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*"Freshwater Crabs and Shrimps (Crustacea: Decapoda)  
of the Nile Basin"*

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[Au1] **Freshwater Crabs and Shrimps  
(Crustacea: Decapoda) of the Nile Basin**

**Neil Cumberlidge**

**Abstract** Freshwater crabs are present in almost all freshwater bodies in the Nile River basin ranging from the main river to mountain streams, and from extensive wetlands to rift valley lakes, but these decapod crustaceans are absent from the more arid regions of the Sahara and East Africa. Some 14 species of freshwater crabs (Potamonautidae) and six species of shrimps (Atyidae, Palaeomonidae) are found in the eight African countries that have at least part of their territory in the Nile drainage. The most species rich country in the Nile basin is Uganda (with more than 12 species), while the vast desert countries of ~~The~~ Sudan and Egypt are relatively species poor and have no endemic species of freshwater crabs, and Ethiopia (although not species rich) has both widespread and endemic species. There is a clear biogeographic and taxonomic divide between the freshwater crab fauna of the Nile catchment which differs significantly from the species groups found in the neighboring Congo basin (Rwanda, Burundi, and D. R. Congo).

## 1 Introduction

The first authors to treat the freshwater crab fauna of Africa as a whole were Rathbun (1904, 1905, 1906), Chace (1942), and Bott (1955), and these works (especially the latter) are still used by many as the standard taxonomic references for this group. Flower (1931) and Williams (1976) focused on the freshwater crab fauna of ~~the~~ Sudan and the Nile, while Williams (1968) revised the taxonomy of the freshwater crabs of Uganda, Kenya and Tanzania. Unfortunately, all of these contributions are now out of date, and contain a number of taxonomic inconsistencies (Cumberlidge, 1999) that make them unreliable to use to assess the freshwater crab faunal composition in the Nile basin. An updated continent-wide monograph of the freshwater crabs of Africa is not available so workers in many

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547

parts of Africa must still refer to original type specimens to identify material and to compile distribution records, making this a daunting task for the non-specialist. Elsewhere in Africa recent taxonomic revisions are available for the freshwater crab faunas of West Africa (Cumberlidge, 1999), Tanzania (Reed & Cumberlidge, 2006), Lake Tanganyika (Cumberlidge et al., 1999; Marijnissen et al., 2004), Angola (Cumberlidge & Tavares, 2006), and southern Africa (Cumberlidge & Daniels, 2008), but large geographic areas such as Central Africa and East Africa are in need of taxonomic revision (Cumberlidge, in prep.). All species identifications, synonymies, and distribution patterns used here are based on direct observation of specimens (including all relevant type material) by the author, because most of the literature on the freshwater crabs of the Nile basin is unreliable.

[Au3]

The first record of the existence of freshwater crabs in the Nile (and indeed anywhere in Africa) was the description of *Thelphusa berardi* Audouin, 1826 (now *Potamonautes berardi*) from Egypt, followed several years later by *Thelphusa nilotica* H. Milne Edwards, 1837 (now *Potamonautes niloticus*) from the Nile. More than 50 years later Hilgendorf (1892) described *Telphusa emini* from northwest Tanzania near Lake Victoria, and de Man (1901) described *Potamonfloweri* (now *Sudanonautes floweri*) from the Bahr el Gebel in The Sudan. Nobili (1906) added a third species of *Potamonautes* from the Ruwenzoris (as *Potamon (Potamonautes) aloysiisabaudiae*), and Rathbun (1909) described *Potamon (Potamonautes) rodolphianus* Rathbun, 1909 from northern Kenya (now *Potamonautes rodolphianus*). This was followed by the description of two species of *Potamonautes* from Ethiopia (as *Potamon (Geothelphusa) antheus* Colosi, 1920, and *Potamon (Geothelphusa) ignestii* Parisi, 1923) (now *Potamonautes ignestii* and *P. antheus*) and another species from Mount Elgon, Uganda (as *Potamon (Geothelphusa) granviki* Colosi, 1924) (now *Potamonautes loveni* (Colosi, 1924)). Subsequent contributions to the freshwater crab fauna of the Nile basin were made by Rathbun (1935) (*Potamon (Geothelphusa) amalerensis* Rathbun, 1935), Chace (1942) (*Potamon mutandensis* Chace, 1942), Bott (1955) (*Potamonautes (Gerdalopotamonautes) gerdalensis* Bott, 1955), and Corace et al. (2001) (*Potamonautes rukwanzi* Corace, Cumberlidge, & Garms, 2001) (see Table 1).

