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Diversity, biology and exploitation of brackish water crabs in West Africa: A review

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ABSTRACT

Crabs are an important biological component of the West African lagoon fauna and are exploited by fishing communities. This paper presents a synthesis of the current understanding pertaining to the diversity, biology and exploitation of these crabs in order to identify promising research paths for this zoological group. A literature review was done. Thirty-two species belonging to thirteen families and twenty-three genera have been indexed by previous investigators and we plan on making use of this information in defining future research direction. The biology of crabs has been the subject of much research focused on *Callinectes amnicola* (Rochebrune, 1883) species. *C. amnicola* is an omnivorous species whose males are known to mature between 63 and 105 mm shell width, while females mature between 83.5 and 116.2 mm shell width. Fertility varies from 0.47 to 4.8 million eggs per female. However, exploitation parameters for this species in various lagoons are not available. A research direction geared towards establishing a new and thorough inventory along with currently nonexistent but relevant exploitation parameters will go a long way in defining sustainable management measures for these crab species.

Keywords: Lagoon crabs, diversity, biology and exploitation, West Africa.

INTRODUCTION

Lagoons and estuaries are considered throughout the world as the most productive aquatic ecosystems (Lalèyè et al., 2007). In the West African tropical region, a succession of lagoons, lakes and estuaries run along the coast (Hardman-Mountford and McGlade, 2002; Lalèyè et al., 2007; Carpenter and De Angelis, 2014). Along the Gulf of Guinea, between Côte d'Ivoire and Nigeria, these ecosystems cover about 3,000 Km^2, with highly diversified living resources that are intensely exploited by a human population of a variety of backgrounds (Lalèyè et al., 2007). This exploitation focuses mostly on fish and crustaceans (Penaeid shrimps and Portunid crabs). Crabs, on the other hand, are a major component of lagoon fauna (Le Loeuf and Intès, 1968; Fischer et al., 1981), represent an important food resource for humans, and are the subject of a remarkable economic activity (Thiam and Diallo, 2010). Worldwide, total crab catches were estimated at 1.2 million tons in 2003 (Thiam and Diallo, 2010).

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However, it should be emphasized that since crabs are coastal creatures that are quite easy to catch, this figure is exclusive of individual and small-scale catching; especially in developing countries where they constitute are a cheap source of protein (Thiam and Diallo, 2010). Compared with fish and shrimps, however, scientific investigation on crabs as opposed to other fisheries groups such as fish and shrimp is lacking (Udoh and Nlewadim, 2011; Sara et al., 2010). In fact, of the identified publications covering research on crabs in West Africa, the first ones date back to the 1960s, although the last one was published in 2017. Of the earlier ones, the very first two are Monod (1956) and Manning & Holtuis (1981) who established the first inventory of the entire marine, lagoon, and land crabs on the West African coast. Literature review on the exploitation and production of *Callinectes* sp. and *Cardisoma* sp. in West Africa (d'Almeida and Fiogbé, 2008) indicates an insufficient body of knowledge about these two species despite their socio-economic relevance. The authors have suggested that knowledge be improved relative to the estimation and exploitation of stocks as well as to the biological understanding necessary for a successful breeding of *Callinectes amnicola* (Rochebrune, 1883) and *Cardisoma armatum* (Herklots, 1851). Considering the full breadth of diversity in crab species in West African lagoons (Monod, 1956; Manning and Holthius, 1981) and in view of the scientific knowledge produced on this zoological group so far (Akin-Oriola et al., 2005; d'Almeida et al., 2006; Arimoro and Idoro, 2007; d'Almeida et al., 2007; d'Almeida et al., 2008; d'Almeida et al., 2009; George et al., 2009; George and Abowei, 2009; d'Almeida et al., 2009; d'Almeida et al., 2010; Udoh and Nlewadim, 2011; Omuvwie and Atobatele, 2013; Olakolu and Fakayode, 2014; Sankare et al., 2014 a; Onyekachi and Edah, 2014; d'Almeida et al., 2014), it appears necessary to have a review in order to establish what the current understanding on this group of crustacean is. We review known lagoon crab species in the Gulf of Guinea, their biology, and exploitation in order to identify relevant research prospects for this zoological group.

To attend this objective, publications touching on lagoon crabs in West Africa were identified using Google Scholar, Scopus, and Agris databases as well as UAC (University of Abomey-Calavi) and the Benin Ministry of Agriculture, Livestock, and Fisheries libraries. Publications search was conducted using the keywords *crabe lagunaire*, *Afrique de l'Ouest* (French) or *lagoon crab*, *West Africa* (English) (Assogbadjo et al., 2011; Wiegleb, 2016; Gangbè et al., 2016; Pochet, 2017). Database of crustacean catalogs of the France National Museum for Natural History, of the US National Museum of Natural History, and of the Leiden Natural Museum were also used. A list of crab species was established using species nomenclature as defined by Ng et al. (2008) as well as the recent systematic revised versions (Shahdadi and Schubart, 2017).

