Habitat Selection of the Black-shouldered Kite (*Elanus caeruleus*) in Agroecosystems of Swaziland

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Abstract

A decline in many African raptor populations may contribute to loss of ecosystem services such as pest control. The Black-shouldered Kite (*Elanus caeruleus*) stands out as an exception, experiencing range expansions due to its proclivity for agricultural landscapes. We surveyed roads throughout Swaziland agroecosystems for Black-shouldered Kites and looked at habitat selection in a used versus available framework. We found that kites selected for savannahs and tall herbaceous vegetation but did not show preferences for or against land use types. We also found a significant relationship with kite presence and low tree densities in the immediate vicinity of a perch site. Singles, pairs and fledgling kites were observed in agricultural landscape, suggesting that although they are not selecting for these areas in proportion to its availability, they are foraging in it. This may be a boon for farmers who implement ecologically based rodent management programs.

KEYWORDS: Agroecosystems, Black-shouldered Kite, ecologically based rodent management, *Elanus caeruleus*, habitat selection, pest-control, Swaziland

Introduction

Loss of biodiversity impacts ecosystem function, and decreases in functional diversity can negatively affect ecosystem resilience (Allen et al. 2005). A system's resilience is a major factor in its ability to withstand changes such as climate, as well as continue to provide ecosystem services (Folke et al. 2002). Continued conversion from traditional subsistence farming to intense cash crop production in southern Africa may threaten many of the ecosystem services that are important to small and large scale farmers (Khumalo et al. 2012). One area of concern is a loss of pest control services due to simplification of both the pest and predator communities (Tscharntke et al. 2005).

Many studies that address avian predator ability to control rodent pests agree that raptors alone cannot fully limit rodent populations (Sinclair et al. 1990, Van Gulck et al. 1998, Wolff et al. 1999, Vibe–Petersen et al. 2006, Paz et al. 2013). Raptors do, however, appear capable of dampening rodent population oscillations (Korpimaki and Norrdahl 1991). Increasing predation risk by raptors may also alter rodent foraging behaviour, potentially reducing crop depredation (Abramsky et al. 2002, Mohr et al. 2003, Preisser et al. 2005, Juliana et al. 2011). Factors that contribute to raptors' ability to dampen rodent populations include rapid numerical responses to increased rodent density and low propensity for raptor populations to be limited by territoriality (Korpimaki and Norrdahl

Studies assessing how agriculture affects functional groups across avian taxa in South Africa show that upper trophic level species' populations, including raptors, are declining, which could in turn impact pest control services (Child et al. 2009, Cumming and Child 2009). Throughout Africa, these declines in raptor populations (Sorley and Andersen 1994, Thiollay 2007, Ogada and Keesing 2010) have been attributed largely to human modification of landscapes that increasingly restrict raptors to protected areas (Buchanan et al. 2009, Coetzee et al. 2009). One species stands out as an exception: the nominate form of Black-shouldered Kite (*Elanus caeruleus* [hereafter, BSKI]; Brandl et al. 1985, Herremans and Herremans–Tonnoeyr 2001, Thiollay 2001, Monadjem and Rasmussen 2008).

The BSKI is a small, diurnal raptor and small mammal specialist (Tarboton 1978, Mendelsohn 1981). While this species by itself is not a substitute for raptors such as buzzards and eagles, it does exhibit those characteristics described by Korpimaki and Norrdahl (1989) that might enable it to impact rodent populations. BSKI are opportunistic specialists that respond to increases in available prey (Parejo and Aviles 2001). They are frequently nomadic and will congregate in communal

roosts in the non–breeding season, thus enabling them to appear in high concentrations during rodent outbreaks (Mendelsohn 1983, 1988). They also spend the bulk of their foraging efforts perch hunting (Mendelsohn and Jaksic 1989); land managers could take advantage of this behaviour by installing artificial perches to encourage BSKI presence (Kay et al. 1994, Wolff et al. 1999, Sheffield et al. 2001). These characteristics make BSKI uniquely qualified to provide agroecosystems with important pest control services.