## 2 Overview of the Decapod Fauna of the Nile System

Freshwater crabs are an ecologically successful group of large and conspicuous decapod crustaceans occurring widely in most tropical and subtropical regions of the world. In continental Africa freshwater crabs of the family Potamonautidae Bott, 1970, are represented by 11 genera and more than 120 species (Cumberlidge, 1999; Cumberlidge et al., 2008; Yeo et al., 2008). Crabs of the genus *Potamonautes* MacLeay, 1838, are abundant in most parts of Africa, are found in almost all available freshwater bodies, and are clearly well-adapted and successful (Bott, 1955; Cumberlidge, 1999). Freshwater crabs are common throughout the Nile river basin but are absent from the more arid regions of the Sahara and the Horn of Africa.

**Table 1** Species of freshwater decapod crustaceans (Potamoidea: Potamonautidae and Caridea: Atyidae, Palaemonidae) found in the Nile River basin. Species that are endemic to the Nile catchment are shown in bold type. Introduced species are also included. Taxonomic authorities are provided in the text

Taxon	Countries of occurrence	IUCN conservation status
POTAMOIDEA,		
POTAMONAUTIDAE		
<i>Potamonautes aloysiisabaudiae</i>	Uganda, D. R. Congo	LC
<i>Potamonautes amalerensis</i>	Uganda	DD
<b><i>Potamonautes antheus</i></b>	Ethiopia	VU
<b><i>Potamonautes berardi</i></b>	Egypt, Sudan, Ethiopia, Uganda, Tanzania, Rwanda	LC
<i>Potamonautes emini</i>	Uganda, Tanzania, Burundi	LC
<i>Potamonautes gerdalensis</i>	Kenya, Tanzania	VU
<b><i>Potamonautes ignestii</i></b>	Ethiopia	VU
<i>Potamonautes loveni</i>	Uganda, Kenya	LC
<i>Potamonautes mutandensis</i>	Uganda	EN
<b><i>Potamonautes niloticus</i></b>	Egypt, Sudan, Ethiopia, Uganda, Kenya, Rwanda	LC
<i>Potamonautes rodolphianus</i>	Kenya	DD
<i>Potamonautes rukwanzi</i>	Uganda	EN
<i>Sudanonautes floweri</i>	Uganda, Sudan, Central African Republic, D. R. Congo, Congo, Gabon, Cabinda, Cameroon, Nigeria	LC
CARIDEA, ATYIDAE		
<i>Caridina nilotica</i>	Egypt, Sudan, Ethiopia, Uganda, Kenya, Tanzania, southern Africa	
<i>Caridina bunyonyiensis</i>	Uganda	
<i>Caridina gordonae</i>	Uganda	
<i>Caridina pseudonilotica</i>	Uganda	
<i>Caridina subventralis</i>	Uganda	
CARIDEA,		
PALAEMONIDAE		
<i>Macrobrachium niloticum</i>	Egypt, Sudan, Kenya, Cameroon, Central African Republic, D. R. Congo	
<i>Macrobrachium rosenbergii</i>	Introduced species in Egypt (native to Thailand)	
ASTACOIDEA,		
CAMBARIDAE		
<i>Procambarus clarkii</i>	Introduced species in Uganda and Kenya (native to the USA)	