The present synthesis of current scientific knowledge on brackish water crabs in West Africa focuses on species encountered in Benin, Ghana, Côte d'Ivoire, Nigeria, and Togo (Figure 1). This review is made as a prelude to establishing an inventory and framing future research aimed at a promising exploitation of these species in Benin.

LAGOON CRABS DIVERSITY IN THE GULF OF GUINEA

Thirty-two crab species are reported in lagoons and associated mangrove habitats from Côte d'Ivoire to Nigeria. These species are divided into twenty-three genera and thirteen families (Table 1).

According to available literature, the highest species richness of lagoon crabs is observed in Nigeria (twenty-three species) and the lowest is observed in Togo (two species). Country size as well as the lagoons selected for developing the inventory justifies the observed gap. Regional surveys conducted during colonial times and around the period of the independence movement in West Africa have not included all the lagoons in such countries as Benin or Côte d'Ivoire. In Benin, no crab species have been reported in the

coastal lagoon, in the Porto-Novo Lagoon, nor in Ahémé lake. This situation equally applies to the Grand Lahou and Aby lagoons in Côte d'Ivoire, as well. Subsequent surveys carried out in Benin, Nigeria, and Côte d'Ivoire revealed that twelve species were not reported in the first regional surveys, namely: *Callinectes sapidus, Callinectes danae, Callinectes marginatus, Geryon maritae, Gecarcinus weileri, Portunus validus, Menippe nodifrons, Pilumnopeus caparti, Ocypoda cursor, Grapsus grapus, Pachygrapsus transversus, Cyclograpsus integrer*. Unlike regional surveys, it is not possible to have access to the collections of national surveys because the authors have not specified the places where reported specimens are kept. New surveys on lagoon crabs are needed. Possibilities of molecular tests could be envisaged. Indeed, recent taxonomic overhauling has affected species of the *Perisesarma* genus in the West African carcinological fauna (Shadadi and Schubart, 2017). Assessing biodiversity according to UICN criteria would also be useful in the face of anthropogenic pressures on natural resources in general and on fisheries resources particularly. Edible species, which are economically important, are more the focus of biological and ecological investigations.

LAGOON CRABS BIOLOGY IN THE GULF OF GUINEA

Available information on the biological aspects of lagoon crabs covers more than 75% of the crab population encountered in Nigerian lagoons (Qua Iboe, Okpoka, Ojo, and Lagos lagoons), in Côte d'Ivoire lagoons (Ebrié, Aby, Grand Lahou and Fresco lagoons), and in Ghanaian waters (Mukwe and Sakumo). This information focuses mainly on *Callinectes amnicola* (Rochebrune, 1883), an abundant and economically-important species. Other scarcely-studied species include *Callinectes pallidus* (Rochebrune, 1883), *Cardisoma armatum* (Herklots, 1851) and *Guinearma huzardi* (Desmarest, 1825).

Callinectes amnicola (Rochebrune, 1883)

Callinectes amnicola has an omnivorous diet that varies with crab size (Sankaré, 2007; George et al., 2009; Santhanam, 2018). The diet consists of oligochaetes, polychaetes, pelecypod molluscs, crustaceans, and aquatic insects (Sankaré, 2007) in Côte d'Ivoire waters. Specimens smaller than 5 cm in size tend to have a scavenger-type diet, while those whose size is between 5 and 10 cm are carnivorous (Sankaré, 2007). In the Lagos lagoon (Nigeria), diet is composed of lobsters, fish, mollusks, and crabs (Onyekachi and Edah, 2014). Maintaining the focus on Nigeria, diet in the Okpoka River is composed of crustaceans, fish, mollusks, annelids, algae, sand particles, and crab parts (George and Abowei, 2009).

Reproduction in *Portunidae* crabs occurs through mating. Crabs capable of swimming have a sexual dimorphism that is already detectable in post-larval stages (Bourgeois-Lebel, 1980; Charles Dominique et Hem, 1981; Sankaré, 2007; Arimoro and Idoro, 2007; Jivoff et al., 2007). *C. amnicola* reproduction in Ebrié Lagoon (Côte d'Ivoire) is characterized by female migration from desalinated zones to the meso-euhaline areas near Vridi channel. This migration is followed by gonad maturation. Males are much more sedentary and are found in oligohaline waters, sometimes in fresh waters (Charles Dominique and Hem, 1981). Studies describing differentiation in *C. amnicola* reproduction organs, with scales of sexual maturity, have been carried out (Charles Dominique and Hem, 1981; d' Almeida et al., 2006; d' Almeida et al., 2007; Sankaré, 2007; d' Almeida et al., 2008; d' Almeida et al., 2009; d' Almeida et al., 2010; d' Almeida et al., 2014). These sexual maturity scales display 7 stages. Table 2 shows size at first sexual maturity for the identified species in some of the lagoons in the study area. The biological cycle of the species described by Lhomme (1994) is presented on Figure 2.

