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ORIGINAL ARTICLE

Species composition, distribution, and relative abundance of medium and large mammals in Guda forest, Southwestern Ethiopia

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This study was carried out to evaluate the composition, relative abundance and distribution of medium and large-sized mammals in the Guda forest, Southwestern Ethiopia. Surveys were carried out to record mammals of three habitat types, namely grassland with scattered trees, woodland, and riverine forest. A total of thirteen mammalian species were recorded. The recorded species were *Potamochoerus larvatus, Syluicapra grimmia, Ourebia ourebi, Marmota monax, Corcuta corcuta, Canis aureus, Civetticitis civetta, Panthera pardus, Felis servestris***,** *Papio anubis, Chlorocebus aethiops, Colobus guereza and Hystrix cristata.* A total of 667 observations records were compiled. The dominant order recorded was Primates (83.2%) followed by Artiodactyla (8.85%) while the least record was Rodentia (1.95%). The species richness varied between stratified habitat types. The species diversity of the study area was *H'*=1.705. The strongest similarity in species composition was found between grasslands with scattered trees and riverine forest. Overall, *Papio anubis*, *Colobus guereza,* and *Chlorocebus aethiops* were the three most abundant species across habitat types. Anthropogenic activities affect the distribution and abundance of species in study area. Therefore, there should be strong law enforcement activities and awareness creation is very important to conserve the area.

Keywords: Distribution, Diversity, Guda forest, Mammals, Relative abundance.

Introduction

Mammals are biologically the most successful groups of animals with the possible exception of arthropods (Stanbury, 1972). They are one of the greatest resources found on the earth, that are the most important components of terrestrial ecosystems and provide vital ecological functions such as pollination (Mora, Méndez, and Gómez, 1999), seed dispersal, predation, and maintaining the balance of populations and communities associated with them (Herrerias-Diego et al., 2008).

Mammals are threatened by various factors induced by humans. Landscape modification and habitat fragmentation are major factors in species loss (Johnstone, et al., 2010). Expansion in agricultural schemes, deforestation, desertification, and hunting resulting from economic activities can cause loss to mammals (Wale et al., 2017). To overcome such enormous pressure from the mammals, conserving and managing them in and outside protected areas is a must among the nations of the world.

A basic requirement for determining the status of species is surveying mammals (Keeping and Pelletier, 2014). Mammal inventories are essential tools to efficiently forward conservation strategies and management practices (Legese et al, 2019). Habitat destruction has also caused some large predatory species to venture into human settlement areas and pose risks to humans and themselves (Dirzo et al., 2009). Cardillo et al. (2005) predicted more rapid loss of large mammals of the world in the near future. The reduction in small and medium-sized mammals may be less evident, but equal to or greater than those of large size.

Mammal inventories are extremely vital to improve our understanding of their geographical distribution (Melo et al., 2012). The ecological relevance of mammals, shortage of ecological data, and increased human threats make the matter very essential and necessary to evaluate their current conservation status (Wuver and Attuquayefio, 2006). The absence and rarity of these mammals in a given ecosystem have severe consequences in the structure, composition, and diversity of forests (Geleta and Bekele, 2016). Hence, surveys of mammalian diversity, abundance, and habitat conditions of a particular ecosystem are the first step for conservation action and provide information to establish appropriate conservation strategies. Understanding which and how mammalian species persist in disturbed fragments may also indicate the minimum requirements of the species and might contribute to their conservation (Bernardo and Melo, 2013).

Several previous studies conducted in Ethiopia on mammals. Yalden and Largen, 1992; Woldegeorgis and Wube, 2012; Kasso and Bekele, 2014, 2017; Geleta and Bekele, 2016, Wale et al., 2017; Atnafu and Yihune, 2018; Qufa and Bekele, 2019. However, the studies conducted on mammals, mainly targeted on National Parks and sanctuaries (Kasso and Bekele, 2014), and the survey on forest is also required. A complete inventory of mammals in different ecosystem types of ecosystem in Ethiopia does not exist and is not well documented (Tefera, 2011). Documents on the status and trends of mammals in various protected areas are needed if they are to be protected and managed. Medium and large mammals are intolerant for human interference and remain the best indicators for most isolated healthy habitats (Kasso and Bekele, 2014).

