is in the form of two pharyngeal suprabranchial chambers allowing them to breathe directly atmospheric air (Bertin and Arambourg 1958). This anatomical specificity permits it to live in muddy water relatively poor in dissolved oxygen.

The water nitrogenous contents toxicity thresholds specific to *P. obscura* is not yet study. However, in aquaculture, the recommended limits for NH_3, NH_4+, NO_2^- and NO_3^- are respectively 0.002, 1.0, 0.01 and 0.1 mg/L (Wedmeyer 1997).

Parachanna obscura prefer freshwater with low salinity. It is caught when the water of the lagoon is fresh or with salinity less than 1 ‰ (Fagade and Olaniyan 1974).

Diet

Snakehead can easily consume a smaller fish of more than half its length (Diana et al. 1985). *P. obscura* is a voracious pelagic carnivore, a formidable predator, a typical piscivorous, an insectivore and a consumer of crustaceans (Reed et al. 1967; Bonou and Teugels 1985; Bailey 1994; Paugy and Levêque 2006b). The diet depending on the developmental stages of *P. obscura*. Larvae feed on algae and protozoa (Blache et al. 1964). An analysis of stomachal contents of juveniles and adults of *P. obscura* showed not only the presence of fry of different fish species but also insects, tadpoles,

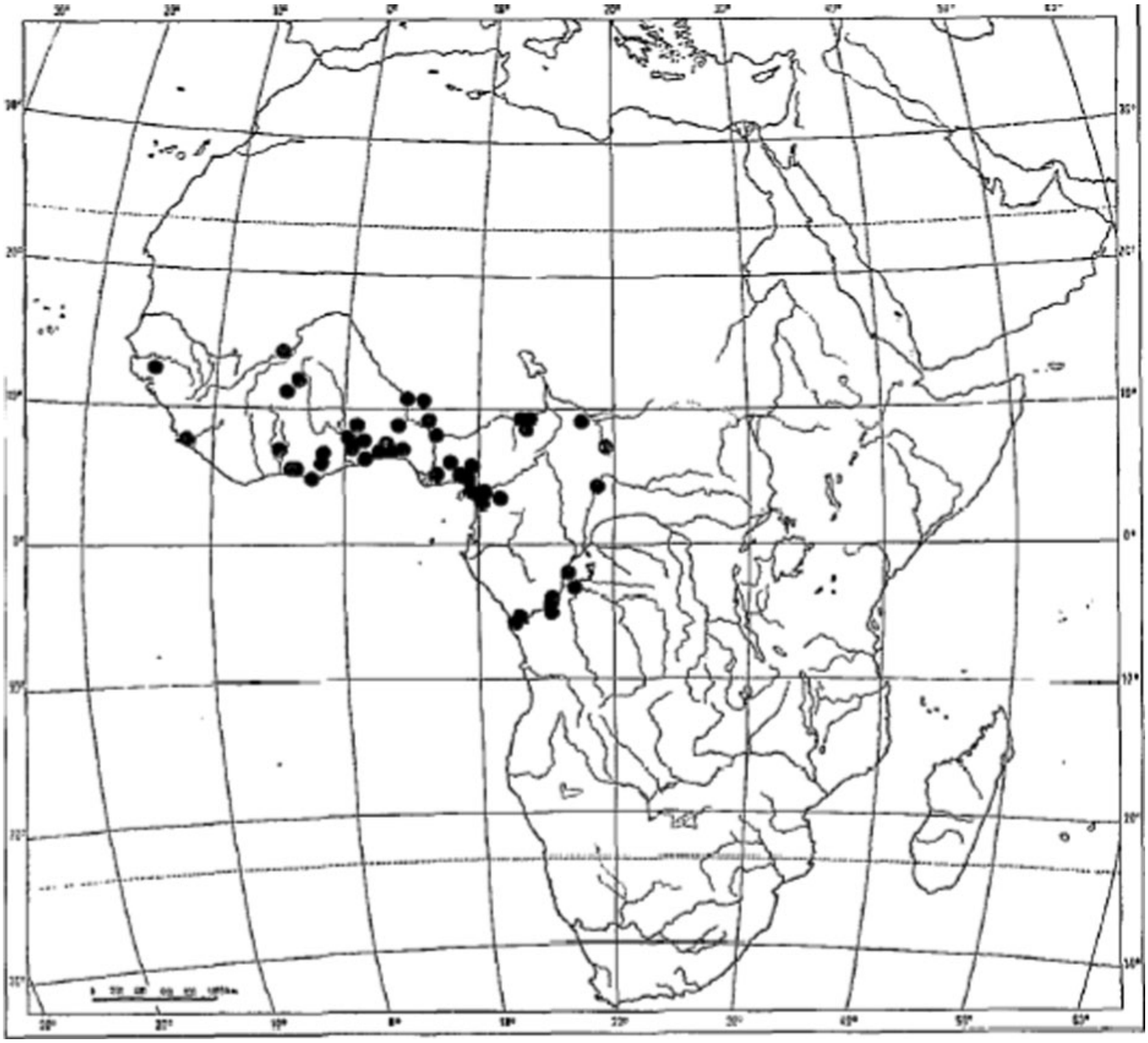

Fig. 2 Geographical distribution of *Parachanna obscura* (Bonou and Teugels 1985)

copepods and shrimps (Imevbore and Bakare 1970; Adebisi 1981; Elliot 1986; Hickley and Bailey 1987; Fagbenro 1996; Idodo-Umeh 2003; Ekpo 2004).

Omotosho (1998), Ama-Abasi and Affia (2010) and Bolaji et al. (2011) showed that juveniles and adults of *P. obscura* are omnivores because they eat fish, detritus, insects, macrophyte materials, worm and plant detritus. They are insectivores-piscivores-invertivores.