Callinectes pallidus (Rochebrune, 1883)

Callinectes pallidus biological cycle occurs in both seawater and lagoon (Lhomme, 1994). Indeed, C. *pallidus* is a coastal marine species that penetrates mesohaline brackish

waters (Monod, 1956; Williams, 1974; Manning and Holthuis, 1981). Its diet was studied in the Ojo Estuary in Badagri, Nigeria. It consists of fish, molluscs, crustaceans, macroscopic plants, algae, sand particles, and unidentified masses (Jimoh et al., 2014; Santhaman, 2018). Males consume more fish while females consume more plants. No reproduction parameters of this species are available.

***Cardisoma armatum* Herklots, 1851**

Studies on *Cardisoma armatum* have focused on its ecoethological parameters, diet, and reproduction. This species colonizes more clay soils, has a mainly phytophagous diet, and feeds mainly on *Paspalum vaginatum* leaves, palm nuts (*Elaeis guineensis*), and coconut (*Cocos nucifera*) (Hounga, 1999). It has an active phase on the land surface at night and an apparent resting phase in burrows in the daytime (Mensah and Gbeto, 2001). Akin-Oriola et al. (2005) have investigated the morphometric, meristic, and growth parameters in *C. armatum* compared with those of *C. pallidus*. Morphometric and meristic parameters and weight-length relationship in *C. armatum* were also compared with those in the *C. amnicola* swimming blue crab in the Nokoué Lake/Porto-Novo Lagoon complex of Benin (Goussanou et al., 2017a). Embryonic development in *C. armatum* has also been described (d'Almeida et al., 2014). It appears that its embryonic development involves a transformation process of a telolecith egg into larva. Fertilized eggs exude from the cavity of gravid or grainy females through gonopores and attach to the bristles of biramous pleopods. These females become ovigerous in the abdomen where embryogenesis takes place and involves the stages of segmentation, gastrulation, and organogenesis. Macroscopically, fertilized eggs and germs shape a cluster whose color changes from orange to yellow, to gray, and finally to black. At the end of this process, the embryos are released into the aquatic environment to undergo actual larval development which, after metamorphosis, will give a juvenile crab that comes out of the lagoon environment to live its life on earth. This explanation supports the occasional arrival of *C. armatum* into lagoon waters (Akin-Oriola et al., 2005). It, however, has to be noted that the *C. armatum* sexual maturity scale, its breeding season, and its first maturity size in various environments in the sub-region are still unknown and are part of the questions future research should address.

***Guinearma huzardi* (Desmarest, 1825)**

The diet of this species consists of mangrove leaves, fish, and other crabs (Lawal-Are and Nwankwo, 2011). The same authors have observed a sex ratio in favor of males. Fertility ranges from 1.5 to 3.5 million eggs with egg diameter ranging from 0.21 to 0.33 mm.

Two species have mainly been the focus of biology-related investigations: *Callinectes amnicola* and *Cardisoma armatum*. Knowledge gained from the biology and ecology of *Callinectes amnicola* is an essential basis for the establishment of sustainable management measures based on biological indicators. Future diet-related investigations focusing on daily dietary habits and an estimation of dietary requirements will be useful to feeding efficiency within the framework of farming this species. As for reproduction parameters, knowledge of the size at first maturity as well as the breeding season and preferred breeding grounds on each lagoon are essential for the sustainable management of crabs.

Regarding *Callinectes pallidus*, the total lack of information on the reproduction of the species will have to be filled in order to understand its life cycle and to assess its exploitation rate in the lagoons of the Gulf of Guinea.

As far is *Cardisoma armatum* is concerned, existing work makes it possible to understand that its life cycle occurs on the earth with an occasional introduction in lagoon waters, just as swimming crabs do (Akin-Oriola et al., 2005). The scale of maturity applicable to the species, its breeding season, and the size at first maturity in the various West African environments are yet to be established. Available information on its

biological life does not, as yet, allow making a statement on the extent of its exploitation.

EXPLOITATION OF LAGOON CRABS IN THE GULF OF GUINEA

Available knowledge relating to the exploitation of lagoon crabs covers primarily the *Callinectes amnicola* species in a few countries. As well, exploitation statistics do not cover that much of a continuous timespan and are derived from short-term investigations. Compiled data is shown in Table 3.