Despite the fact that freshwater crabs are among the most important invertebrates inhabiting African fresh waters, until recently they were only poorly known. This situation is now changing and there is currently an upsurge of interest in freshwater crab taxonomy, identification, phylogeny, diversity, distribution patterns,

and conservation status (Cumberlidge, 1999; Daniels et al., 2006; Cumberlidge & Daniels, 2007; Cumberlidge et al., 2008; Yeo et al., 2008). As a result, our present knowledge of African freshwater crab biology in northeastern Africa has advanced greatly since the earlier contributions by Flower (1931), Chace (1942), Bott (1955), and Williams (1968, 1976, 1991). Some 13 species of freshwater crabs are found in the eight African countries that have at least part of their territory in the Nile drainage in Egypt, The Sudan, Ethiopia, Uganda, Kenya, Tanzania, and Rwanda, reaching as far south as the Kagera River in Burundi. This is a relatively small number of species compared to the rest of the Afrotropical region whose fauna comprises 137 species in 20 genera and two families (Potamonautidae and Potamidae Ortmann, 1898) (Cumberlidge et al., 2008; Yeo et al., 2008). These decapods are present in all of the Nile's freshwater ecosystems, from the headwaters south of the equator north to the delta in Egypt where it flows into the Mediterranean Sea. Some species are widespread and common throughout the Nile river basin, some have more limited distributions and occur only in a particular region, while others are point endemics that are only found in a single locality.

All of the freshwater crabs in northeastern Africa belong to the exclusively Afrotropical freshwater crab family Potamonautidae. The freshwater crab fauna of the Nile basin is dominated by species of *Potamonautes* which is the largest and most cosmopolitan of the African genera, and includes more than 70 species distributed throughout sub-Saharan Africa (Cumberlidge, 1999; Cumberlidge et al., 2008; Yeo et al., 2008), with about one fifth of these species occurring in the Nile basin. Besides large rivers and small streams, freshwater crabs are also found in a number of lakes in Ethiopia, Uganda, and Kenya, not all of which are directly connected with the Nile river basin. Thirteen species of *Potamonautes* occur in the Nile River basin plus one species of *Sudanonautes* Bott, 1955, which represents the easternmost outlier of a West and Central and African genus (Cumberlidge, 1999). Shrimps of the family Atyidae are also found throughout the Nile River basin, with the commonest species (*Caridina nilotica* (P. Roux, 1833)) distributed widely in eastern and southern Africa from the Nile basin to South Africa (Monod, 1980), and there is a single record of this species occurring in Lake Upemba in the Congo basin (Roth-Woltereck, 1942). *Caridina nilotica* is part of a taxonomically unstable species complex whose distribution includes not only the entire eastern part of Africa from Egypt to South Africa, but also extends eastward to include the Indo-West Pacific region as far as southern Japan, Australia and Polynesia.

In Lake Victoria *C. nilotica* is abundant and is a major prey item of the Nile perch. In Lake Bunyonyi in Uganda *C. nilotica* is absent but there are four endemic species of *Caridina* in this isolated crater lake that is close to, but not connected to the Nile catchment (Richard & Clark, 2005). Shrimps of the genus *Macrobrachium* (Palaemonidae) such as *M. niloticum* (P. Roux, 1823) are also found in this system in the Nile in Egypt, the White Nile, and Lake Turkana, as well as in Lake Chad and the Chari and Logone Rivers in Central Africa (Monod, 1980). The Thai species *M. rosenbergii* has been introduced into Egypt for aquaculture.