A complete inventory of mammals in different ecosystem types of ecosystem in Ethiopia does not exist and is not well documented (Tefera, 2011). Documents on the status and trends of mammals in various protected areas are needed if they are to be protected and managed. Among various forests in Ethiopia, the Guda forest is one of them, believed to harbor different mammalian species, but no survey was conducted on the diversity and abundance of mammalian species in the study area. Guda forest, different rivers

located in area that play a crucial role in regulating ecosystem processes and functions. Despite this, the forest has been under human interference (e.g., poaching, cultivation, uncontrolled fire, firewood collection, and logging for charcoal production) and livestock pressures. Such human-induced actions can adversely affect forest wildlife. Although urgent management actions are needed to abate these threats and mitigate the actual and potential impacts on biodiversity, it is also important to understand the status of prominent biological components, such as mammals. This understanding would assist ecologists in determining the magnitude of the impacts and taking more effective, informed management decisions. Therefore, the present study was to determine the composition of the species, the relative abundance and distribution of medium and large mammals and the predominant threats to wildlife in the Guda Forest, Southern Ethiopia.

Materials and Methods

Description of study area

The investigation will be carried out in Guda forest located in Mari Mansa district, Dawuro Zone, SNNPR. It is situated between 6°56' 00" to 7°04' 00" north and 37°02' 00" up to 37°16' 00" east. It is located to the southwest of Ethiopia at a distance of about 453 and 518 km from Addis Ababa across Butajira-Hosana and Jimma via Tarcha, respectively, and 321 km from the regional capital (Hawassa) (Fig. 1). Mari Mansa district has a total of 20 kebeles, of which 19 are rural-based kebeles administration areas and the remaining one is urban kebele. It lies in three agro- ecological regions: *Kola* region which is within 500-1500 meters above sea level (m.a.s.l) and receives 500-1,500 millimeters (mm) of rainfall; *Woyina Dega* within 1501-2500 m.a.s.l and receives 1281501-2500 mm; and *Dega* at above 2500 m.a.s.l and receives more than 2500 mm.

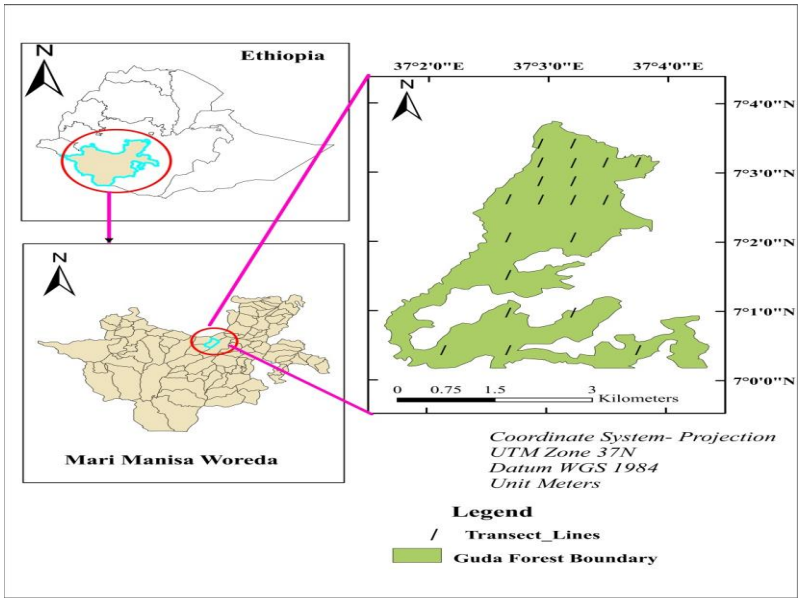

Fig. 1. Location of the study area and sampled area where the transect line distributed among different habitats in the study area.