In Côte d'Ivoire lagoons, most *Callinectes amnicola* fishing is done by gillnets. This gear has a potential danger for the maintenance of the fertility of the stock, since catches are generally made before breeding, and fishing pressure seems very high (Charles Dominique and Hem, 1981, Lhomme, 1994). On the Ebrié lagoon, Charles Dominique and Hem (1981) have reported the following select crab fishing gear: gillnets; crab trap, and multiply-hooked lines. On the other hand, the poorly selective gear which captures almost all size classes include gillnets, seines, and purse seines.

From 2006 to 2009, average catch per unit effort was 33 kg/landing for the Fresco Lagoon, 16.5 to 32.25 kg/landing for the Grand-Lahou Lagoon, from 25 to 38.5 kg/landing for the Ebrié Lagoon and from 5 to 88.25 kg/landing for the Aby Lagoon (Sankaré et al., 2014a).

In the Lagos Lagoon of Nigeria, circular lift net and wire basket traps are fishing gears inventoried (Babatunde, 2008). The catch per unit effort varies from 2.5 to 15 crabs for circular lift net (very selective gear) as opposed to 5.6 to 17 crabs for wire basket trap. In Benin, crab fishermen are estimated to number roughly 2030, including 588 women (Gnimadi et al., 2008).

The socio-economic importance of *Callinectes amnicola* in West African lagoons (Le Loeuf and Intes, 1968, Gnimadi et al., 2008, d'Almeida and Fiogbé, 2008) justifies the fact that the available exploitation information is relevant only to this species. Crab catches have generally doubled in Beninese lagoons between 2000 and 2008. This increase is also observed in Ivorian lagoons with the exception of the Aby Lagoon where catches have decreased (Sankaré et al., 2014a). The decrease in catches in the Aby Lagoon is related to the increase in the number of fishermen, fishing gear, the catching of females, and the closure of the lagoon's natural channel (Sankaré et al., 2014b). From Côte d'Ivoire to Nigeria, exploitation parameters have not been evaluated. However, this information is available on other economically-important *Portunid* crabs such as *Portunus pelagicus* and *Portunus sanguinolentus* elsewhere in the world (Muller et al., 2006; Dash et al., 2013; Chutapa et al., 2014). Dash et al. (2013) report an exploitation rate of E = 0.61 for *Portunus sanguinolentus* in India between 2009 and 2010. In Thailand, Chutapa et al. (2014) have reported an exploitation rate of E = 0.71 for *Portunus pelagicus* between 2008 and 2009. Analyzes are made by these authors, which gave recommendations for sustainable management of crab fisheries. The FiSAT II software (Sparre & Venema, 1998) which uses the size frequencies to generate the population and exploitation parameters is used. Considering the strong fishing pressures reported on the *Callinectes amnicola* species in West African lagoon environments (Charles Dominique and Hem, 1981; Lhomme, 1994; Gnimadi et al., 2008; d'Almeida and Fiogbé, 2008; Sankaré, 2007; Sankaré et al., 2014a; Sankaré et al., 2014b), it is highly recommended to evaluate the exploitation parameters of the *Callinectes amnicola* species in the various lagoon ecosystems in the Golf of Guinea. The socio-economic importance of crab fisheries also deserves to be studied. As for the *Cardisoma armatum* land crab, apart from catching by traps known in West African countries, catch statistics are not available.

FARMING LAGOON CRABS IN THE GULF OF GUINEA

Callinectes amnicola farming trials have been tested and show that it can be done in drainable ponds (Sohou et al., 2016;

Goussanou et al., 2017b). Effective command of the control of the *Scylla serrata* brackish water crab farming, which belongs to the same family as *Callinectes amnicola* (Mirera, 2014; Davis, 2004), can serve as a basis for further domestication studies. With regard to *Cardiosoma armatum*, the conditions of its rearing in pens have also been studied (Edéa et al., 2015). The rearing in pens (sandy substrate with fresh water) is still unsuccessful (Mensah and Gbeto, 2001; Edea et al., 2015). The artificial reproduction of the species and larval development are described by Cuesta and Anger (2005) in an aquarium. A salinity of 25‰ allows the best survival of eggs and larvae through metamorphosis. Subsequent trials should take into account this optimum salinity value for crab farming purposes.