In Africa, there is increasing interest in using ecologically based rodent management (EBRM) systems to deal with pests, particularly the Natal Multimammate Mouse (*Mastomys natalensis*) (Makundi and Massawe 2011). The Natal Multimammate Mouse is the top crop damage-causing rodent in Swaziland (Monadjem et al. 2011, Takele et al. 2011), where it is a significant pest in sugarcane fields and experiences population irruptions that can greatly increase economic losses (Stenseth et al. 2003). Sugarcane plantations tend to have over–simplified small mammal communities, and a recommendation to address this imbalance is that intensive agricultural systems integrate natural habitat features to counteract homogenization (Hurst et al. 2013, 2014). In conjunction with successful EBRM methods such as community trapping (Taylor et al. 2012), a mosaic of natural habitat within agroecosystems may also promote the presence of BSKI as a population control agent by providing roosting and breeding sites. BSKI are known predators of Natal Multimammate Mice in fallow agricultural fields (Van Gulck et al. 1998), as well as many other rodent species. Implementing EBRM with BSKI, however, presupposes a solid understanding of habitat utilization by this raptor. To address this issue our study examined habitat utilization by BSKI in Swaziland agroecosystems at multiple scales to identify those habitat characteristics positively associated with BSKI presence.

Methods

Study Area

Our study was conducted from 22 May 2014 to 3 August 2014 in agroecosystems throughout eastern Swaziland. Swaziland is a landlocked country in southeastern Africa, covering 17 565 km^2 with elevation ranging from 21–1 862 m above sea level (Goudie and Price Williams 1983). The country consists of four major geographical regions: the Highveld to the west, Middleveld in the center, the Lowveld to the east, and the Lubombo Mountains in the far east (Goudie and Price Williams 1983). Average annual temperatures range from 15° to 23° C, with a distinct rainy season from October to March (Goudie and Price Williams 1983). Natural vegetation types include grassland, open, acacia, and broadleaf savannah, as well as mixed bushveld. In 2013, 71% of the nation's land was devoted to agriculture, consisting largely of sugar cane, maize, and citrus (WB 2015).

Field Methods

We established a 440-km route along primary and secondary roads (Fig.1) and systematically surveyed one-third of the route with two observers for 4–5 hours between 08:00 and 17:00 at a cruising speed of approximately 80 km/h. When either observer sighted a BSKI, we took GPS coordinates of the location. We also selected a number of random points generated with ArcMap 10.1 (Environmental Systems Research Institute, Inc., Redlands, CA USA) along the available study route to compare use versus availability (Manly et al. 2002). We went to each of these points and identified the nearest available perch location (power line or tree) to measure the same variables as those taken at bird-sight locations. We considered a point independent at an 892-m radius, thus if at any time a bird was seen within that distance of one of the available sites, we
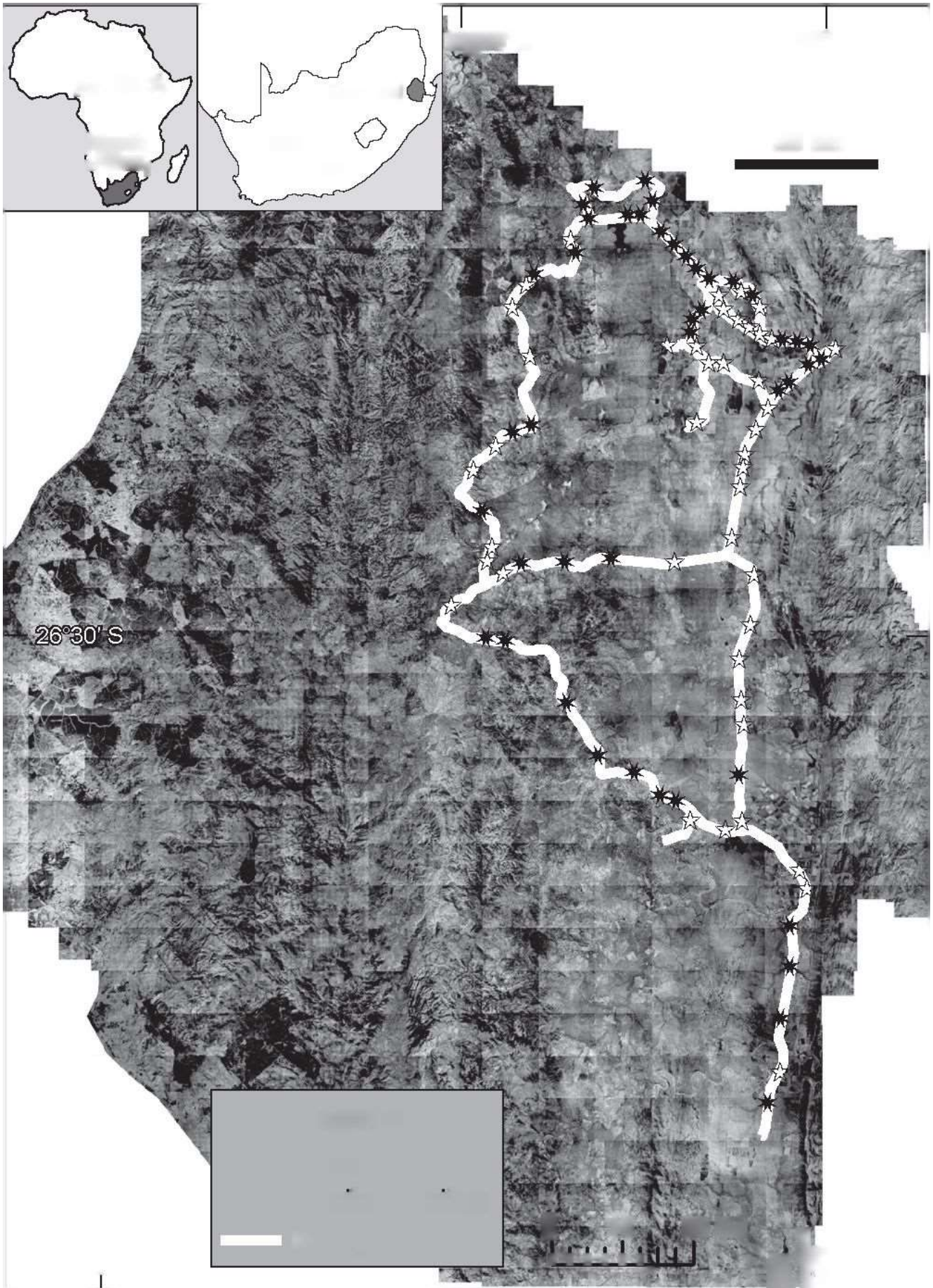
Figure 1. Map of Swaziland showing 440-km study route and used/available sites surveyed.

