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Distribution and abundance of freshwater crabs (*Potamonautes* spp.) in rivers draining Mt Kenya, East Africa

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With 4 figures and 3 tables

Abstract: Little is known about population densities of freshwater crabs, or their ecological importance, in African rivers. This study aimed to quantify crab abundance in rivers draining Mt Kenya. Invertebrates were sampled from 21 sites on 19 rivers. Sample sites were divided into: open sites in agricultural land from which trees were mainly absent; shaded sites, in agricultural land, with cultivated catchments but heavy shading by riparian trees; and forest sites, still dominated by natural vegetation. Crabs, mainly *Potamonautes odhneri*, were recorded from 14 of the 21 sites, including all forest sites, and were significantly more abundant in forest sites than in either type of agricultural site. However, there was no difference in biomass among habitat types, because individual crabs were significantly smaller on average in forest sites. This was due to the large numbers of small juvenile crabs recorded in forest sites, whereas small juveniles were almost absent from all agricultural sites. Although numerically unimportant relative to other macroinvertebrates, crabs accounted for at least 70% of total macroinvertebrate biomass from forest and shaded agricultural sites, and averaged around 40% in open agricultural sites. It is possible that crab reproduction occurs mainly or exclusively in forested areas, which would therefore act as a recruitment source for populations farther downstream in agricultural areas.

Key words: Shredders, East Africa, detritus processing, biomass estimates, rivers, crustaceans.

Introduction

Freshwater crabs are important components of freshwaters in Africa. Over one hundred species are known, found in all types of freshwater habitats (Dobson 2004). They are the main component of the diet of a range of freshwater predators, including otters (Butler & du Toit 1994, Purves et al. 1994), water mongoose (Purves et al. 1994), kingfishers (Arkell 1979) and eels (Butler & Marshall 1996). Therefore, the size and species composition of crab populations may have important bottom-up implications for the river catchment ecosystem. Crabs play an important role in human disease transmission, as second intermediate hosts for the vectors of paragonimiasis (e. g. Udonsi 1987, Ollivier et al. 1995) and onchocerciasis (e. g. McMahon et al. 1958, Grunewald et al. 1979). They are also consumed by humans in some parts of the continent, particularly in West Africa, both at a subsistence level (e. g. Udonsi 1987) and as part of

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commercial fisheries (e. g. Sachs & Cumberlidge 1991).

Despite the ecological and economic importance of freshwater crabs, little is known about their population densities. There are several population estimates from southern Africa, but all are of a single large bodied species, *Potamonautes perlatus* (H. Milne Edwards). Population densities of this species range from 0.1 to 2.2 individuals m^{-2} in Zimbabwe (Turnbull-Kemp 1960, Butler & du Toit 1994), and typically from 0.3 to 5.2 m^{-2} in Western Cape Province, South Africa (Arkell 1979, King 1983, Hill & O'Keeffe 1992), although Somers & Nel (1998) recorded densities up to 15.6 m^{-2} in a Cape Peninsula stream. Variation in biomass estimates for this species is high: Turnbull-Kemp (1960) estimated 5.5 – 13.6 g (wet mass) m^{-2} (approximately 2.1–5.2 g (dry mass) m^{-2}) in Zimbabwe, while Hill & O'Keeffe (1992) estimated 54–136 g (dry mass) m^{-2} in the Cape.

Elsewhere in Africa, our knowledge of crab population densities is almost non-existent. Furthermore, very little is known about the possible effect of anthropogenic impacts on their populations. In East Africa, it is probable that introduction of rainbow trout (*Oncorhynchus mykiss* (Walbaum)) into streams without a natural predatory fish species has led to a reduction in crab numbers through predation (Williams et al. 1964). Crabs are also vulnerable to direct competition from introduced crayfish (Ogada 2006) and possibly to disease transmitted via exotic crayfish (Avenante-Oldewage 1993). Furthermore, they may be impacted by habitat alteration. Stream-living species are omnivorous, but predominantly detritivorous (Williams 1962, 1965, Hill & O'Keefe 1992), feeding heavily on detrital inputs from surrounding terrestrial vegetation. Many species are also semi-terrestrial (Williams 1968, Cumberlidge 1999), so the adjacent riparian environment can be as important to them as the aquatic environment.

In view of the poor state of our understanding of these animals, gathering basic information such as distribution and population density is an essential first step in quantifying their importance to freshwater ecosystems in Africa. The aim of this study was to quantify regional distribution and abundance of freshwater crabs, through an extensive survey of rivers draining Mt Kenya. By surveying a large number of sites in a geographically restricted area, we determined their abundance and biomass relative to other macroinvertebrates. As a secondary objective, we assessed the degree to which human impacts on catchment vegetation may be affecting crab numbers.