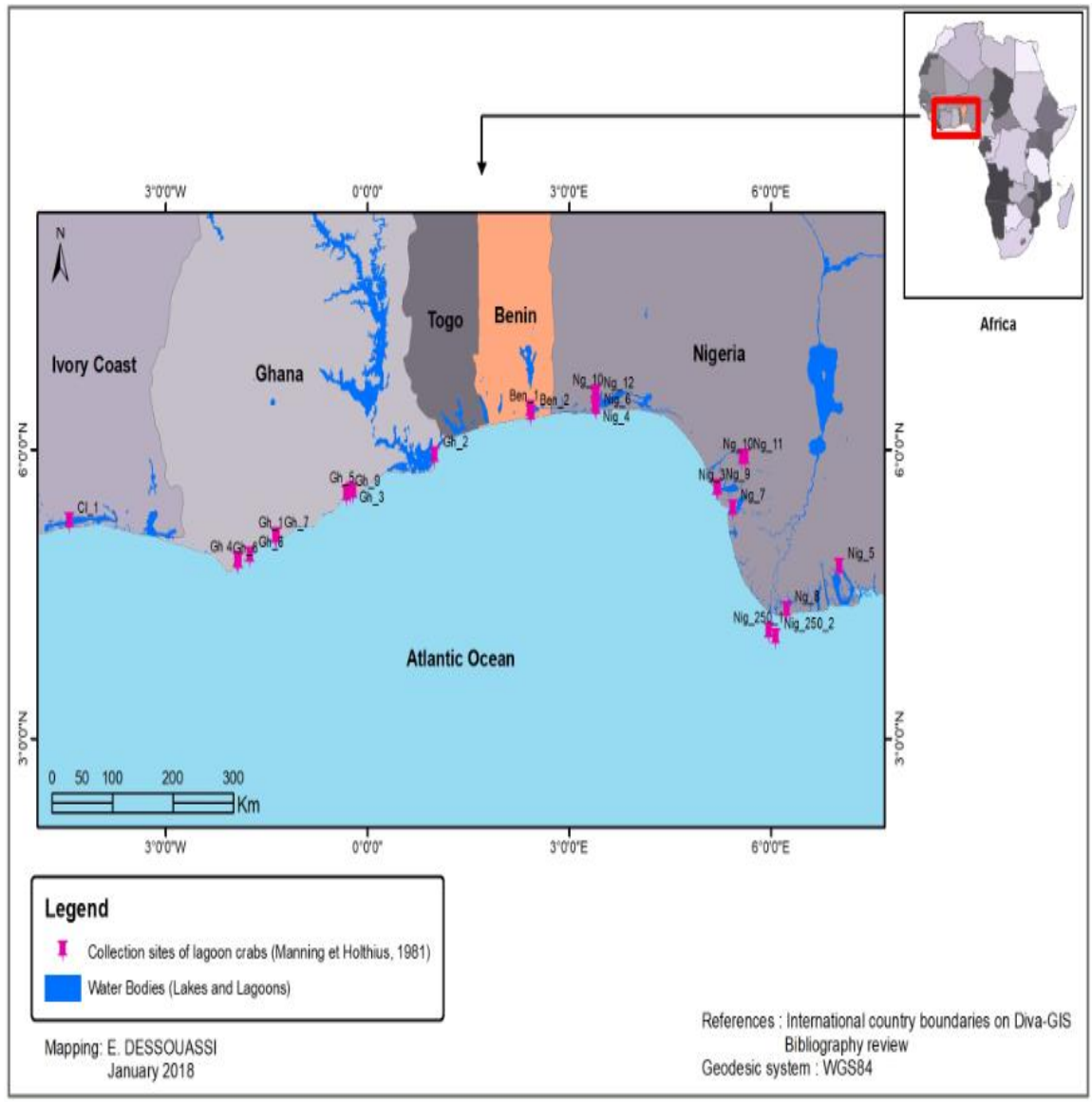

Figure 1: Geographical area covered by the review.

Table 1: List of crab species identified in the lagoons of five countries on the Gulf of Guinea.

Family/Species	Country	Museums/ Register Number	References
Dromiidae			
Sternodromia monodi (Forest & Guinot, 1966)	Nigeria	RMNH.CRUS.D.27151 RMNH.CRUS.D.27152	Manning and Holthuis (1981)
Dorippidae			
Phyllodorippe armata (Miers, 1881).	Nigeria	RMNH.CRUS.D.23325	Manning and Holthuis (1981)
Menippidae			
Menippe nodifrons Stimpson, 1859	Côte d'Ivoire	N/A	Sankaré (2005)
	Benin	N/A	Hountogan (2012)
Euryplacidae			
Machaerus oxyacanthus (Monod, 1956)	Nigeria	RMNH.CRUS.D.44442	Manning and Holthuis (1981)
Parthenopidae			
Parthenopoides massena (Roux, 1830)	Nigeria	RMNH.CRUS.D.24025 RMNH.CRUS.D.24026	Manning and Holthuis (1981)
Pilumnidae			
Pilumnopeus africanus (De Man, 1902)	Nigeria	RMNH.CRUS.D.23664	Manning and Holthuis (1981)
	Nigeria	USMN 170334	https://collection.nmnh.si.edu/
	Côte d'Ivoire	USNM	Manning and Holthuis (1981)
	Benin	RMNH.CRUS.D.19944-RMNH.CRUS.D.19946	Manning and Holthuis (1981)
Pilumnopeus caparti (Monod, 1956)	Côte d'Ivoire	N/A	Sankaré (2005)
Portunidae			
Callinectes amnicola (Rochebrune, 1883)	Ghana	RMNH.CRUS.D.58	Manning and Holthuis (1981)
	Ghana	USNM 170116-170118	https://collection.nmnh.si.edu/
	Togo	USNM 143985	Manning and Holthuis (1981) https://collection.nmnh.si.edu/
	Nigeria	USNM 120943	Manning and Holthuis (1981) https://collection.nmnh.si.edu/
	Côte d'Ivoire	N/A	Sankaré (2005)
	Benin	N/A	Murai et al. (2003); Adandédjan (2012); Hountogan (2012); Dessouassi (2014), Mensah (2014)
	Nigeria	RMNH.CRUS. D.15533	Manning and Holthuis (1981); http://bioportal.naturalis.nl