Also, *P. obscura* has a background enzyme allowing it to digest proteins, fats and carbohydrates contained in food (Fagbenro et al. 2005; Odedeyi 2007). Thus, various glycosidases (amylase, sucrase, maltase and lactase), proteases (trypsin, chymotrypsin and pepsin) and lipases were detected in the different regions of its gut. *P. obscura* is a piscivorous species which has a well-differentiated stomach and the ratio between its total intestinal length and standard length is equal to 0.55 (Paugy et al. 1994).

Growth

Parachanna obscura has a remarkable growth performance (2 g/day) (Dabbadie 1996) and can reach a

Table 1 Values of constants «a» and «b» in the relationship $W = aL_S^b$ between total weight (W) and standard length (Ls)

Ecological area	a	b	References
Cross River (Nigeria)	0.0098	2.904	King (1996)
Adadama Lake (Nigeria)	0.0063	3.134	King (1996)
Imo River (Nigeria)	0.0059	3.088	King (1996)
Cross River (Nigeria)	0.0014	2.75	Ama-Abasi and Affia (2010)
Enyong Stream (Nigeria)	0.0018	2.607	Bolaji et al. (2011)

maximum total length of 56 cm (King 1996; Olaosebikan and Raji 1998). Its maximum body weight up to 1 kg (Ita 1984). When the fry *P. obscura* are used to control the recruitment of *Oreochromis niloticus* with a predator–prey ratio of 1: 30, they can reach 1 kg after 4–5 months (De Graaf et al. 1996; Bolaji et al. 2011).

Several authors studied the relationship between the standard length and the total weight of *P. obscura* specimens, expressed as $W = aLs^b$ (W = total weight, in g; Ls = standard length, in mm). These relationships between the length and the body mass established in different ecological areas by King (1996), Ama-Abasi and Affia (2010); Bolaji et al. (2011) showed that the values of the exponent "b" are close to "3" (Table 1). Length-weight regression was allometric in favour of weight. This is consistent with observations on the majority of tropical fish communities (Royce 1972; Lagler et al. 1977).

