A Rapid Survey of the Decapod Crustaceans of the Boké Préfecture, Guinea

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Chapter 3

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INTRODUCTION

The decapod crustaceans (crabs, shrimps and lobsters) of the mangrove and freshwater ecosystems of Guinea are part of a faunal group that is widely distributed throughout West Africa from Senegal to Cameroon. A checklist of the 20 families and 77 species of decapod crustaceans of the mangrove and freshwater ecosystems of West Africa compiled from literature sources is supplied in Appendix 2. This represents a useful starting point because little is presently known of the crabs and shrimps of Guinea and there are precious few works that specifically focus on the decapod crustaceans of that country (Ushakov 1970). The literature on the marine crabs and shrimps of West Africa (that includes Guinea) is becoming dated (Rathbun 1900; Holthuis 1951; Monod 1956; Manning and Holthuis 1981) and to my knowledge, little new work is now being done. There has been a similar general neglect of the freshwater crabs and shrimps of the inland waters of West Africa (including Guinea), and these are only now becoming known (Powell 1976, 1977, 1979, 1980; Monod 1977, 1980; Cumberlidge 1987, 1991, 1996a,b, 1999; Cumberlidge and Huguet 2003).

Decapod crustaceans are ecologically important because they play a significant role in the ecological processes of aquatic ecosystems, acting at different trophic levels as herbivores, detrivores, predators, and prey. As abundant macroinvertebrates, the decapods constitute a complex group of conspicuous organisms in the mangroves and inland freshwater ecosystems of Guinea. Decapod crustaceans are economically important because shrimps serve as important food resources for the carnivorous fish of the region, and the abundant populations of daytime active crabs (such as fiddler crabs) are important prey for species of wading birds feeding on the exposed tidal mudflats. Finally, decapod crustaceans are medically important because the commonest freshwater crab species (*Liberonautes latidactylus*) is the second intermediate host of *Paragonimus uterobilateralis*, the human lung fluke that cause human paragonimiasis in parts of Guinea. These same freshwater crabs also serve as the hosts of the larvae of biting blackflies (*Simulium*) that are the vectors of *Onchocerca volvulus* the cause of river blindness (onchocerciasis) in parts of Guinea and elsewhere in West Africa.

The present RAP survey focused on three areas in northwest Guinea, one in coastal savanna that borders on a mangrove ecosystem, one in the mangrove ecosystem itself, and one in an inland freshwater savanna ecosystem. The results of these surveys represent the first intensive study of the decapod crustacean fauna of this part of Guinea, and as such are of great value for a better understanding of the species composition and distribution, as well as offering valuable information about the overall status of these ecosystems in this region.

METHODS

A rapid assessment was made of the decapod crustacean fauna of three study sites in the maritime zone of Boké Préfecture in northwest Guinea, West Africa, over a three-week period from 22 April to 10 May 2005. The three main study sites were: Site 1, the freshwater habitats of a savanna ecosystem bordering on coastal mangroves in the vicinity of the Rio Kapatchez; Site 2, the marine and brackish waters of the mangroves in the vicinity of Kamsar; and Site 3, the fresh-

water habitats of the inland savanna ecosystem west of Sangaredi. The sampling localities in site 1 at Sarabaya, Batipon, Kibola, and Songolon in the Rio Kapatchez region consisted of freshwater rivers, streams, swamps, ponds, and permanent marshes in savanna, as well as reclaimed rice fields in former mangrove forest near the mouth of the Rio Kapatchez (which had been dammed and closed off from tidal influence in 1997). The sampling localities in site 2 in the Kamsar region included Kamsar Port, Taïgbé East (N'Tebe), Taïgbé West, Kaiboutou (Kamsar Southeast), Tarénsa (Kamsar North), and Kataméne. The habitats sampled included coastal and estuarine mangrove forests, brackish water tidal rivers, intertidal mudflats, tidal drainage channels, sandy beaches, and rice fields in areas where mangrove forest had been cleared. The microhabitats studied included river banks, burrows dug into mud, sand, and rocky debris, submerged leaf litter, aquatic vegetation, marginal vegetation, the undersides of rocks, and woody debris. The sampling localities in site 3 in the areas around Boulléré village west of Sangaredi included localities along four year-round spring-fed rivers - the Nyblbihoun, Bhoudgehoun, Kerewoul, and Djolijedidi - that are all tributaries of the Tinguelinta River (Appendix 3).