Callinectes pallidus (Rochebrune, 1883)	Nigeria	RMNH.CRUS.D.15532	http://bioportal.naturalis.nl/ (Manning and Holthuis (1981); Amadi(1990); Akin-Oriola et al.(2005)
	Ghana	USNM 14879	Manning and Holthuis (1981) https://collection.nmnh.si.edu/
	Côte d'Ivoire	N/A	Sankaré (2005)
Callinectes marginatus (A. Milne-Edwards, 1861)	Benin	N/A	Aka et al. (1999)
	Nigeria	N/A	Amadi (1990) ; Akin-Oriola et al. (2005)
	Côte d'Ivoire	N/A	Sankaré (2005)
Callinectes sapidus Rathbun, 1896	Benin	N/A	Adandédjan (2012)
Callinectes danae Smith, 1869	Benin	N/A	Adandédjan (2012)
Sanquerus validus (Herklots, 1851)	Benin	N/A	Murai et al. (2003)
Portunus inaequalis (Miers, 1881)	Nigeria	RMNH.CRUS.D.24575-24577 RMNH.CRUS.D.25287	Monod (1956) ; Manning and Holthuis (1981)
Panopeidae			
Panopeus africanus A. Milne-Edwards, 1867	Nigeria	RMNH.CRUS.D.15548	http://bioportal.naturalis.nl/ ; Monod (1956)
	Côte d'Ivoire	N/A	Sankaré (2005)
	Benin	RMNH.CRUS.D.18735	Manning and Holthuis (1981)
Xanthidae			
Nanocassiope melanodactylus (A. Milne- Edwards, 1867)	Nigeria	USNM	Manning and Holthuis (1981)
Gecarcinidae			
Cardisoma armatum Herklots, 1851	Côte d'Ivoire	N/A	Monod (1956)
	Ghana	RMNH.CRUS.D.58	Manning and Holthuis (1981).
	Ghana	MNHN 2403	Monod (1956)
	Togo	N/A	Monod (1956)
	Benin	RMNH.CRUS.D.17890	Manning and Holthuis (1981) ; Adandédjan (2012)
	Nigeria	RMNH.CRUS.D.15472	Manning and Holthuis (1981)
Johngarthia weileri (Slendler, 1912)	Nigeria	N/A	Amadi (1990) ; Akin-Oriola et al. (2005)
Grapsidae			
Goniopsis pelii (Herklots, 1851)	Ghana	RMNH.CRUS.D.68	Manning and Holthuis (1981
	Nigeria	RMNH.CRUS. D.15518	Manning and Holthuis (1981); http://bioportal.naturalis.nl
	Benin	N/A	Hountogan (2012)