removed that site from the analysis. We chose this distance based on previously reported average home range size of 2.5 km^2 for BSKI in South Africa (Mendelsohn 1981).

We measured habitat variables for each of the sites including distance to nearest tree in each of the four cardinal directions up to 400 m using a rangefinder, whether the perch used was a power line or tree, and if the immediate area (30-m radius) was dominated by short ($\leq$ 15 cm) or tall (> 15 cm) herbaceous vegetation. When we observed more than one bird at any given site or observed a bird at a known used site, we used the data from the earliest observation. We also categorized sites into habitat types using aerial imagery in ArcMap 10.1. No pre-existing land use classification was available, so we estimated proportions of the study area consisting of sugarcane, developed areas (urban areas, small villages, and settlements), and undeveloped areas (protected reserves and pastures) using ArcMap 10.1. A site was assigned to each category based on the centroid location. We additionally classified sites into land cover categories of bushveld, savannah, or cultivated lands according to the most dominant category.

In addition to recording bird sightings and measuring habitat variables, we made anecdotal observations of bird behaviour. We noted whether birds were seen in pairs, whether they were interacting with other bird species, and if a bird was a juvenile or adult based on the freshness of the reddish juvenile plumage on the chest and buffy tips to the flight feathers (Bustemante 1993).

Statistical Analysis

We analysed all categorical covariates using a two-way chi-square test as a design I with estimated proportions of available resource units (Manly et al. 2002). We analysed our only continuous covariate, average distance to nearest tree, with a Student's t-test (Zar 1984).

Results

We recorded a total of 88 bird sightings at 43 used sites; in some cases birds were seen within the 892-m radius of a previously recorded site, and occasionally multiple birds were seen at a single location. We compared these to 43 random sites that we considered available. Of the birds sited, 95% were observed perching on power lines. Black-shouldered Kites used savannah more often in proportion to its availability ($\chi_2^2 = 7.37$, $p = 0.025$: Table 1) and selected tall herbaceous ground cover over short cover ($\chi_1^2 = 10.47$, $p = 0.001$: Table 2). They did not select or avoid any other habitat type in relation to its availability. Average distance to nearest tree did not differ among used and available sites at the 400-m distance. However, when we removed distances greater than 100 m from the analysis, the mean distance to nearest tree was greater at used sites than at available sites ($t_{47} = -1.71$, $p = 0.047$: Fig. 2).