The majority of the sampling was done during the day, with limited sampling at night aided by headlamps. The survey was strictly qualitative and was performed both manually and by using hand nets (mesh size 2 mm), and occasionally basket traps. Due to the rapid nature of this survey, no attempt was made to standardize procedures. Specimens were fixed and stored in 70% ethanol and identified using the keys and descriptions supplied by Rathbun (1921), Monod (1956), Manning and Holthuis (1981), Powell (1976, 1977, 1979, 1980), Monod (1977, 1980) and Cumberlidge (1999). The majority of the sampled material was deposited in the crustacean collection at Northern Michigan University, Marquette, Michigan USA, with duplicate specimens in the Museum of Comparative Zoology, Harvard, Cambridge, Massachusetts.

RESULTS

The decapod crustaceans collected in the three study sites during the RAP included 20 species in 14 genera and 11 families (Table 3.1). The marine and mangrove species of brachyuran crabs belonged to five families - the Ocypodidae (*Uca tangeri, Ocypode cursor*), the Gecarcinidae (*Cardisoma armatum*), the Sesarmidae (*Metagrapsus curvatum, Sesarma (Perisesarma) huzardi, Sesarma (Perisesarma) alberti, Sesarma (Chiromantes) elegans,* and *S. (C.) angolense*), the Grapsidae (*Goniopsis pelii, Pachygrapsus gracilis, and P. transversus*), and the Portunidae (*Callinectes amnicola* and *C. pallidus*). One species of anomuran was collected (the hermit crab *Pseudopagurus granulimanus*) in the family Paguridae. In freshwaters, two species of freshwater crabs belonging to two families, the Potamonautidae (*Liberonautes latidactylus*) and Gecarcinucidae (*Afrithelphusa monodosus*) were collected together with four species of shrimps belonging to three families, the Palaemonidae (*Macrobrachium vollenhovenii, M. macrobrachion*), Atyidae (*Caridinopsis chevalieri*), and Desmocarididae (*Desmocaris trispinosa*). Details of the material collected and the collection localities for each species are provided in Appendix 3.

Sites 1 and 3: Sarabaya and Sangaredi

The climate in the coastal region of northwest Guinea can be characterized as humid with sharply contrasting wet and dry seasons with rainfall of between 2,500 mm and 4,000 mm and a dry season of between 5 to 6 months (from November to April). At the end of the dry season in late April there was very little surface water except for a few low-lying ponds of standing water and most rivers and streams were dry. The decapod crustaceans collected from the freshwater ecosystems in the present study included two species of freshwater crabs and four species of freshwater shrimps. Notably, the rare red-listed freshwater crab species, *Afrithelphusa monodosus* Bott, 1959, was recorded for the first time since its original collection in 1947, and was previously known only from the male holotype (Cumberlidge 1987, 1999). A small series of specimens of *A. monodosus* were collected including the first adult female (Appendix 3). The original vegetation cover found at the collection locality (farmland near the village of Sarabaya) lies in southern Guinea savanna in the semi-deciduous moist forest zone. Specimens of *A. monodosus* were collected from cultivated land from burrows made into permanently moist soil each with a shallow pool of water at the bottom. The soil in this area remains wet year round, even at the end of the dry season after a six-month period without rain. It is assumed that this locality either has an underground water table close to the surface, or a nearby spring. The natural habitat of *A. monodosus* is still unknown but presumably this cultivated land was originally a permanent freshwater marsh. There were no nearby sources of surface water and it is clear that these crabs do not need to be immersed in water (as do their relatives that live in streams and rivers), and that *A. monodosus* can meet its water requirements (such as for osmoregulation and keeping their respiratory membranes moist) with the small amount of muddy water that collects at the bottom of their burrow. This species is clearly a competent air-breather and has a pair of well-developed pseudolungs similar to those seen in the related West African endemic genus *Globonautes. Afrithelphusa monodosus* belongs to the Globonautinae (presently in the family Gecarcinucidae) and as such is one of only five species in two genera that belong to a rare group of freshwater crabs endemic to the Upper Guinea forest block.

The species of shrimps collected in freshwater habitats (sites 1 and 3) belonged to three families, the Desmocarididae, Palaemonidae, and Atyidae. *Desmocaris trispinosa* represents the first record of this endemic West and Central African shrimp genus and species in Guinea. This family comprises only this single genus and only two species. The

Table 3.1. List of species of decapod crustaceans collected during the RAP survey and their collection sites in Guinea.