	Côte d'Ivoire	N/A	Monod (1956) ; Manning and Holthuis (1981)
Pachygrapsus gracilis (Saussure, 1858)	Nigeria	RMNH.CRUS. D.15553	Manning and Holthuis (1981); http://bioportal.naturalis.nl
	Ghana	USNM 170340	Manning and Holthuis (1981) https://collection.nmnh.si.edu/
	Benin	RMNH.CRUS.D.19935	Manning and Holthuis (1981)
	Côte d'Ivoire	N/A	Sankaré (2005)
Pachygrapsus transversus (Gibbes, 1850)	Côte d'Ivoire	N/A	Sankaré (2005)
Grapsus grapsus (Linneaus, 1758)	Côte d'Ivoire	N/A	Sankaré (2005)
Cyclograpus integer H. Milne Edwards, 1837	Côte d'Ivoire	N/A	Sankaré (2005)
Sesarmidae			
Metagrapsus curvatus (H. Milne Edwards, 1837)	Nigeria	RMNH.CRUS.D.31013 RMNH.CRUS.D.30887 RMNH.CRUS. D.15537	Manning and Holthuis (1981); Shahdadi and Schubart (2017) http://bioportal.naturalis.nl
	Côte d'Ivoire	N/A	Sankaré (2005)
	Benin	N/A	Adandédjan (2012)
	Ghana	RMNH.CRUS. D.182	Manning and Holthuis (1981).
Chiromantes(Sesarma)angolense De Brito Capello, 1864	Nigeria	RMNH.CRUS. D.15538	http://bioportal.naturalis.nl
	Ghana	MNHN 2398	Monod (1956)
	Benin	N/A	Hountogan (2012)
	Côte d'Ivoire	N/A	Monod (1956)
Chiromantes (Sesarma) buettikoferi De Man, 1883	Nigeria	RMNH.CRUS.D.30988	Manning and Holthuis (1981)
	Côte d'Ivoire	RMNH.CRUS.D.19862	Manning and Holthuis (1981)
Armases elegans (Herklots, 1851)	Ghana	RMNH.CRUS. D.150-151	Monod (1956)
	Côte d'Ivoire	N/A	Sankaré (2005)
	Benin	N/A	Adandédjan (2012)
	Nigeria	RMNH.CRUS. D.15567	Manning and Holthuis (1981) ;http://bioportal.naturalis.nl
Guinearma alberti (Rathbun, 1921)	Nigeria	RMNH.CRUS. D.15536	Manning and Holthuis (1981) ;http://bioportal.naturalis.nl
	Côte d'Ivoire	N/A	Monod (1956)
Guinearma huzardi (Desmarest, 1825)	Côte d'Ivoire	RMNH.CRUS.D.19849	Manning and Holthuis (1981)
	Benin	RMNH.CRUS.D.18729	Manning and Holthuis (1981) ; Adandédjan (2012)

	Ghana	RMNH.CRUS.D.132	Manning and Holthuis (1981).
	Ghana	MNHN 2398	Monod (1956)
	Ghana	USMN 170346	https://collection.nmnh.si.edu/
	Nigeria	RMNH.CRUS.D.15539	Manning and Holthuis (1981) http://bioportal.naturalis.nl/
	Nigeria	MNHN 2498	Monod (1956)
Ocypodidae			
Ocypode africana De Man, 1881	Ghana	RMNH.CRUS.D.27227	Manning and Holthuis (1981)
	Benin	RMNH.CRUS.D.18736	Manning and Holthuis (1981) ; Adandédjan (2012)
	Côte d'Ivoire	N/A	Sankaré (2005)
	Nigeria	RMNH.CRUS. D.15517	Manning and Holthuis (1981); http://bioportal.naturalis.nl
Ocypode cursor (Linneaus, 1758)	Côte d'Ivoire	N/A	Sankaré (2005)
Afruca tangeri (Eydoux, 1835)	Ghana	RMNH	Manning and Holthuis (1981)
	Ghana	RMNH.CRUSD. 262	Manning and Holthuis (1981
	Côte d'Ivoire	N/A	Sankaré (2005)
	Benin	N/A	Adandédjan (2012)
	Ghana	RMNH.CRUS.D.15535	Manning and Holthuis (1981

MNHN: French National Museum for Natural History (Paris), USMN: US National Museum of Natural History; RMNH: Leiden Naturalis Museum; NA: museum/register number not available.

Table 2: Size at first sexual maturity in *Callinectes amnicola* in the lagoons of the Gulf of Guinea.

No	First maturity size (cm)		Reproductive period	Females fertility (million eggs per crab)	Area	References
	Male	Female				
1	8	9	March-April and August	0.5 - 2	Côte d'Ivoire: Aby-Tendo-Ehy lagoon complex	Sankaré (2007)
2	6.3	8.35	N/A	1.902 ± 0.24 to 2.82 ± 0.32	Ghana: Mukwe and Sakumo	Kwei (1978)
3	9.16	11.62	N/A	N/A	Benin : Ahémé lake	Dessouassi (2014)
4	10.5	11.0	N/A	0.47 - 4.48	Nigeria : Lagos lagoon	Santhanam (2018)

N/A: Not available.