Methods

Study area

Fieldwork comprised a survey of rivers draining Mt Kenya (Table 1). With a maximum elevation of 5199 m a. s. l., and an average elevation of the upper plateau greater than 4000 m, Mt Kenya is the largest and highest mountain in the central highland region of Kenya. It is approximately circular in planform with a diameter of about 75 km. It extends above the tree line into an alpine vegetation zone above 3200 m, but below this it is thickly forested. The forest extends down to an altitude of around 2000 m on the windward eastern and southern sides, below which it is heavily cultivated. On the drier western and northern sides, forest extends down to around 2400 m altitude, below which the main land use is grazing. The height and size of the mountain ensure that it has a significant impact on local weather, with almost daily rainfall on its upper slopes resulting in a large number of permanently flowing rivers radiating from its peak. Most rivers rise from glaciers and tarns in the alpine zone, but then flow through forest for at least 10 km before reaching cultivated or grazed areas.

Freshwater crabs in this region are members of the genus *Potamonautes* (Potamonautidae). Three species are known from Mt Kenya (N. Cumberlidge, pers. comm.): *P. odhneri* (Colosi), *P. jeanneli* (Bouvier) and *P. alluaudi* (Bouvier). However, as the taxonomy of this group is poorly understood, their distributions, including altitudinal ranges, in the region are unknown.

Field sampling

Field sites were chosen partially for their accessibility, and most therefore were close to the tarmac road that encircles the mountain. However, all sites were upstream of access roads to minimise localised disturbance due to runoff. The survey was carried out over five days from 25th to 29th October 2001, at the beginning of the short rainy season. We attempted to survey main rivers (defined as those having a width of at least 5 m) from all zones around the mountain. However, we were unable to sample several rivers due to inaccessibility or recent heavy rainfall, and in the wetter west and south we avoided rivers running adjacent to those already sampled, in order to ensure a good geographical spread of field sites. In the drier north, in contrast, we sampled one river smaller than 5 m width, because there are few permanent rivers in this area.

At each site, latitude, longitude and altitude were determined using a hand held Garmin™ Global Positioning System (GPS), and were later confirmed using a 1 : 150,000 scale map of the Mt Kenya region (Tourist Maps (K) Ltd, Nairobi, 2004). Adjacent land use and vegetation, stream width, temperature and conductivity were recorded; pH was recorded for most sites, but equipment problems meant that pH readings are not available for four of the sites. Degree of shading was estimated from visual observation in the field. Land use was allocated to one of three habitat types – open, shaded or forest. Open sites were those in which the dominant land use was agricultural, but riparian tree cover was low and channel shading was less than 30 %. Shaded sites were those in which the dom-

Table 1. Details of sample sites. Sites are numbered in a clockwise sequence around the mountain, starting to the SW. Sites marked with * were only sampled adjacent to a single bank, due to difficulty of access. Conductivity and pH values are a mean of three measurements made on the sample date. The letter after each temperature reading indicates the time of day during it was measured: a = 09.00–12.00; b = 12.00–17.00; c = 17.00–19.00. Crab biomass is estimated dry mass; a dash signifies no crabs recorded.