Family	Scientific Name	Site 1 Sarabaya	Site 2 Kamsar	Site 3 Boulléré
Palaemonidae				
	Macrobrachium vollenhovenii			present
	Macrobrachium macrobrachion			present
Atyidae				
	Caridinopsis chevalierii			present
Desmocarididae				
	Desmocaris trispinosa	present		
Paguridae				
	Pseudopagurus granulimanus		present	
Portunidae				
	Callinectes pallidus	present	present	
	Callinectes amnicola		present	
Potamonautidae				
	Liberonautes latidactylus	present		present
Gecarcinucidae				
	Afrithelphusa monodosus	present		
Sesarmidae				
	Metagrapsus curvatum		present	
	Sesarma (Perisesarma) huzardi		present	
	Sesarma (Perisesarma) alberti		present	
	Sesarma (Chiromantes) elegans		present	
	Sesarma (Chiromantes) angolense		present	
Grapsidae				
	Goniopsis pelii		present	
	Pachygrapsus gracilis		present	
	Pachygrapsus transversus		present	
Ocypodidae				
	Uca tangeri	present	present	
	Ocypode cursor		present	
Gecarcinidae				
	Cardisoma armatum		present	

desmocaridid shrimps are specialized to live in anoxic, organically rich freshwater swamps in conditions where other species of shrimps cannot survive (Appendix 3).

Two of the other three other species of shrimps collected here belong to the family Palaemonidae (*Macrobrachium vollenhovenii* and *M. macrobrachion*) and are migratory species whose larvae need to develop in salt water (Appendix 3). This means that adult females of these species release their newly hatched larvae into the river currents that carry them downstream where they develop via a series of stages in the brackish waters of the coastal mangrove forests. The third species of shrimp collected was the atyid *Caridinopsis chevalieri* which is a small species that is a permanent resident of freshwater streams and rivers, and (like the freshwater crabs) has no larval stages, and shows direct development, whereby juvenile shrimps hatch directly from large eggs (Appendix 3).

Site 2: Kamsar

In Guinea, mangroves are found along a large part of the coastal and estuarine shores and penetrate several kilometers inland up the tidal waters of the estuaries. The landward margins of the mangroves furthest away from the direct influence of saltwater grade into palm swamps and freshwater swamp forests. Stands of the oil palm, *Elaeis guineensis* Jacq., are found in the higher sandy areas of the mangrove forests. The salinity of the waters in the mangrove zone varies from full strength seawater on the seaward side to brackish water of medium salinity in the middle of the zone, to almost freshwater in the parts where major rivers enter the system. In addition to variable salinities, the tidal nature of the mangroves means that the organisms of the mangrove community must deal with large fluctuations in water levels twice daily, from low tides that expose large expanses of mudflats, to high tides which inundate the mangroves. The species of crabs collected in the present study (Table 3.1) are typical members of the brachyuran fauna found in the mangrove forest ecosystems throughout West Africa (Appendix 2). The decapod crustaceans of the mangrove community in Guinea are zoned roughly according to salinity regime, tidal level, and type of substrate. Species that might be expected to also occur in this ecosystem (but that were not collected by the sampling methods used here), represent elements of the mangrove decapod community that constitute the mainly-marine species that enter the mangroves at high tide and leave at low tide. Species of decapods that would be collected in traps and nets set to catch benthic species, and those that actively swim in the water column include brachyuran crabs (in the families Portunidae and Xanthidae), and penaeid and caridean shrimps in the families Penaeidae, Palaemonidae, Atyidae, and Alpheidae. The only crustaceans in this category collected here were two species of the large predatory blue crabs of the genus *Callinectes*.

The limitations of the present survey mean that it is likely that a number of species remain to be found, and that Appendix 2 is not an exhaustive species list. That is, despite previous studies, the complete decapod crustacean fauna of Guinea, as for other parts of West Africa, is still not known. Furthermore, in no single case do we know enough to be able to plot accurately the distribution of any species of decapod crustacean within Guinea. In general, the species best known taxonomically are those from the coastal and freshwater zones that are widespread in the freshwater ecosystems or in the coastal zone of West Africa. Even including the new records made in the present paper, the number of decapod species known to occur in Guinea is still very low, given the extent of the country's dense and varied hydrographic system and the diversity of environments. It is likely that more intensive and comprehensive collecting efforts will increase this number and give a better idea of the composition and distribution of the decapod crustaceans fauna of that country.