We observed seven pairs over the study period, including two adults with two fledglings. The fledglings were first observed on 15 July at a site that typically had a single hunting adult, and when the fledglings were recorded they were accompanied by two adults. These four birds were resighted together three more times, the last observation on 1 August. Another pair was seen actively defending their territory against a Lizard Buzzard (*Kaupifalco monogrammicus*) on 30 May, and a lone juvenile was seen adjacent to this site on 23 May.

Discussion

Black-shouldered Kites were conspicuous when perched on power lines along roads. Consequently, we may have had a greater detection probability for these birds as opposed to those in trees. That they selected for savannah confirms what we already know about this species' preferences from previous studies (Mendelsohn and Jaksic 1989, Thiollay 2001, Seavy and Apodaca 2002). Studies
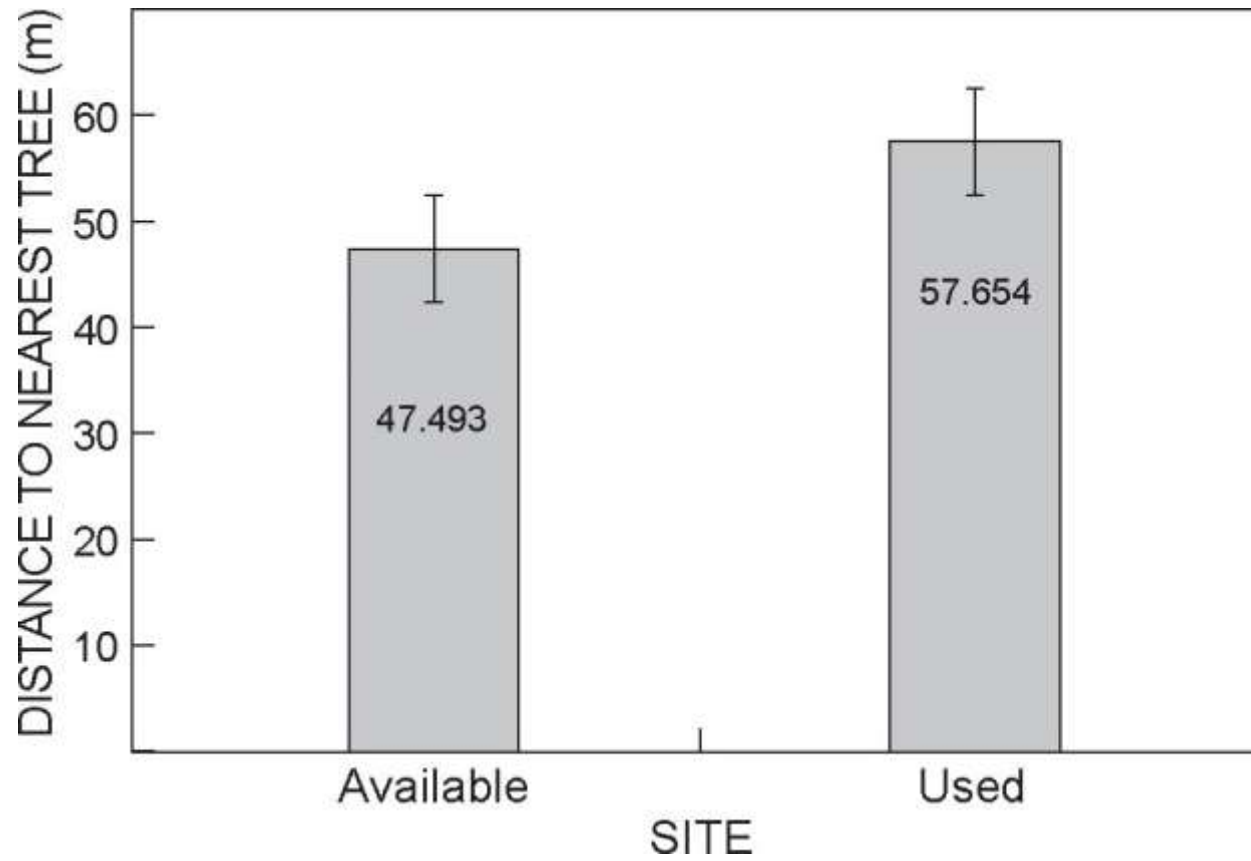
Figure 2. Mean distance to nearest tree up to 100 m (n = 50) with standard error bars at used and available sites in Swaziland.