No.	River name and location	Altitude (m)	Width (m)	Direction of flow	Habitat	Temperature (°C)	Conductivity (μScm^{-1})	pH	Crab biomass ($DM\ m^{-2}$ (1 s. e.))
1	Sagana River 00°27′03″ S, 37°02′42″ E	1660	12	SE	Open	23 b	228	8.3	–
2	Nairobi River 00°22′33″ S, 37°00′21″ E	1730	6	S	Shaded	25 b	237	8.2	7.42 (3.60)
3	Thego River 00°20′42″ S, 37°02′48″ E	1780	7	SE	Forest	19 b	51	7.6	15.08 (10.07)
4	Naro Moru River at Nanyuki Road 00°09′41″ S, 37°01′16″ E	1990	5	NW	Open	16 c	48	7.4	0.85 (0.85)
5	Burguret River 00°06′34″ S, 37°02′14″ E	1960	6	W	Shaded	12 a	39	7.6	2.06 (1.95)
6	Likii River 00°01′13″ N, 37°05′18″ E	1960	16	W	Open	13 b	42	7.6	–
7	Sirimon River 00°03′20″ N, 37°12′24″ E	2190	5	WNW	Open	12 b	44	7.3	–
8	Timau River 00°05′15″ N, 37°14′39″ E	2240	4	NW	Shaded	13 b	266	7.8	–
9	Mariara River 00°01′26″ S, 37°39′39″ E	1560	7	SSE	Shaded	22 c	161	NA	–
10	Thingithu River 00°03′43″ S, 37°39′38″ E	1550	8	SE	Shaded	18 a	131	NA	11.85 (11.85)
11	Iraru River 00°09′08″ S, 37°40′39″ E	1220	10	E	Open	21 a	87	NA	–
12*	Mutonga River upstream 00°10′52″ S, 37°36′38″ E	1650	8	ESE	Open	18 b	127	7.2	0.28 (0.28)
13	Mutonga River downstream 00°12′07″ S, 37°39′35″ E	1330	15	SE	Shaded	19 b	123	6.8	2.00 (1.81)
14*	Mara South River 00°15′52″ S, 37°38′58″ E	1430	22	NE	Shaded	21 b	118	6.9	5.76 (3.53)
15	Nithi River 00°17′15″ S, 37°39′51″ E	1260	13	NE	Open	21 b	157	7.2	–
16*	Ruguti River 00°20′37″ S, 37°36′13″ E	1500	15	SE	Forest	17 a	104	7.4	2.06 (1.22)
17	Gituambugi River 00°21′58″ S, 37°34′30″ E	1600	5	SE	Forest	18 a	147	6.8	9.53 (5.39)
18*	Rupingazi River 00°32′34″ S, 37°25′56″ E	1310	15	SE	Open	18 b	61	6.8	4.30 (4.07)
19	Thiba River 00°33′59″ S, 37°19′21″ E	1320	6	E	Open	23 b	106	6.9	1.37 (1.37)
20	Ragati River 00°29′07″ S, 37°08′55″ E	1740	8	SE	Shaded	20 b	78	6.9	10.03 (9.27)
21	Naro Moru South River at Karandi Bridge 00°10′45″ S, 37°06′45″ E	2270	8	W	Forest	11 a	28	NA	6.00 (3.74)

inant land use was also agricultural, but there was still extensive riparian tree cover, so that at least 70 % of the channel at the sampling point was shaded; there was, however, no undisturbed riparian zone. Forest sites were defined as areas still with the original forest cover; all were at altitudes higher than any clearance in their respective catchments, so the rivers were undisturbed upstream of the sample point. The only exception to this classification was the Nairobi River (site 2); this was a forested catchment, but the site was classified as a shaded agricultural site because of the heavy grazing by livestock in the area, including the riparian zone.

Invertebrates were sampled using a Surber sampler (area $0.0625\ m^2$, mesh size $250\ \mu m$). Five samples were taken from randomly chosen points over a 10 m stretch of river; in several of the larger rivers, high water levels meant that samples were confined to within 3 m of one bank (see Table 1), but they were taken randomly within the area that could be reached. All samples were taken in a water depth of 20–40 cm. Following removal of excess water by sieving through a 0.1 mm mesh, samples were preserved in the field using 4 % formalin and transported to the laboratory for analysis.

Laboratory processing

In the laboratory, macroinvertebrates were removed from each sample, identified to a coarse taxonomic level and counted.

Table 2. Density (numbers m^{-2}) of invertebrates in each of the three habitat types. s. e. = standard error. Note that density of Potamonautidae in this table includes sites from which they were absent, and therefore values for open and shaded sites are lower than those presented in Fig. 1.

Taxon		Open		Shaded		Forest	
		mean	s.e.	mean	s.e.	Mean	s.e.
Ephemeroptera:	Baetidae	1232	192	912	144	928	176
	Prosopistomatidae	3.2	1.6	1.6	0	2.4	1.6
	Leptophlebiidae	92.8	16	121.6	33.6	288	68.8
	Heptageniidae	384	51.2	352	56	491.2	115.2
	Caenidae	134.4	27.2	88	25.6	96.8	33.6
	Oligoneuriidae	12.8	6.4	–	–	1.6	1.6
Diptera:	Chironominae	896	118.4	1568	224	2080	1264
	Tanypodinae	48	8	64	11.2	47.2	19.2
	Orthocladiinae	1.6	1.6	1.6	1.6	–	–
	Ceratopogonidae	43.2	9.6	67.2	11.2	64.8	24
	Simuliidae	156.8	35.2	1152	400	916.8	208
	Tipulidae	25.6	4.8	30.4	6.4	96	28.8
Coleoptera		480	70.4	880	160	369.6	68.8
Trichoptera		368	78.4	384	64	547.2	192
Hymenoptera		9.6	4.8	22.4	14.4	5.6	3.2
Plecoptera:	Perlidae	25.6	6.4	70.4	11.2	47.2	28.8
Odonata		19.2	4.8	20.8	6.4	20	8
Hydracarina		38.4	9.6	139.2	38.4	36	20.8
Planaria		68.8	17.6	240	88	21.6	8
Oligochaeta		688	288	256	144	92	43.2
Nematoda		4.8	1.6	6.4	3.2	0.8	1.6
Mollusca		12.8	8	1.6	0	4	1.6
Ostracoda		9.6	4.8	43.2	25.6	9.6	6.4
Decapoda:	**Potamonautidae**	**3.2**	**1.6**	**9.6**	**1.6**	**107.2**	**59.2**