DISCUSSION

Decapod Crustaceans in Guinean Freshwaters

As a group the decapods are basically marine, but in the tropics a small proportion of species have made the evolutionary invasion into fresh water and even onto land. Four brachyuran and three caridean families have freshwater representatives in Guinea, but only five families (two brachyuran and three caridean) have penetrated into inland freshwaters beyond the tidal limit, not all of which are entirely independent of seawater for their entire life cycle. Interestingly, true crayfish (Astacoidea) are completely absent from the inland waters of tropical Africa, where the freshwater crabs seem to be their ecological equivalents.

Only two out of the six species of freshwater crabs found in Guinea (Cumberlidge 1999; Cumberlidge and Huguet 2003) were collected during this survey, presumably because of the relatively limited sampling area (northwest Guinea), which lies outside of the recorded range for these other species (*Potamonautes ecorssei, Liberonautes nimba, Afrithelphusa gerhildae,* and *Globonautes macropus*). Three of the four species of freshwater shrimps collected in the present study have already been recorded before from Guinea, but *Desmocaris trispinosa* is a new record for this species in Guinea, extending its range westward from Sierra Leone (Powell 1977; Monod 1977, 1980). The fact that a number of species of West African shrimp (in the families Penaeidae, Atyidae, Palaemonidae and Alpheidae) that occur in brackish and fresh water ecosystems were not collected was presumably because of the time of year that the collections were made. A number of these species are migratory and enter mangrove and freshwater ecosystems only after the rainy season has begun. On the other hand, the absence of such species among the material examined might be related to the collecting methods used here, and to the short collecting period for each site, rather than indicating that they do not occur in the surveyed area.

Two different life history strategies are seen in the decapod crustaceans living in Guinean freshwaters – larval

development and direct development. Larval development is shown by those species whose eggs hatch into a larval stage that requires seawater to develop further. Included in this group are the large-bodied migratory species of shrimps (such as *Macrobrachium vollenhovenii* and *M. macrobrachion*) that live far inland in the upper reaches of freshwater rivers and streams in West Africa (including Guinea) and release their newly hatched larvae into the river currents. The larvae drift passively downstream to coastal environments where they develop and metamorphose eventually into post-larval juvenile shrimp. These juveniles remain there until they are large enough to migrate upstream against the current back to the original adult (freshwater) habitat. Migratory freshwater shrimp species therefore represent important links between the headwaters and estuaries of these rivers in Guinea. Damming rivers and diverting water from rivers may therefore impact larval migration in these species. Furthermore, the exact location of the nursery grounds where larval development is uncertain, but it is either somewhere in the mangroves, or in the offshore waters. We also lack data on the subsequent recruitment of metamorphosed post-larvae to upstream populations of adults, and the factors that control the upstream migration of juveniles.

Direct development is seen in those species whose eggs hatch directly into juvenile shrimps or crabs, thus eliminating all larval stages and the need for a seawater phase in the life cycle. Decapod crustaceans that are permanent residents of freshwater ecosystems have a long evolutionary history in freshwater and typically have a highly modified life cycle in which all larval stages are suppressed and their eggs produce juvenile crabs or shrimps. In Guinea, a number of species of the crabs (Potamonautidae and Gecarcinucidae) and shrimps (Desmocarididae and Atyidae) show direct development. Embryonic development (from egg to first-stage shrimp in *Desmocaris* or to hatchling crab in the freshwater crabs) takes approximately six weeks. Furthermore, female freshwater crabs keep their hatchlings under their abdomen for several more days after they hatch from eggs.

Decapod Crustaceans in Guinean Mangroves

The decapod crustacean fauna of the mangroves of northwest Guinea was found to be typical of that for the West African region (Appendix 2). Most species in Guinea (Table 3.1) have a wide distribution in the mangroves of West and Central Africa from Senegal to Angola, and have already been recorded from other localities in this region (Rathbun 1900, 1921; Monod 1956; Manning and Holthuis 1981; Cumberlidge and Sachs 1989). Considering the habitat similarities of the East Atlantic mangrove ecosystems, and the fact that most species are widely distributed across the entire range wherever mangroves occur, it is highly probable that species that are common in neighboring countries are also found in Guinea. Interestingly, the mangrove communities surveyed in the present study lacked the endemic species and genera of camptandrine crabs (Ocypodidae) and euryrhynchan (Palaemonidae) and desmocaridid (Desmocarididae) shrimps reported for the Niger delta in Nigeria (Powell 1976, 1977, 1979, 1980; Manning and Holthuis 1981). These taxa are nevertheless included in Appendix 2 as potential members of the Guinean fauna.