### 3 Biology

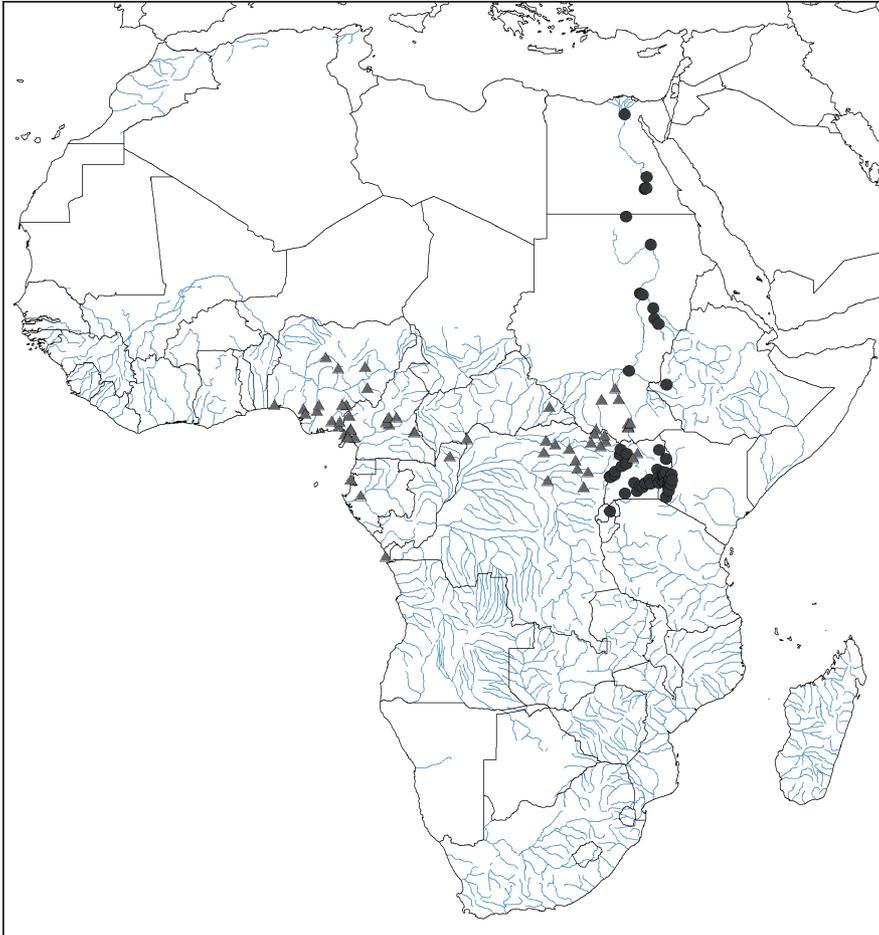
Freshwater crabs are present in almost all freshwater bodies associated with the Nile River catchment ranging from mountain streams to large lowland rivers, and from extensive wetlands to rift valley lakes. In seasonally arid areas some species are semi-terrestrial, live in burrows, and move about on land at night. All African freshwater crabs are very similar in terms of their breeding strategy (they all have direct development from egg to hatchling crabs, and they all lack larval stages) but they differ widely in their choice of habitat within the continent's freshwater ecosystems (Cumberlidge, 1999). The complicated topography and equally diverse habitats found in the Nile river catchment is no doubt responsible for much of the diversity and endemism of the freshwater crabs. Freshwater crab populations living in crater lakes or in highland streams often become isolated due to the fragmentary nature of these habitats coupled with the limited dispersal ability of crabs associated with their low fecundity and direct development (Cumberlidge, 1999). These animals are the largest macro-invertebrates in African freshwater ecosystems and there is some evidence that they occupy key positions in aquatic food webs and that they dominate benthic invertebrate communities in terms of biomass (Hill & O'Keeffe, 1992; Somers & Nel, 1998; Dobson et al., 2002).

A large part of our present knowledge about the freshwater crabs of the Nile River basin is the result of long-term studies of onchocerciasis (river blindness) in the highland areas of East Africa (the Ethiopian highlands, the Ruwenzoris, and Mount Elgon). Those investigations were aimed at identifying associations between freshwater crabs and the aquatic larval stages of the biting blackflies of the genus *Simulium* that serve as vectors for the parasite *Onchocerca volvulus*. The immature stages of *Simulium* need to develop in fast-flowing rivers and streams, and must attach themselves either to stones or to the carapace of river-living species of freshwater crabs in order to complete their development into adult flies (McMahon, 1951; McMahon et al., 1958; Barnley & Prentice, 1958; Williams et al., 1964; Crosskey, 1990; Williams, 1991). Control measures for the spread of river blindness focus on limiting the numbers of blackflies, and one possibility for such control involves understanding the relationship between *Simulium* larvae and freshwater crabs.