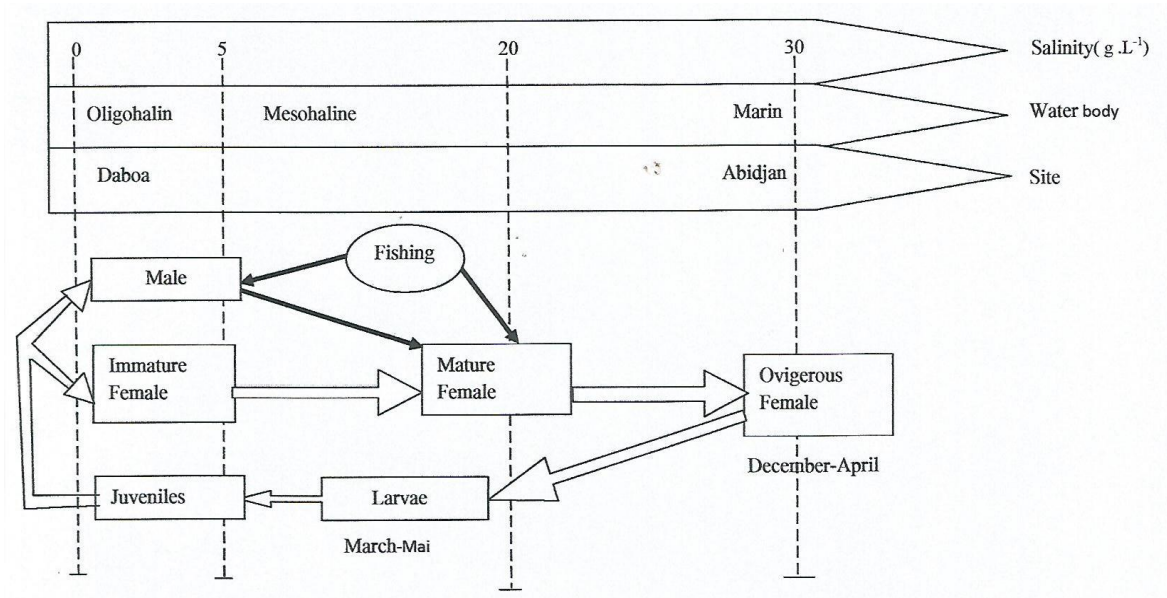

Figure 2: Biological cycle of *Callinectes amnicola* in Ebrié lagoon, Côte d'Ivoire (Lhomme, 1994).

Table 3 : Catch data of *Callinectes amnicola* crabs in a few lagoons in the Gulf of Guinea.

Country	Water body	Reference years	Annual production (tons)	References
Benin	Nokoué Lake	1990 - 2000	2678.605	D/Pêches (2001)
		2016	828	DPH(2016); DPH(2017a); DPH (2017b); DPH(2017c)
	Porto-Novo Lagoon	1990 - 2000	342.28	D/Pêches (2001)
		2016	74.11	DPH(2016); DPH(2017a); DPH (2017b); DPH(2017c)
	Nokoué Lake-Porto-Novo Lagoon	2008	5846.464	Gnimadi et al. (2008)
	Ahémé Lake	1990 - 2000	541.985	D/Pêches (2001)
		2016	79.85	DPH(2016); DPH(2017a); DPH (2017b); DPH(2017c)
	Coastal Lagoon	1990 - 2000	173.6238	D/Pêches (2001)
	Ahémé Lake-Coastal Lagoon	2008	1379.016	Gnimadi et al. (2008)
Côte d'Ivoire	Aby Lagoon	2001	3747	Sankaré (2007)
		2006-2009	2720	Sankaré et al. (2014a)
	Ebrié Lagoon	1975	190	Charles Dominique and Hem (1981)
		1979	825.2	Charles Dominique and Hem (1981)
		2006-2009	2248	Sankaré et al. (2014a)
	Grand-Lahou Lagoon	2006 - 2009	823	Sankaré et al. (2014a)
	Fresco Lagoon	2006 - 2009	14.75	Sankaré et al. (2014a)

Conclusion

The knowledge based on lagoon crabs is variable in Gulf of Guinea countries, namely from Côte d'Ivoire to Nigeria. West African surveys conducted in the 1960s provided information on diversity. This information has been supplemented in some countries (Côte d'Ivoire, Benin, and Nigeria) by national surveys.

Thirty-two species belonging to thirteen families and twenty genera are known in West African lagoon environments. The highest species richness was reported in Nigeria (23 species) and in Côte d'Ivoire (22 species). Seventeen species have been identified in Benin, 11 in Ghana, and 02 species in Togo. *Callinectes amnicola* breeding biology, diet, and growth have been studied in Côte d'Ivoire and Nigeria lagoons. However, the *Callinectes amnicola* breeding season, dietary habits, and growth have been studied in Ivorian and Nigerian lagoons. Breeding areas of this species are not yet known in most of West African lagoons. However, its size at first maturity, breeding season and best breeding grounds are not yet known in most of West African lagoons.

The estimation of exploitation parameters of this species which is intensely caught in different lagoons seems important for management measures.

It is also important to initiate research on the socio-economic importance of *Callinectes amnicola* caught in lagoons. *Cardisoma armatum* species has also been investigated in some biological surveys. The other thirty species are potential research subjects.

COMPETING INTERESTS

The authors declare that they have no competing interests.

AUTHORS CONTRIBUTIONS

CED collected the diversity data and wrote the manuscript. AC and LG collected the biology data. DA collected the exploitation data. DL and PL read and corrected the manuscript.

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