The dominant plant species in the forest are *Syzygium guineense, Prunus Africana, Cordia Africana, Croton macrostachyus, Croton macrostachyus, Terminalia laxiflora, Dracaena steudneri, Dracaena steudneri, Podocarphus falcatus,* and *Eucalyptus camaldulensis.*

Methods of data collection

In the field, direct and indirect techniques were employed. Surveys in the sampled areas were carried out twice a day, early in the morning (6:00 to 8:00) and late in the afternoon (16:00 to 19:00) when most mammals were more active in the study area (Dereje et al., 2015). During data collection, the researcher and two field assistants walk on foot along each transect and directly count all the individuals sighted with their respective species using unaided eyes and binoculars. A total of 20 randomly laid transect lines were established to count the sighted mammals. The number of transects varied between habitats depending on their size: 9 in grassland with scattered trees, 7 in the woodland, and 6 in river forest. The length of each transect line was 5 km and a fixed sight distance of 200 m was used on both sides of transects was used in grasslands with scattered trees and in woodland. The sighting distance in the river forest was fixed to 100 m due to the increased vegetation thickness that obscures accurate observation and identification of mammals beyond the 100 m distance from the transect lines.

Mammal surveys were carried out from July to September 2020 during the wet season and from January to March 2021 during the dry season. Data collection was carried out while walking quietly and gently along each transect and recording animal observations. Data recorded whenever an individual animal or group of animals was sighted were as follows: date, time, habitat type, species name, individual number of each species, and GPS location (Girma et al., 2012). Animal counting was carried out with the naked eye and using 7 × 50 mm and 8 × 40 mm Bushnell binoculars. Whenever deemed necessary, Kingdon's (2003) field guide book was used for identification of mammals. In addition to direct observation, indirect evidence such as fecal droppings, feed marks, foot print, dens, territorial markings, spine, call, and other evidence were also recorded (Sutherland, 2006).

Data analysis

Data were analyzed using descriptive statistics and the species diversity index. The diversity of mammalian species of the study area was calculated using Shannon–Weaver Index of diversity:

$H' = -\sum Pi \ln Pi$

Where *H '* is the Shannon index of diversity, *Pi* is the proportion of individuals of a species in a sample, and ln=Natural logarithm (Shannon and Weaver, 1949). Simpson index of diversity was followed (1-*D*) using the formula: *J*=*H*′/*H*′ max, where *H*′ is the observed index of diversity and *H*′ max=ln(*S*); *S*=the number of species in each habitat; ln=Natural logarithm was calculated to determine the uniformity and dominance among the mammalian species. Relative abundance was used to calculate the occurrence of each species occurrence in the study area. Finally, a rarefaction curve can be computed to compare the mean species richness between the three habitat types of the study area (Colwell, Mao, and Chang, 2004).

Results

A total of 667 individual animals of 13 medium and large mammal species, belonging to eight families and four orders, were identified by direct and indirect field evidence in the Guda forest (Table 1). Among the four orders, the order Carnivora was the first most abundant order in terms of the number of both families (4 families) and species (5 species), the order Artiodactyla was the second most abundant in terms of both number of families (2 families) and species (4 species), the order Primates was represented by one family and two species, whereas the order Rodentia was represented by single species. The abundant order according to the number of observations from the study area was recorded by the order Primates which include 83.2% (N=555) of individuals followed by the order Carnivora which includes 8.25% (N= 55) and order Rodentia was the least abundant, which composes 1.95% (N= 13).

Table 1. Mammalian species identified in the Guda forest.

Order	Family	Common Name	Scientific Name	Local Name	No. of observation	Relative frequency
Artiodactyla	Suidae	Pig	*Potamochoerus larvatus*	Guduntsaa	14	2.1
	Bovidae	Grey duiker	*Syluicapra grimmia*	Gen'iya	19	2.85
		Oribi	*Ourebia ourebi*	Gaaraa	7	1.05
		Marmot	*Marmota monax*	Pugiyaa	19	2.85
Carnivora	Hyeaniadae	Spotted hyena	*Corcuta corcuta*	Babark'iya	4	0.6
	Canidae	Golden Jackal	*Canis aureus*	Worakana	7	1.05
	Viverridae	African Civet	*Civetticitis civetta*	Segiya	12	1.8
	Felidae	Leopard	*Panthera pardus*	Maahiya	9	1.35
		African Wildcat	*Felis servestris*	Shur maahiya	8	1.2
Primates	Cercopithecidae	Olive baboon	*Papio anubis*	Geleshshuwa	254	38.1
		Vervet monkey	*Chlorocebus aethiops*	K'aariya	128	19.2
		Colobus monkey	*Colobus guereza*	Wonnuwa	173	25.9
Rodentia	Hystricidae	Crested Porcupine	*Hystrix cristata*	K'us'ariya	13	1.95
Total					667	100%