## 4 Freshwater Crabs of the Nile System: Egypt, The Sudan, and Ethiopia

### 4.1 Egypt

Two common and widespread species of freshwater crabs – *Potamonautes berardi* (Audouin, 1826) and *Potamonautes niloticus* (H. Milne Edwards, 1837) – are found throughout the vast expanse of the Nile River basin from the delta in Egypt to Lake



**Fig. 1** Distribution of *Potamonautes niloticus* (black circles), a common species of freshwater crab endemic to the Nile River basin, and of *Sudanonautes floweri* (black triangles), a widely distributed West and Central African freshwater crab, whose range extends into the upper Nile river basin in Uganda

Victoria and its tributaries in equatorial Africa (Fig. 1). *Potamonautes berardi* is a common aquatic river crab recognized by its uniform brown colour, its small size at maturity, and by the smooth margins of its anterior carapace. *Potamonautes berardi* occurs in the major channels of the Nile and its tributaries and has a wide distribution in the Nile River basin in Egypt, Sudan, Ethiopia, Uganda, Tanzania, and Rwanda (Williams, 1976; Cumberlidge, 1997, 1998).

*Potamonautes niloticus* is a large and common species with a very wide distribution that is known from more than 60 localities in six countries associated with the Nile River and its tributaries in Egypt, Sudan, Ethiopia, Uganda, Kenya,

and Rwanda. This species is easily recognized by the rows of distinct spines along the anterior margins of its carapace, and its populations are abundant enough in Lake Victoria to support small-scale local fisheries. *Potamonautes niloticus* occurs in a range of aquatic habitats including the major channels of the Nile itself and its lowland tributaries, in small and large lakes associated with the river basin, as well as in small clear fast-flowing mountain streams with rocky beds, and sluggish warm lowland streams with muddy bottoms (Bott, 1955; Williams, 1964; Cumberlidge, 1997, 1998). This species is completely dependent on aquatic habitats and it never leaves the water whether it is found in streams, rivers, or lakes. The Nile River delta in Egypt places two Afrotropical species (*P. berardi* and *P. niloticus*) in close proximity to the Palaearctic species *Potamon potamios* Olivier, 1804 (Potamidae), an eastern Mediterranean taxon whose range extends into the Sinai Peninsula in Egypt (Brandis et al., 2000). The freshwater crab species list for Egypt is therefore relatively impoverished and includes just three species (none of which is endemic to that country), but these belong to two genera and two families.

## 4.2 *The Sudan*

Despite being Africa's largest country, ~~The~~ Sudan has only three species of freshwater crabs: *P. berardi* and *P. niloticus* which occur along the entire course of the river including Sudan, and *Sudanonautes floweri* (de Man, 1901) which is found in the vast swamps of the Sudd in the Bahr el Gebel in southwestern Sudan, and south into the Acholi District of northwestern Uganda. *Sudanonautes floweri* is a large species easily recognised by its purplish brown body and its contrasting yellow–orange postfrontal crest and yellow orbital border (Cumberlidge, 1999). A fourth as yet undescribed species occurs in the streams draining the Imatong Mountains on the Sudan–Uganda border (Cumberlidge, in prep.). Despite its presence in the Nile basin *S. floweri* is actually a widespread West and Central African species that is on the eastern edge of its range in Sudan and Uganda. It has a wide distribution in the Niger, Chad and Congo basins (in the rivers Benue, Chari, and Congo) (Rathbun, 1921; Balss, 1936; Monod, 1980; Cumberlidge, 1995, 1999; Cumberlidge & Daniels, 2008). This species prefers the moister regions of the woodland and guinea savanna zones from central Nigeria, northern Cameroon, and the Central African Republic reaching as far eastward as southern Sudan and northeast Uganda (Cumberlidge, 1999). *Sudanonautes floweri* is also common in the humid tropical rainforest habitats in southeast Nigeria, south Cameroon, Bioko, Central African Republic, D. R. Congo, Congo, Gabon and Cabinda (Angola) (Cumberlidge, 1999; Cumberlidge & Tavares, 2006; Cumberlidge & Daniels, 2008). *Sudanonautes floweri* is an ecologically versatile species that is equally at home in both aquatic and semi-arid environments and lives in shallow streams, rivers, and ponds, as well as in burrows near streams and rivers (Rathbun, 1921; Cumberlidge, 1995, 1999). This species is also found on land either next to water or some distance away, because it is capable of breathing air, and can function well for

long periods out of water. The widened and highly arched carapace, and the lack of teeth on the anterolateral margins of the carapace are features often associated with air breathing and burrow living (Cumberlidge, 1999). This body shape contrasts with the flattened, deeply grooved and spiny carapace of exclusively aquatic river living species such *P. niloticus*.