Dead wood (DW) and non-woody coarse particulate organic matter (CPOM) were cleaned of inorganic sediment, dried and then weighed. The carapace width (CW) of each individual crab was determined at its widest point to the nearest 0.1 mm using callipers. Individuals with a CW < 3 mm were categorised as small juveniles, recently released from maternal care. Each crab was carefully cleaned to remove excess moisture, and its wet mass determined using a balance accurate to 0.001 mg. The combined wet mass for all other macroinvertebrates within each sample was determined following the same procedure. In view of the potential taxonomic value of the specimens collected, dry mass of crabs was not determined directly, but estimated using the linear equation:

Dry mass = 0.3836 (Wet mass).

This equation was derived from drying and reweighing approximately 50 crab specimens from a river in the Kenyan Rift Valley, and verified using specimens from other locations – and representing several species – in central and western Kenya; the relationship is strong ($R^2 = 0.9617$). Dry mass was not estimated for other macroinvertebrates because of the wide variety of taxa present and therefore the potential for error in such estimates; therefore only wet mass was available.

Data analysis

Number and biomass of crabs per m^2 were estimated for each site. Small juveniles were assumed not to be representative of the general population, as they were generally highly aggregated within the sites in which they occurred (possibly having recently been released from maternal care); therefore, estimates of numbers were made both including and excluding small juveniles. The number and biomass (wet mass) of macroinvertebrates excluding crabs was compared among habitat types using 1-way ANOVA, after $\log_{10}$ transformation. Among sites where crabs were present, number and biomass (estimated dry mass) of crabs were compared among habitat types using 1 way ANOVA, after $\log_{10}$ (n +1) transformation, and individual habitat types were compared using Tukey's test. Crab numbers and biomass (wet mass) as a percentage of total macroinvertebrates were calculated. Size of individual crabs was compared among habitat types; distribution among size classes is non-normal, so comparisons of CW were made using a Kruskal-Wallis test, followed by pairwise comparisons among habitats using Mann-Whitney U tests.

Relationships among the physico-chemical parameters were explored using linear regression; this method was then used to determine relationships between abiotic parameters and estimated mean crab biomass per site. Among sites where crabs were present, the relationship between crabs and organic matter standing stocks was investigated. Crab numbers and biomass (estimated dry mass) were each compared with standing stocks of CPOM and DW using linear regression of mean values per site. Regressions were performed with and without small juveniles. All analyses were carried out using SYSTAT Version 11.00.01, with the exception of regressions, which were carried out using Sigmaplot for Windows Version 9.01.

Results

In total, 21 sites were sampled on 19 rivers, of which nine were classified as open, eight as shaded and four as forest (Table 1). There was no geographical bias to any of the habitat types, but there were fewer forest sites than the others due to the relative difficulty of access to primary forest areas during the rainy season. All sites contained large numbers of non-crab macroinvertebrates (Table 2); these included a high proportion of small-particle detritivores such as Caenidae, Chironominae, Simuliidae and Oligochaeta, but Tipulidae were the only shredders, comprising less than 1% of total numbers. There was no difference in overall macroinvertebrate numbers ($F_{2,18}$ = 0.030, P = 0.971) or biomass ($F_{2,18}$ = 0.4598, P = 0.639) among the three habitat types.

Crabs were recorded from 14 of the sites sampled. Those from sites 4 and 5 were identified in a subsequent study as *Potamonautes odhneri* (N. Cumberlidge, pers. comm.). Crabs from six further sites were compared with adults from sites 4 and 5. Specimens from sites 2, 3, 10, 14 and 18 were representatives of this species, whereas those from the relatively high altitude site 21, although very similar, showed a difference in gonopod morphology, suggesting a second species (possibly *P. jeanneli*). All other specimens were either females, for which precise determination is not yet possible, or were too immature or damaged to allow identification, but their general appearance suggested that no more than one species was sampled per site, and that this was *P. odhneri* or a closely related species.