All of the mangrove decapods in Guinea belong to families that include representatives found in the mangroves elsewhere in the tropics, and in many cases the genera are the same. In a few cases the same species occurs in both West African (East Atlantic) and American (West Atlantic) mangrove communities. Genera such as Penaeus, Alpheus, Palaemon, Macrobrachium, Uca and Sesarma tend to occur in mangrove habitats worldwide and form the basis of the decapod mangrove fauna in each case. The distinctness of the West African mangrove decapod fauna lies in the relative importance of particular families. Compared to the Indo-Pacific mangrove fauna, the West African fauna is deficient in penaeid shrimp and ocypodid crab species, but is relatively rich in alpheid, palaemonid, and desmocaridid shrimps. The difference in the shrimps at least seems partly due to the low salinities of the West African waters that favor caridean shrimps over penaeid shrimps. Nonetheless it is difficult to explain why in most of the world's mangrove communities the fiddler crab genus Uca has four to six species each with its own niche, but in West African mangroves there is only a single species, U. tangeri. This species occupies a very wide series of microhabitats (mud flats, sandy and rocky beaches, both above and below the high tide line, and in mangroves) that are equivalent to several different ecological niches that are occupied by a number of species in mangroves elsewhere in the tropics. Some mangrove crabs (Gecarcinidae, Ocypodidae, Grapsidae and Sesarmidae) are restricted to brackish waters subject to daily tidal fluctuations, while one family (Gecarcinidae) is terrestrial, and lives virtually independently of water. However, the requirement of its larvae for seawater restricts these crabs to coastal environments and they are never found far inland.

Two of the most commercially important mangrove species, the penaeid pink shrimp *Penaeus duorarum* and the swimming crab *Callinectes amnicola,* are not actually permanent residents of the mangrove community. The larval forms that hatch from the eggs of these species are released by the adult females into the plankton where they metamorphose into a series of larval stages until they finally resemble young crabs or shrimps. After this, they migrate into the tidal creeks in the mangroves to complete their growth. Both species are active swimming predators and presumably take advantage of the high productivity of the mangrove ecosystem. The commercial species harvested from the mangrove community for food or for bait consist of shrimp (*Penaeus*, *Palaemon*, *Palaemonetes*, and *Macrobrachium*), swimming crabs (*Callinectes*), and the land crab (*Cardisoma*). *Cardisoma* has a nuisance value because its numerous and extensive deep underground burrows that perforate the coastal lands above the high tide line, thereby providing breeding sites for mosquitoes, and potentially causing leaks in marine barrages, fishponds, and rice field embankments.

Conservation Implications

The decapod crustaceans are extremely important components of the marine, mangrove, and freshwater ecosystems, all of which are seriously understudied. This fauna is important in Guinea not only because it includes a number of economically important species of crabs and shrimps but also because it includes an entire subfamily of red-listed species of freshwater crabs.

All three of the study sites surveyed during this RAP showed a great deal of human disturbance, including the clearing of the semi-deciduous moist coastal forest for farmland (site 1), the cutting of mangrove forest and the building of saltwater dykes for rice farming (site 2), and large-scale slash and burn agriculture (site 3). Despite this, the freshwater crab and mangrove crab communities were found to be more or less intact as far as the ratio of numbers of species expected *vs*. the number of species found, which may mean that most of these animals have flexible habitat requirements that can be easily adapted to human-altered conditions. Population levels of the common creek crab *Liberonautes latidactylus* and *Macrobrachium vollenhovenii* based on the sampling done here are considered to be secure. And the fiddler crab *Uca tangeri* was found to be flourishing, with populations estimated to be in the millions of individuals. *Uca tangeri* was abundant in a number of different habitats, living in colonies of burrows dug in sandy beaches above and below the high water line, burrowing in tidal mudflats and in the *Rhizophora, Avicennia,* and *Laguncularia* zones of mangrove forests, and in rice fields that were once mangrove forests. Also very abundant was the large West African land crab, *Cardisoma armatum,* whose burrow colonies were found almost everywhere on the landward side of the coastal mangrove forests in the Kamsar region (site 2). Land crab populations were estimated here to be in the tens of thousand of individuals. Other mangrove species with very abundant population levels were *Metagrapsus curvatus* and *Goniopsis pelii*, which were captured at almost every locality that was sampled in the mangrove ecosystem.