The type locality of *S. floweri* is the Bahr el Gebel in southwestern Sudan between the Albert Nile and the White Nile where the river spreads out to form the great open wetland of the Sudd, comprising standing waters and flooded land dominated by papyrus and grass swamps (Beadle, 1981). The lentic waters of this vast swamp have high rates of organic decomposition and persistently low oxygen levels, high carbon dioxide levels, and reduced light levels, but the steady current flowing northwards through the channels prevents complete stagnation. This low-oxygen environment may explain the absence of *P. niloticus* and *P. berardi* from the Sudd, but this is apparently not a problem for the air-breathing species *S. floweri*. In Nigeria and Cameroon (but not in the Nile River basin) *S. floweri* serves as an important second intermediate host to the human lung flukes *Paragonimus uterobilateralis* and *P. africanus* (Voelker & Sachs, 1977; Sachs & Cumberlidge, 1990; Cumberlidge, 1999).

### 4.3 Ethiopia

The lower reaches of the Blue Nile in western Ethiopia support the common Nile crab *P. niloticus*, while *P. berardi* is more widely distributed in the highland areas in Amhara, Southern, and Oromia Regions. The rivers draining the Ethiopian highlands in the Blue Nile region of western Ethiopia in the Amhara Region host two large endemic species of freshwater crabs: *P. antheus* (Colosi, 1920) and *P. ignestii* (Parisi, 1923). *Potamonautes antheus* occurs south in the Gambella, Oromia and Southern Regions, while the rivers draining the southwestern Ethiopian highlands flow south into Lake Chew Bahir in the Southern region where an undescribed species is found (Cumberlidge, in prep.). *Potamonautes ignestii* is found near Gondar in the northwestern highlands in the Lake Tana catchment area which includes the source of the Blue Nile, and this area supports a second (as yet undescribed) species of freshwater crab (Cumberlidge, in prep.). It is likely that other species will be discovered when exploration in Ethiopia improves.

### 4.4 Freshwater Crabs of the Upper Nile Basin: Uganda, Kenya, Tanzania, Rwanda, and Burundi

The southernmost part of the Nile catchment comprises the Lake Victoria basin and its associated lakes (Kioga, Albert, Edward, George) and their tributaries in Uganda, Kenya, Tanzania, Rwanda, and Burundi. Lake Turkana in northern Kenya

is included here because this large lake was isolated from the Nile basin relatively recently.

#### 4.4.1 Uganda

The vast majority of the freshwater ecosystems in Uganda are part of the Nile River basin. Lake Victoria is the largest of the lakes in this region, and while its northern shore is in Uganda, its northeastern shore is in Kenya, and its southern and western shores are in Tanzania. Most (but not all) of the major lakes in this part of the Nile basin have populations of freshwater crabs. For example, *P. niloticus* is found in Lake Victoria, the Victoria Nile, Lake Albert, and the Albert Nile (and probably Lake Kioga) but there are no records of any species of freshwater crab from either Lake George or Lake Edward, despite efforts to collect there. It is of interest to note that although *P. niloticus* occurs commonly in Lake Victoria in Uganda and Kenya, this species has never been recorded from the Tanzanian part of this lake. Besides lakes, *P. niloticus* is also found in the lower reaches of the rivers and fast-flowing streams draining highland areas in Uganda. The series of small isolated crater lakes in western Uganda are not strictly speaking part of the Nile drainage, and most of these do not support populations of freshwater crabs (as far as we know). Exceptions to this are Lakes Mutanda and Bunyonyi in the Kigezi District of western Uganda where *P. mutandensis* (Chace, 1942) is found (Chace, 1942), and Lake Rukwanzi, a crater lake in the Ruwenzori, where *P. rukwanzi* Corace, Cumberlidge, and Garms, 2001, occurs (Corace et al., 2001).