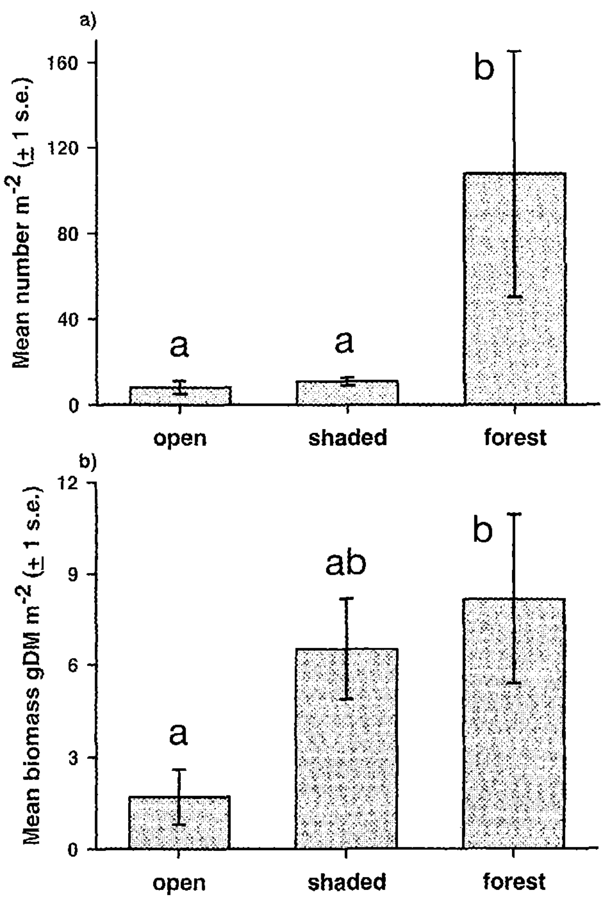

Fig. 1. a) Number and **b)** biomass (estimated dry mass) of crabs in streams running through the three habitat types around Mt Kenya. Figures exclude sites from which no crabs were recorded. Letters refer to habitat types showing no significant difference (Tukey's test: P.0.05).

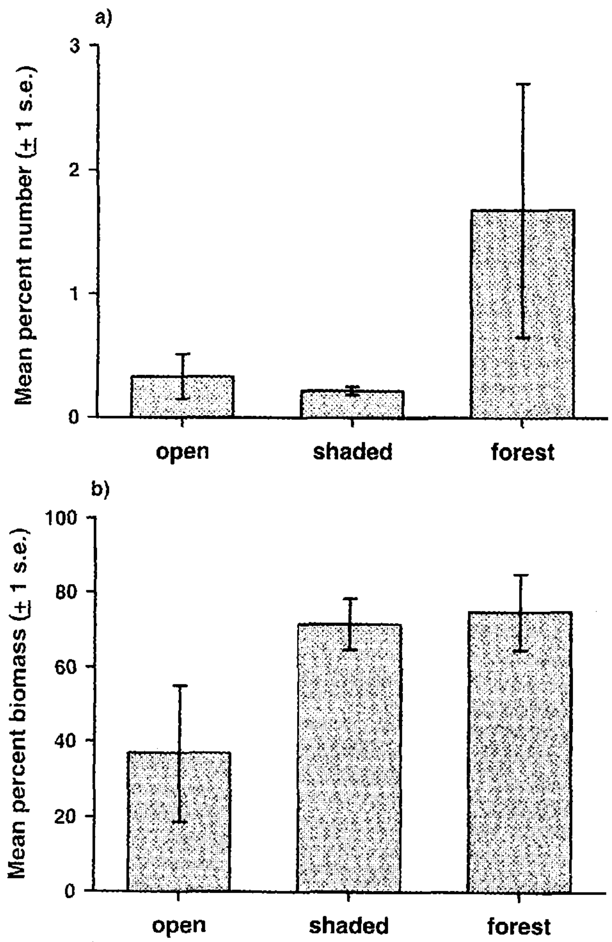

Fig. 2. a) Number and **b)** biomass of crabs as a percentage of total macroinvertebrates in streams running through the three habitat types around Mt Kenya. Biomass comparisons were made using wet mass. Figures exclude sites from which no crabs were recorded.