Reproduction

The size at first maturity of *P. obscura* is 24.5 cm (Adebisi 1987). It breeds throughout the year but much more during and just after the flood (Victor and Akpocha 1992). It is a species with iteroparous asynchronous oogenesis wearing oocytes at various stages of development and its fecundity varied with stages III, IV and V (Victor and Akpocha 1992). There is no visible difference between the sexes in this species and sexes could only be determined on dissection of the gonads (Sparre and Venema 1979). It breeds naturally in large aquariums or fish pond with dense vegetation, floating plants and a sandy soil (Victor and Akpocha 1992).

During spawning, partners color changes. The appearance of the male changes it color and its brown color goes to a bright blue and tasks on the sides, usually a dark brown, becoming deep and dark steel blue. In the female, the bright spots on the fins become blue, and brown spots on his body changed to a deeper shade of brown. The tip of the pectoral fins of both male and female become silvery white (Balon 1984). The couple formed circles on the surface of the water in an open area of the layer of floating plants. The circular movements become more intense. The male starts to swim on the back of the female and wraps around his body. In this position, the genitals are side by side. Partners intertwine and remain in that position for 10–20 s. Meanwhile, the female lays eggs which are immediately fertilized by the male. After a short rest, the act of reproduction starts again. The eggs are yellow and have 1.33 mm in diameter. Both parents then guard the eggs (Balon 1984; Adebisi 1987; Lagler et al. 1977). The relative fecundity was 19.46 oocysts/g of body weight (Adebisi 1987). The duration of egg incubation varies with temperature and photoperiod. It is 24 h in a pond and 48 h in an aquarium (Balon 1984). Larvae are yellow. At the 3rd post-hatch day, larvae execute a continuous up and down movement for aerial respiration and become free to swim. Their swim in group as a "cloud" until they reach the size of 3.4 mm and benefit throughout the period of parental care. After around a week the fry are large enough to feed on brine, shrimp, nauplii and microworm (Gosse 1963).

Parasitofauna

Parasites are the most common pathogens the aquaculturist will encounter. Parasitological studies are therefore very important in the development of fisheries potential of freshwater habitat. Studies on the parasitofauna of *P. obscura* showed that it can be infested at various organs by several parasites (Table 2).

Hematology and sensitivity to heavy metals

The use of heamotological parameters in diagnosing the health condition of fish is acquiring acceptance worldwide, as a tool in the management of fish farms

Table 2 Parasites of *Parachanna obscura* and infected organs

Parasites	Trematodes	Cestodes	Nematodes	Myxidium
Species	*Clinostomum metacercaria* (Akinsanya and Hassan 2010; Ogbulie et al. 2003; Akinsanya 2007); *Eutrianchoratus magnum* (Paperna 1969; Dossou 1985); *E. minulus* (Paperna 1969; Dossou 1985) *E. imbachi* (Dossou 1985); *Diplostomum* sp. (Ogbulie et al. 2003); *Capillaria* sp. (Ogbulie et al. 2003); *Acetodoxtra* sp. (Ogbulie et al. 2003)	*Polyonchobothrium* sp. (Ogbulie et al. 2003)	*Paracamallanus cyathopharinx* (Akinsaya and Hassan 2010); *Procamallanus spiralis* (Yakubu et al. 2002); *Camallanus* sp. (Ogbulie et al. 2003); *Spinectus* sp. (Akinsanya 2007); *Contracaecum* sp. (Akinsanya 2007; Akinsanya and Hassan 2010)	*Myxidium parachannae* (Sakiti1997); *M. distichodi* (Fomena et al. 2010); *M. sangei n* sp. (Fomena et al. 2010)
Organs	Intestine	Intestine	Intestine	Gallblader

(Blaxhall 1972; Blaxhall and Datisley 1973). Thus, the characteristics of normal blood *P. obscura* were studied by Kori-Siakpere et al. (2005) and Adebayo et al. (2007). His hematocrit varies between 19.28 and 26.4 %. As for normal levels of leukocyte (10^3/mm^3), hemoglobin (g/dl) and erythrocyte (10^{12}/L), they vary respectively from 4.01 to 19.07, 5.70 to 11.48 and 1.67 to 2.00.