The shrimp *Caridina nilotica* (Decapoda, Caridea, Atyidae) is a widely distributed species found throughout the Nile basin and elsewhere in eastern and southern Africa. Interestingly, Lake Bunyonyi in southwestern Uganda lacks *C. nilotica* but supports four endemic species of *Caridina* (*C. bunyonyiensis* Richard & Clark, 2005, *C. pseudonilotica* Richard & Clark, 2005, *C. subventralis* Richard & Clark, 2005, and *C. gordonae* Richard & Clark, 2005) (Richard & Clark, 2005). The Louisiana red claw crayfish *Procambarus clarkii* (Girard, 1852) (Astacoidea: Cambaridae) has been introduced to several parts of East Africa, including some localities in the Nile River basin. *Procambarus clarkii* is a relatively large, prolific, aggressive, burrowing crayfish that is an invasive species worldwide (Holdich, 1999; Howard & Matindi, 2003) that has been reported to have had severe ecological impacts on native populations of fish, plants, and freshwater crabs in Lake Naivasha in Kenya (Foster & Harper, 2006a,b). The introduction of *P. clarkii* in Lake Bunyonyi in Uganda is a cause for concern because it has taken over the lake and is doing so well that populations of the native freshwater crab species (*P. mutandensis* Chace, 1942) might well be negatively impacted.

The Rwenzori (also written as Ruwenzori) Mountains in western Uganda host populations of freshwater crabs in the fast-flowing mountain streams flowing through moist tropical forest, in the lowland major rivers flowing through dry savanna, and in some of the small crater lakes associated with the western rift valley. *Potamonautes aloysiisabaudiae* Nobili, 1906, is the commonest species

at higher altitudes in the upper reaches of the Kigezi and Rwenzori Rivers draining the Rwenzori Mountains. This species is also found on the D. R. Congo side of the border in rivers that are part of the Congo basin. The warmer lower reaches of these rivers are home to *P. niloticus*, but this species is not found in the cooler high altitude waters of these systems. Williams (1976) reported that *P. idjiwiensis* (previously known only from Lake Kivu) also occurs in the Rwenzoris but this record has not been confirmed here by direct reexamination of material.

[Au4] The highlands east of Lake Victoria in eastern Uganda near the border with Kenya support a number of species of freshwater crabs including *P. amalerensis* Rathbun, 1935, from Mount Debasien, and *P. niloticus* and *P. loveni* (Colosi, 1924) from Mount Elgon. Freshwater crabs from the forested slopes of Mount Elgon in Uganda that were collected by T. R. Williams and his colleagues during surveys in the 1960s proved to belong to two new species of *Potamonautes* and these are currently being described (Cumberlidge & Clark, in prep.). In this part of Africa, wherever *P. niloticus* occurs in fast-flowing upland streams with turbulent water it is often associated with the blackfly *Simulium neavei* the vector of *Onchocerca volvulus* that causes onchocerciasis (river blindness) in humans (Hynes et al., 1961; Williams et al., 1961).

#### 4.4.2 Kenya

This largely semi-arid country includes a large number of rivers that are seasonal, and in many areas freshwater resources are scarce at most times of the year. The Nyanza and Western Provinces of southwestern Kenya are the only parts of this country that lie in the Nile river basin; the streams and rivers that flow south and west into the northeastern corner of Lake Victoria have healthy populations of *P. niloticus*. This species extends for considerable distances up these rivers until it reaches altitudes where the waters are too cold for its liking. A second species, *P. gerdalensis* Bott, 1955, is also found in the Nyana Province of southwestern Kenya (and across the border into the neighboring part of Tanzania) where it occurs in rivers entering Lake Victoria from the north and east (Bott, 1955; Reed & Cumberlidge, 2006). This species seems to replace *P. niloticus* in iron deficient lowland rivers (Shaw, 1959a, b; Williams, 1976). The northern parts of the Rift Valley Province and Eastern Provinces in northwestern Kenya lie in a very hot arid region with vast stretches of dry country that includes Lake Turkana that is associated with one small endemic species of freshwater crab, *P. rodolphianus* (Rathbun, 1909). Although Lake Turkana is not presently connected to the Nile River basin, it was isolated relatively recently and is currently fed by rivers flowing south from the southern Ethiopian highlands. The ancient connections of this lake with the Nile basin are indicated by the presence of two nilotic species of freshwater shrimps, *Caridina nilotica* and *Macrobrachium niloticum* in Lake Turkana.