Table 3. Summary of comparisons of crab carapace width (CW) among habitat types. Analyses were carried out after pooling all site data within habitat classes. Key: NS = not significant (P >0.05).

	K-W test statistic	d.f.	P
	35.672	2	<0.001
Comparison of CW	Mann-Whitney U statistic		P
Open vs shaded	87.5		NS
Open vs forest	1149		<0.001
Shaded vs forest	1916		<0.001

Crabs were recorded from all of the forest sites and all but two of the shaded sites (Table 1). They were significantly more abundant in forest sites than in either type of agricultural site, even following exclusion from the analysis of sites from which no crabs were recorded ($F_{2,11}$ = 5.915, P = 0.018; Fig. 1 a). There was a significant effect of habitat type on biomass ($F_{2,11}$ = 4.852, P = 0.031); crab biomass was lower in open sites than forest sites, but there was no difference between shaded sites and the other two habitat types (Fig. 1 b). In all sites, crabs com-

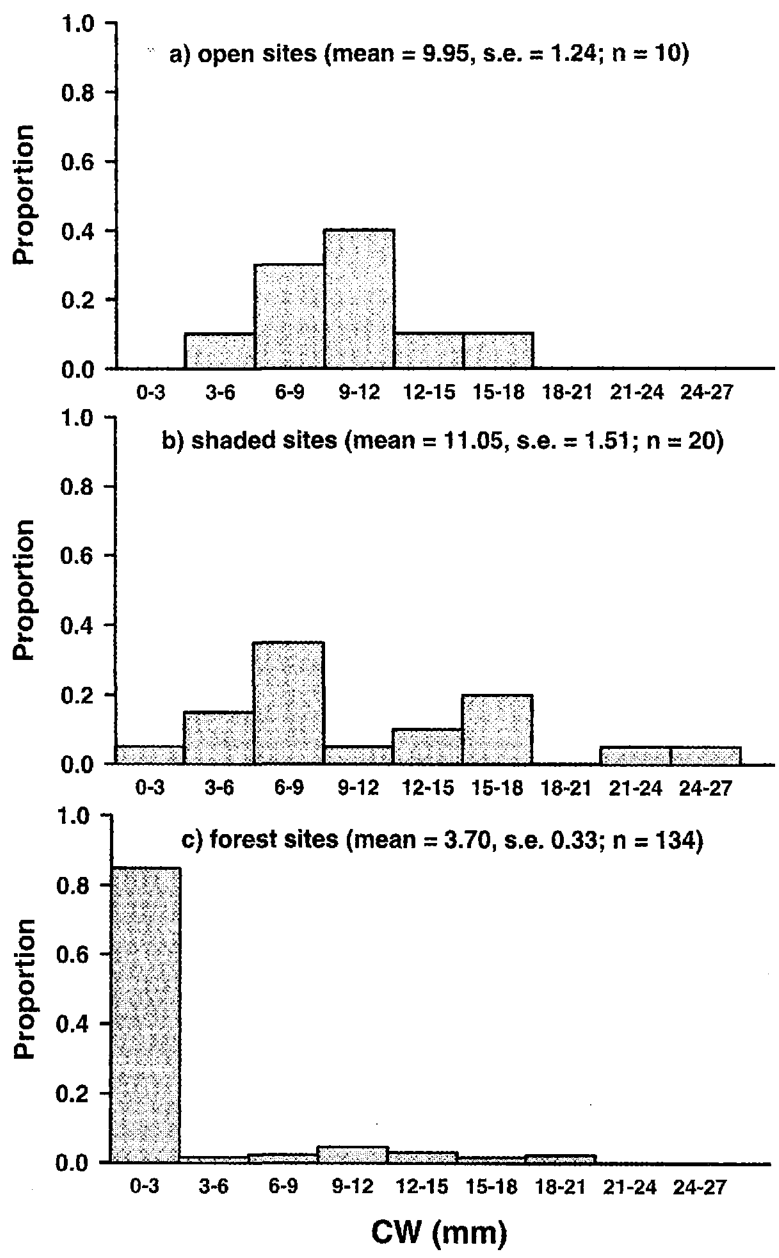

Fig. 3. Carapace width (CW) of individual crabs in streams running through the three habitat types around Mt Kenya. Measurements are presented in 3 mm size categories, as a proportion of the total number recorded in each habitat.

prised a small proportion of total macroinvertebrate densities, rising to around 1.6 % in forest sites but considerably less than 1 % in agricultural sites (Fig. 2 a). In terms of biomass, however, they dominated shaded and forest sites, often exceeding 70 % of total biomass; even in open sites, where crabs were present they averaged nearly 40 % of total macroinvertebrate biomass (Fig. 2 b).