The number of individual observations recorded and the relative frequency of each mammal species was presented in Table 1. The most dominant individual recorded was from order Primates namely *Papio anubis* 38.1% (*N*=254) followed by *Colobus guereza* 25.9% (N=173), and the least dominant species recorded from the Carnivora namely *Corcuta corcuta* 0.6% (*N*=4) followed by *Canis aureus* 1.05% (N=7).

The species richness varied across the habitat types stratified (Fig. 2). About 13 species recorded, the species richness of the categorized habitats was 13, 12 and 8 for woodland, grassland with scattered tree and riverine forest, respectively. The total number of observations of mammals in the woodland was N=303, river forest N=234, and grassland with scattered trees N=130.

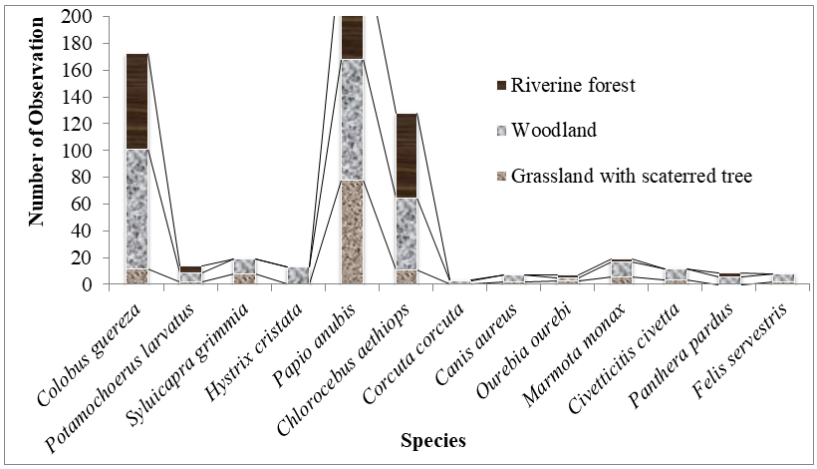

Fig. 2. Number of species observed among the three stratified habitat types.

The abundance of mammals varied between seasons (Table 2). 352 (52.77%) individuals were recorded in the dry season while 315 (47.23%) individuals were recorded in the wet seasons. The relative abundance of the different mammalian species varied from 0.28 to 37.5% in the dry season and from 0.32 to 38.7% in the wet season.

Table 2. Mammal species record and their relative frequency observations during the survey period.

Species	Season			Relative Abundance		
	Dry	Wet	Total	Dry	Wet	Total
Potamochoerus larvatus	11	3	14	3.13	0.95	2.1
Syluicapra grimmia	12	7	19	3.41	2.22	2.85
Ourebia ourebi	6	1	7	1.7	0.32	1.05
Marmota monax	10	9	19	2.84	2.86	2.85
Corcuta corcuta	1	3	4	0.28	0.95	0.6
Canis aureus	5	2	7	1.42	0.63	1.05
Civetticitis civetta	4	8	12	1.14	2.54	1.8
Panthera pardus	4	5	9	1.14	1.59	1.35
Felis servestris	1	7	8	0.28	2.22	1.2
Papio anubis	132	122	254	37.5	38.7	38.1
Chlorocebus aethiops	68	60	128	19.3	19	19.2
Colobus guereza	93	80	173	26.4	25.4	25.9
Hystrix cristata	5	8	13	1.42	2.54	1.95
Total	352	315	667	100	100	100

The diversity of mammal species was determined in each habitat type and in the study area were determined (Table 3). The highest species richness was recorded in the N=13 forest and the least eight species were recorded in the reverine forest. The higher and lower evenness of the mammalian species was recorded in forest (E=0.4985) and grassland with scattered trees (E=0.3774), respectively.

Table 3. Species diversity indices between habitats during the survey period.