#### 4.4.3 Tanzania, Burundi, and Rwanda

The rivers that rise in Rwanda and Burundi and flow across northwestern Tanzania into the northwestern corner of Lake Victoria host populations of the common Nile crab, *P. niloticus*. In addition, the streams and rivers of the Bukoba region of northwestern Tanzania support populations of two other species, *P. emini* (Hilgendorf, 1892) and *P. berardi*. *Potamonautes emini* has also been recorded from Lake Victoria in this part of Tanzania (Williams, 1976; Reed & Cumberlidge, 2006).

## 5 Biogeography

The freshwater crab family Potamonautidae is found throughout the African continent and is endemic to the Afrotropical region (Cumberlidge et al., 2008; Yeo et al., 2008). The two genera of freshwater crabs found in the Nile basin (*Potamonautes* and *Sudanonautes*) are not endemic to this system but the majority of species of *Potamonautes* (8 out of 12 [66.6%]) are endemic to the river basin and its nearby lakes, with only *P. aloysiisabaudiae*, *P. berardi*, *P. emini*, and *P. loveni* also occurring outside of the river basin (as does *S. floweri*).

Figure 1 summarizes the distribution patterns of *P. niloticus*, a widespread and exclusively nilotic species, and *S. floweri* (a species with a distribution that includes the Nile, Congo, Chad and Niger River basins) based on combined distribution data from the author and from the recent literature (Cumberlidge, 1997, 1998; Reed & Cumberlidge, 2006). The vast Nile River basin has distinct nilotic species (such as *P. niloticus*) as well as a number of local or regional endemics that are all from highland regions, mostly in Ethiopia (*P. antheus* and *P. ignestii*) and Uganda (*P. aloysiisabaudiae* and *P. amalerensis*) (Table 1). The most species-rich country in the Nile basin is Uganda (with nine species). The vast desert countries of ~~The~~ Sudan and Egypt are relatively species poor and have no endemic species of freshwater crabs, while Ethiopia (although not species rich) has both widespread and endemic species. There is a clear biogeographic and taxonomic divide between the freshwater crab fauna of the Nile catchment (Table 1) and the Congo basin (Rwanda, Burundi, and D. R. Congo), with only *P. aloysiisabaudiae* and *S. floweri* being found in both river basins. The same can be said for the parts of the neighboring countries of Tanzania and Kenya that lie outside of the Nile basin (Reed & Cumberlidge, 2006). It of interest to note that the freshwater crab faunas of Uganda, Kenya, and Tanzania are all distinct from each other, except for a few species whose distributional ranges overlap the borders between these countries (Reed & Cumberlidge, 2006).

The present assessment of freshwater crab biodiversity in the Nile (13 species in two genera, with six more species of *Potamonautes* in the process of description) is likely to be an underestimate because the absence of records for freshwater crabs in many parts of the Nile basin may be the result of uneven collecting efforts

that have left large areas unsurveyed. The Nile basin is home to five taxa whose conservation status warrants their inclusion in the IUCN Red List (IUCN, 2004) as either vulnerable or endangered (Table 1). Although great advances have been made recently in our knowledge of African freshwater crabs in general, our present state of knowledge of the distribution of freshwater crabs in the Nile basin makes it difficult to draw firm conclusions about the meaning of the absence of records for the areas that have not yet been surveyed, especially the more inaccessible places that lie well away from population centers and roads.

## [Au5] References

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### Author Queries

- [Au1]: Please include “Reed & Cumberlidge, 2006; Cumberlidge & Daniels, 2007; Williams, 1964; Voelker & Sachs, 1977; Williams et al., 1961” in the list.
- [Au2]: Please check if ‘the Sudan’ should be made ‘The Sudan’ for consistency. Update in all the occurrences.
- [Au3]: Please update Cumberlidge, in prep. And include this references in the list.
- [Au4]: Please update Cumberlidge & Clark in prep. Please include this in the ref list.
- [Au5]: Please provide citations for “Foster & Harper, 2007; Ortmann, 1893; Williams, 1961, 1962, 1965, 1970.
- [Au6]: Please provide the publisher details in Milne Edwards, 1837.