Parachanna obscura has high levels of heavy metals (Cu, Mn, Zn, Cd, Cr, Ni and Pb) in their tissues (gills, offal, muscle and liver (Obasohan 2007, 2008). The results revealed that the concentrations of all the metals in the tissues (offal, gills, muscle and liver) were higher than the concentrations of the metals in water and indicated bioaccumulation. It has been reported that enhanced metal levels in fish tissues arise through bio-magnification at each trophic level and carnivorous bottom feeders concentrate higher metal levels (Porter et al. 1975; Forstner and Wittman 1981). *P. obscura* is a known voracious bottom feeder (Reed et al. 1967; Paugy and Levêque 2006a, b) and could thus have bio-accumulated heavy metal levels from the river sediment in its various tissues.

Moreover, when species of *P. obscura* are exposed to different concentrations of Cadmium; histological changes of the liver showed hepatic separation, bloody appearance, and deposition of a brownish-yellow substance, which increased with rising concentrations of metal. Behavioral changes observed included reduced activity, avoidance response, and deposition of a slimy-whitish film on the body of the fish, which increased with concentration and exposure time (Tawari-Fufeyin et al. 2007).

Prospect for aquaculture

Parachanna obscura has high economic value and represents a good potential for African aquaculture (Micha 1974; Fagbenro 1989; Victor and Akpocha1992; Bolaji et al. 2011). It is not a fatty fish but an intermediate one (Mujinga et al. 2009). Because of its tasty flesh, with only few bones, *P. obscura* is favourite food fish and constitute an extremely important part of the staple food for African people (O' Bryen and Lee 2007). As previously mentioned, it has remarkable growth (2 g/day) and a good commercial value (Dabbadie 1996). *P. obscura* occupies a prominent place in the diet of local people and its natural production can not met local demands (O'Bryen and Lee 2007; Anonymous 2010).

Vitamins were used to induce reproduction of *P. obscura* (Armbrust 1963). *P. obscura* is reared in small reservoirs in hydro-agricultural purpose in Ivory Cost, at the Institute of Savannah (IDESSA) of Bouake (Lazard and Legendre 1994). It is also extensively cultured in Cameroon, Nigeria and Democratic Republic Congo (De Graaf 2004; FAO 2007; Bassey and Ajah 2010). *P. obscura* is used to control the recruitment of *Oreochromis niloticus* with a ratio of predator—prey to 1:30 (De Graaf et al. 1996).

Despite this technical and socio-economic potentiality, *P. obscura* farming in intensive or semi—intensive system has not yet been initiated in Africa. Therefore, domestication of this species should start to provide further guidance for fish farming and diversification of fish species used so far in farming in Africa. Culture of this species will contribute to the much desired increase in the supply of fish protein. Webber and Riordan (1976) stated that one of the main obstacles in the development of aquaculture is the availability of fry. Then, artificial breeding of this species, optimal conditions for successful larval rearing and grow-out phase should be studied. No work has yet been undertaken on nutritional requirements and stocking density of *P. obscura* larvae and fingerlings. Studies on the ideal age of weaning, nutritional requirements both quantitative (ration size) and qualitative (protein and lipid), and appropriate stocking densities at different developmental stages should be conducted.

Conclusion

The development of aquaculture adapted to African inland waters is one of the solutions to the problem of rising imports of fish to the mainland. Some species showing interesting aquacultural potential as *P. obscura*, are identified. *P. obscura* is a hardy, undemanding oxygen species with rapid growth performance. It has high tasty flesh and commercial value. Currently, one of the problems facing the domestication of this species is the absence of external sexual dimorphism. Failing to start its domestication by larvae from artificial reproduction, we can collect larvae or fry of natural water bodies and transfer them to farming controlled systems. Under these conditions, they could be gradually adapted to a pellet covering their nutritional requirements.

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