Land cover	Available	$\hat{\pi}$	Used	$\hat{o}$	Selection ratio	Standardized ratio	SE (selection ratio)	Lower	Upper
								Confidence limits	
Bushveld	17	0.395	11	0.256	0.647	0.178	0.179	0.199	1.095
Savannah	9	0.209	21	0.488	2.333	0.643	0.708	0.562	4.104
Cultivated	17	0.395	11	0.256	0.647	0.178	0.179	0.199	1.095
Total	43	1	43	1	3.627	1			

Table 1. Design I with estimated proportions of available resource units (Manly et al. 2002) for land cover categories at used and available sites in Swaziland, where π represents a ratio of available to total units, and ô represents a ratio of used to total units.

Herbaceous cover	Available	π̂	U	ô	Selection ratio	Standardized ratio	SE (selection ratio)	Lower	Upper
								Confidence limits	
Short (≤15 cm)	29	0.674	14	0.326	0.483	0.189	0.100	0.234	0.732
Tall (>15 cm)	14	0.326	29	0.674	2.071	0.811	0.459	0.924	3.219
Total	43	1	43	1	3	1			

Table 2. Design I with estimated proportions of available resource units (Manly et al. 2002) for land cover categories at used and available sites in Swaziland, where π represents a ratio of available to total units, and ô represents a ratio of used to total units.

that examined foraging selection in other raptor species show that shorter vegetation is preferred over taller vegetation (Toland 1987, Garcia et al. 2006, Swolgaard et al. 2008); however, our results indicated kites select for tall herbaceous cover. In our study area, birds were sighted on road verges where there was a distinct contrast between areas that had been burned or mowed and areas that were not managed, hence our classification of short and tall herbaceous vegetation. In other systems, short vegetation presumably allows easier access to prey, while our study areas classified as short were typically nearly bare, and were likely avoided entirely by rodents (Monadjem 1999). Our decision to truncate the average distance to nearest tree revealed a significant relationship with lower tree densities, which corroborated previous findings (Balbontin et al. 2008). Canopy cover presumably decreases visibility for an aerial hunting predator, whereas trees more than 100 m from a perch site seem unlikely to have any effect.

We found no evidence that BSKI selected for or against land used for agriculture, although 22 of the 43 used sites contained agriculture activity and 11 birds were observed directly in agricultural areas. A recent study in northern Tanzania found BSKI nearly absent from cultivated areas adjacent to Serengeti National Park (Byrom et al. 2014); this contradicts our findings as well as other studies that have noted BSKI in agricultural areas (Brandl et al. 1985, Balbontin et al. 2008). The presence or absence of suitable perching sites may limit BSKI use of agricultural areas (Van Gulck et al. 1998). In areas where BSKI presence is desired, installation of perches may encourage occupation, particularly power line-like structures (Wolff et al. 1999).

Our behavioural observations indicated at least some birds remained in pairs on territories during the dry season. Black-shouldered Kites are thought to breed opportunistically in relation to prey availability, which typically fluctuates with precipitation (Mendelsohn 1984, Monadjem and Perrin 2003). The presence of adults indicated that these were recently fledged juveniles, and reports

of post-fledgling dependence period vary from an average of 34–81 days (Bustemante 1993, Mendelsohn 1981). Both of these sites, along with all but one of the other pairs observed, contained substantial amounts of sugarcane. Breeding pairs consume larger quantities of prey (Slotow and Perrin 1992) and the high observed incidence of pairs in agricultural settings indicate that birds may be keying in on the abundance of prey in and around sugarcane fields.

Our results confirm that BSKI do forage in agricultural settings in Swaziland, but our inability to individually mark animals raised many questions. Where they nest and how their home ranges vary in different habitat types are examples of questions that radio-marked animals may help answer. For managers attempting to encourage BSKI presence for rodent management purposes, power line-like perches, some moderate amount of herbaceous vegetation, and low tree densities are the only recommendations available without further investigation.

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