Boké Préfecture in northwest Guinea lies on the extreme western fringe of the Upper Guinea forest ecosystem that extends from Guinea into Sierra Leone and eastward through Liberia, Côte d'Ivoire and Ghana into western Togo. The Upper Guinea forest has been severely altered by centuries of human activities that have changed the rainfall patterns and the original vegetation, so that today much of the Boké region consists of a humid savanna, rather than forest. Despite this, the Upper Guinea forest supports a biologically rich and diverse assemblage of life with a number of unique species, including an endemic group of freshwater crabs. In fact, this ecosystem is considered to be one of the world's priority biodiversity conservation areas because of its high degree of species endemism. Today this forest is highly fragmented, habitats are reduced, and many of the ecosystem's unique species are threatened, including all five species of red-listed endemic freshwater crabs (IUCN 2004). Taxonomically these crabs are considered different enough from all other species in Africa to warrant their placement in a separate superfamily, family and subfamily (Gecarcinucoidea: Gecarcinucidae: Globonautinae) from the other freshwater crabs found in West Africa (Potamoidea: Potamonautidae). The Upper Guinea endemics are *Globonautes macropus* from Liberia and Guinea, *Afrithelphusa leonensis* (Cumberlidge, 1987) and *A. afzelii* (Colosi, 1924) from Sierra Leone, and *A. monodosus* (Bott, 1959) and *A. gerhildae* (Bott, 1969) from Guinea. All five species of West African endemic crabs are extremely rare and all were originally known only from a handful of preserved type specimens in museums.

From the short time spent in northeast Guinea and the limited areas surveyed, it is difficult to definitively evaluate specific threats to the decapod fauna. It is recommended that further more detailed studies be carried out on the biology and ecology of crustacean species, not just of the surveyed areas, but of the country as a whole. This might be achieved by an incentive program that encourages interest and research by Guinean scientists and their students or employees from local institutions (e.g., Guinée Écologie and the universities) on marine, mangrove, and freshwater crustaceans. Furthermore, the habitats occupied by crustaceans were found to be generally highly altered and not in good conservation status. The main threats to the aquatic environment that may affect the decapod fauna are siltation of rivers, conversion of mangrove forests into rice fields, and deforestation from traditional slash and burn agricultural practices. Continuing and/or intensifying these activities would decrease the availability of suitable habitats for shrimps and crabs and negatively impact the population levels of commercially important species of crustaceans on a middle and long-term basis. The degradation of mangroves and gallery forests in savanna would be particularly harmful because the mangroves and freshwater streams and rivers support the largest biomass of shrimps and crabs. The monitoring of riparian vegetation according to local legislation should also be intensified, and campaigns that promote environmental education aimed at raising the local population's awareness of the importance of gallery forests and mangrove forests to the health of the ecosystems should be encouraged. Studies attempting to recover impacted areas should be promoted. The mangrove ecosystems offer very favorable conditions for the productivity and diversity of crustacean decapods. Mangroves also provide nursery / breeding grounds for commercial species of shrimps and fish, and feeding grounds for a large number of species of wading birds. Mangrove ecosystems deserve special attention when conservation measures are taken because a number of different groups would benefit.

CONSERVATION RECOMMENDATIONS

Site 1: Sarabaya Area

Prior to this study *Afrithelphusa monodosus* was known only from a single specimen collected from 'Boké' in Guinea in 1947, and this species is listed as Critically Endangered (CR

C2b) on the IUCN Red List of Threatened Species (Inland Water Crustacean Specialist Group 1996). The discovery of the presence of the red-listed freshwater crab *A. mondodus* is significant, and encouraging, but it must be remembered that this species is still only known from an estimated population of less than 200 individuals, all from a single locality. Furthermore, the natural habitat of this species is still not known because the new locality is in highly disturbed cultivated land. It is recommended that further surveys of the permanent freshwater marshes in the Sarabaya area and elsewhere in Boké Préfecture be made to (1) establish the extent of the population levels of this species, (2) to better define its distribution, (3) to describe its natural habitat in order to define its ecological requirements, and (4) to identify present and future threats. Two other IUCN Red Listed species of freshwater crabs (*A. gerhildae* and *Globonautes macropus*) are also listed as occurring in Guinea (Cumberlidge 1999; IUCN 2004), but little is known of their distribution, ecology, habitat requirements, or current population levels. It is recommended that follow-up studies be made of these important macroinvertebrates so that they can be afforded protection should this prove necessary.