Crabs were significantly smaller in forest sites than agricultural habitats, but there was no difference between open and shaded sites (Table 3; Fig. 3). Forest sites were dominated by small juveniles, with relatively few adults and sub-adults. Among all agricultural sites, in contrast, only a single small juvenile was recorded. The impact of large numbers of small juveniles on habitat comparisons is illustrated by their removal from analyses: with juveniles excluded, the average size of crabs in all habitat types was similar (CW mean 10.0 [standard error 1.2] mm in open sites, 11.5 [1.5] mm in shaded sites and 12.0 [0.9] mm in forest sites) and the difference in densities was markedly reduced (8.0 [3.1] m^{-2} in open sites, 10.1 [1.9] m^{-2} in shaded sites and 16.0 [3.5] m^{-2} in forest sites).

There was a significant relationship between altitude and both temperature ($F_{1,20}$ = 21.743, R^2 = −0.534, P <0.001) and pH ($F_{1,16}$ = 5.180, R^2 = 0.257, P = 0.038), although not with conductivity. However, none of these parameters had a significant effect on crab biomass. There was a positive relationship between crab numbers and standing stocks of DW, which strengthened when small juveniles were excluded, but no relationship between crab biomass and DW (Fig. 4). A similar pattern was found with CPOM, which was itself strongly correlated with biomass of DW ($F_{1,12}$ = 80.537, P <0.001, R^2 = 0.870).

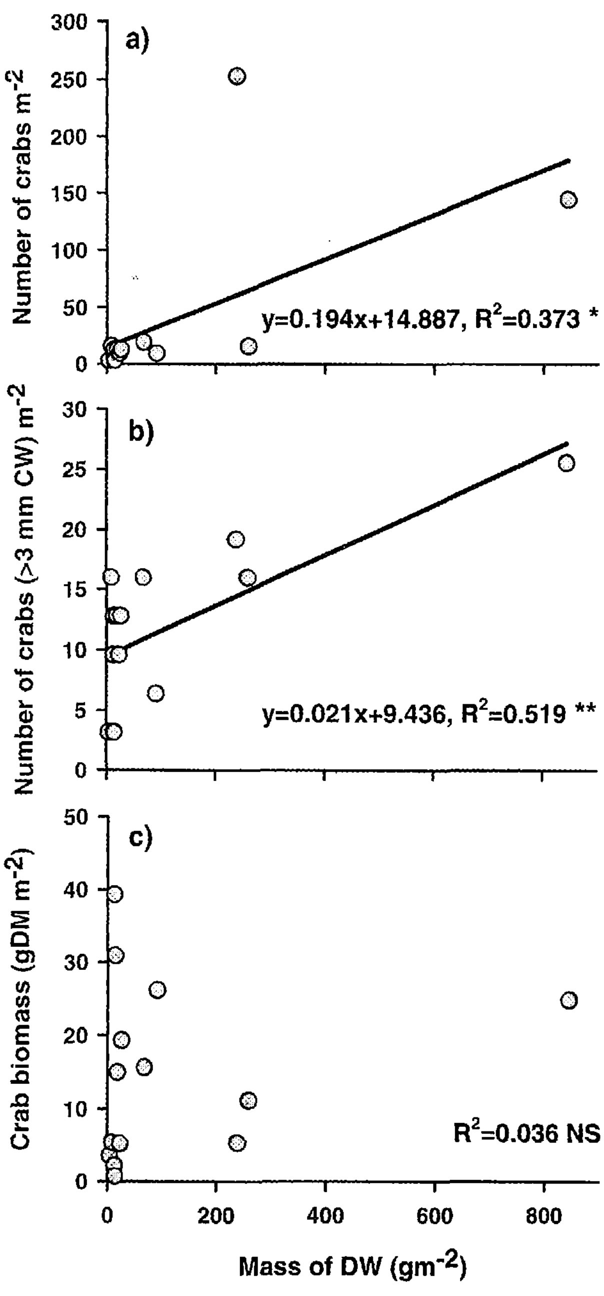

Fig. 4. Relationship between benthic mass of DW and **a)** number of crabs; **b)** number of crabs with CW >3 mm; **c)** biomass of crabs (estimated dry mass). The relationship is based on mean values recorded per site and is extrapolated to values per m^2. Key: DM = dry mass. N = 14 in each case. NS = not significant (P >0.05); * = P <0.05; ** = P <0.01.