Site 2: Kamsar Area

The mangrove ecosystems examined during the present survey represent only a small portion of that found in the coastal region of Guinea. These, in turn, are part of an extensive mangrove forest that stretches along the coast of West Africa from Guinea Bissau to Nigeria and Cameroon. West African Mangrove swamps are located on the flood plains of rivers and creeks and along the Atlantic coast. This environment is highly variable in terms of rainfall, soil, and environmental stresses. The mangrove forests in the Kamsar area have suffered a great deal from human disturbance that appears to be driven by traditional farming practices and by pressure from population growth. The main human activities in the mangrove forest ecosystems sampled in the present study include fishing (for fish, crustaceans and shellfish), firewood cutting (for salt extraction, palm oil production, and cooking) and deforestation for rice production. In the study sites visited in the Kamsar region, large areas of tidal mangrove forest are being cleared for rice cultivation. The conversion of mangrove forest to rice fields by traditional methods involves the construction of up to 2 m high mud dykes (levées) along tidal creeks so that the land behind the dykes is no longer inundated by saltwater at high tide. The anti-saltwater barrier constructed in 1997 to prevent the entry of seawater separate the land behind the mouth of the Rio Kapatchez mangrove ecosystem from flooding by seawater at high tide, together with the deforestation behind the dykes, is a large-scale example of this.

Such actions radically alter the nature and composition of the land behind the dykes which now only receives freshwater from the river and rainfall (instead of a mixture of seawater and freshwater), thereby changing the community composition of the natural ecosystem. The cleared mangroves have been transformed into vast rice fields consisting of large flooded grassy areas interspersed by stands of oil palms. The impact of these human activities on the mangrove ecosystems can best be understood in terms of the services that such ecosystems provide. Mangroves protect the coastline and the surrounding land and also serve to stabilize estuaries. These ecosystems also serve as significant nursery grounds for commercially important species of crustaceans and fish and feeding grounds for large flocks of wading birds at low tide. While it may already be too late for the mangroves in the heavily-populated regions around Kamsar, it is recommended that consideration be given to these wider impacts, and that as yet unspoiled sections of the mangrove forests in Guinea be set aside as protected areas, so that these will not suffer the same fate as large parts of this important ecosystem are currently experiencing.

Site 3: Sangaredi Area

The moist Guinea savanna ecosystems and farmland surveyed during the present study in the region around the village of Boulléré to the west of Sangaredi were heavily impacted by traditional slash and burn agricultural practices whereby large areas of land have been cleared for rice cultivation. The other dominant feature of this region are large areas of exposed rock which either lacks vegetation altogether, or has only a thin cover. The other tracts of land in this region that apparently have a substantial vegetation cover are in fact heavily disturbed by farming practices, because these areas are currently in a fallow period (up to seven years) at the end of which they will be burnt and used for cultivation. Because this is rain-fed seasonal agriculture, the burning of the secondary forests takes place at the end of April/beginning of May (during the survey period) in anticipation of the first rains, which in 2005 began on May 11. Large areas of this land are arid and consist of sparse grass and exposed rocks, while the best remaining forest cover was gallery forest near the year-round spring-fed rivers, and the forests growing on the steeper hillsides. The practice of uncontrolled burning, that even includes the gallery forest fringing the rivers in some places, leaves the streambeds unshaded and exposed to very high temperatures with the subsequent negative impact on the survival of aquatic organisms such as fish, crustaceans, and other invertebrates. The large species of shrimp (*M. vollenhovenii* and *M. macrobrachion*) found in all streams surveyed are abundant, grow to large body sizes, and support a small local fishery. The larvae of these species require saltwater to develop which means that the first stage larvae released by adult females are carried by the current downstream to the coastal waters (including mangrove ecosystems) to complete their development. When the juvenile shrimps grow large enough to be able to swim against the current in the river they return to the freshwaters of the inland streams where they develop into adults. It is not clear what the impact of the large-scale alterations of the mangroves will have on the long-term population levels of these migratory species. It is recommended that the gallery forests along the rivers and streams be protected from burning (and

perhaps be set aside as protected areas), and that the sustainable management of the mangrove ecosystems takes into account the function of these ecosystems as nursery grounds for commercially important species of crustaceans and fish.

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