Discussion

Abundance and ecological role of crabs

This study demonstrated that freshwater crabs are widespread in the Mt Kenya region. They were recorded from two thirds of the sites sampled, including all of those with undisturbed vegetation. It also demonstrates their importance in most of the streams in which they occur. Although population densities were low compared to other benthic fauna, their much greater size means that they dominated the total macroinvertebrate biomass of streams in which they occurred. Calculated population densities and overall biomass were equivalent to those of the large-bodied southern African *Potamonautes perlatus* (Turnbull-Kemp 1960, Hill & O'Keeffe 1992). Furthermore, it is almost certain that our biomass values are underestimates. The problems of accurate population estimates of freshwater crabs are well known, as is the difficulty of sampling the entire population range using a single method (Disney 1971, Kino 1990, Dobson et al. 2007). Surber sampling rarely captures mature individuals, for which baited traps are needed, hence the absence of fully adult specimens in our samples. Subsequent sampling in sites 4 and 5 using baited traps demonstrates that the species most commonly caught – *Potamonautes odhneri* – has a typical CW of 25–30 mm when fully adult (unpublished data), considerably larger than most of the specimens caught in the Mt Kenya survey.

The degree to which crabs dominate the macroinvertebrate biomass suggests that they feed on a basal resource such as detritus. Although no quantitative analysis of crab diet has been carried out around Mt Kenya, examination of gut contents of several specimens from site 21 (unpublished data) demonstrated a similar pattern to that recorded by Williams (1962, 1965) and Hill & O'Keeffe (1992): relatively more invertebrates consumed by small individuals, but dominance of coarse detritus among all size classes. There was no relationship between crab biomass and mass of CPOM in the study sites, but this result may be a consequence of the time of year during which our survey took place. We sampled at the beginning of the rainy season when the first significant rains for several weeks were falling into some of the catchments. It is probable, therefore, that there had been recent redistribution and removal of detritus in these systems. The crabs are presumably more resistant than CPOM to flood events, and so any attempt to relate their numbers to standing stocks of detritus would need to be carried out over a longer time period than the snapshot study of ours.

Habitat effects

Our study sites covered a wide altitudinal range, and therefore showed a range of water temperatures and pH. However, these variables, along with conductivity, had no apparent influence on crab densities. In contrast, habitat type was a strong predictor of abundance.

The relationship between habitat and average body size suggests the possibility that reproduction in these species is more successful in forested habitats. Unlike their marine counterparts, freshwater crabs do not have a free-living larval stage, but emerge directly from the egg as miniature crabs. Potamonautid females carry their eggs and hatchling juveniles in their abdominal brood pouch until the offspring are large enough to fend for themselves, which is when their CW is around 2.5 mm (Disney 1971). The vast majority of specimens recorded from forest sites were very small juveniles, in the 2.5–3 mm CW range; if these juveniles are removed from the analysis, the average size of crabs in all habitat types is similar and densities, although still highest in forest sites, are similar to those in shaded sites and only twice those recorded in open sites. With so few forest sites sampled, we would not presume that this result provides clear evidence for greater reproduction in undisturbed streams, but small juveniles were present in three of the four forest sites (and numerically dominant in two of them), whereas in all the agricultural sites, both open and shaded, only a single small juvenile individual was caught. As almost all the rivers draining Mt Kenya have their source in or above the forest that clothes the upper slopes of the mountain, this forest region may act as a nursery area from which crabs then migrate downstream. From a conservation perspective, therefore, freshwater crabs may be impacted by land use, in that densities are much lower and reproduction may be impaired in agricultural areas compared with forest. This finding is analogous to that of Zimmerman & Covich (2003), who found that juveniles of the freshwater crab *Epilobocera sinuatifrons* (A. Milne Edwards) in Puerto Rico were more abundant in a stream running through undisturbed forest than in a similar stream whose catchment forest had been cleared and then re-established.

Conclusion

This study has demonstrated that crabs are an important component of the benthos in permanently flowing East African streams. Beyond the clearly pivotal role that such a large biomass may be expected to play in the ecology of rivers, there is an intrinsic conservation interest in understanding human impacts upon freshwater crabs. They have recently been highlighted as a group for which more than half of the East African species may be endangered or vulnerable, but for which too little information is available to make a realistic assessment of their conservation status (Darwall et al. 2005). It is now therefore essential that their importance in detritus processing, and therefore wider ecological function, is determined and that the impact of land use change on their populations is better understood.

Acknowledgements

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