Species diversity index	Grassland with scattered tree	Woodland	Reverine forest	Over all diversity indices
Taxa_S	12	13	8	13
Individuals	130	303	234	667
Dominance_D	0.3839	0.2128	0.303	0.2525
Simpson_1-D	0.6161	0.7872	0.697	0.7475
Shannon_H	1.511	1.869	1.327	1.705
Evenness_e^H/S	0.3774	0.4985	0.471	0.4231
Equitability_J	0.6079	0.7286	0.6379	0.6647

The dominance of mammalian species was recorded from highest to the lowest in grassland with scattered trees (D=0.3839) and woodland (*D*=0.2128), respectively. The overall species richness of the Guda forest was 13, and the Shannon-Wiener index values were (H ′=1.770) while the Simpson's index of diversity was (0.7475) in the study area.

Table 4. The similarity of mammalian species among the three types of habitat types in the Guda forest.

Habitat	Grassland with scattered tree	Woodland	Reverine forest
Grassland with scattered tree	-	0.04	0.3
Woodland	0.04	-	0.2381
Reverine forest	0.3	0.2381	-

Among the three habitat types, more similarity was observed between grasslands with scattered trees and Reverine forest (SI=0.3) followed by woodland and river forest (SI=0.2381). Similarity was lower in woodland and grassland with scattered trees (SI=0.04) (Table 4).

Discussion

Our results indicate that 13 species of medium and large mammal species were identified from 667 total observational records that belong to four orders and eight families. The mammalian diversity of the current study is nearly similar compared to that of Woldegeorgis and Wube (2012) who recorded 14 mammal species from Yayu forest in southwest Ethiopia. The result is similar to that of other parts of Africa, 13 species of large mammals recorded from the Ishaqibin Community Conservancy, Kenya (Muchai et al*.,* 2008).

Some studies in areas of different levels of protection levels across the country revealed that the medium and large mammals recorded were lower than the result obtained from our study. For example, Atnafu and Yihune (2018) recorded 12 mammal species in the Mengaza communal forest, East Gojjam, Ethiopia; Legese et al. (2019) recorded 12 mammal species in the Wabe forest fragments, Gurage zone, Ethiopia; Lemma and Tekalign (2020) recorded 12 mammal species in the Humbo community-based forest area, Southern Ethiopia; Worku and Girma (2020) recorded 10 mammal species in the Geremba mountain fragment, southern Ethiopia.

In contrast, the number of medium and large mammals recorded during the present study was small compared to several other studies conducted in Ethiopia. For example, Qufa and Bekele (2019) recorded 15 species in the Lebu natural protected forest, Ethiopia; Dirba et al. (2020) recorded 28 species in Loka Abaya national park, Ethiopia; Geleta and Bekele (2016) recorded 15 mammal species in the Wacha Protected Forest, Western Ethiopia; Kasso and Bekele (2017) fragmented remnant forests around Asella town showed a total of 22 mammalian species; Gebo and Takele (2020) recorded 21 mammal species in Faragosa communal forest, Gamo Zone. The small number of mammalian species recorded in the study area could be due to human impacts in and around the forest area. The adverse effect of the limited survey period, fuel wood, agricultural expansion, the grazing and human settlement of humans around forest was the major reason.

Some studies carried out in different countries revealed that the recorded medium and large-sized mammals recorded were higher than the result obtained from the present study. Bene et al. (2013) recorded 23 species in Sime Darby, Liberia; CortésMarcial et al., (2014) recorded 18 species in Juchitan, Isthmus of Tehuantepec, Oaxaca, Mexico; Melo et al. (2015) recorded 33 mammals in northern Amazon, Brazil.

The orders of mammals recorded in the present study were consistent with the study carried out on medium and large-sized mammals in different localities. For example, Woldegeorgis and Wube (2012) in Yayu forest in southwest Ethiopia, Qufa and Bekele (2019) in Lebu natural protected forest Ethiopia and Lemma and Tekalign (2020) in Humbo community-based forest areas in southern Ethiopia identified four orders. During this study, the leading order was recorded in Primates followed by Artiodactyla, which is consistent with the survey of Lebu natural protected forest and Yayu forest but vice versa with Humbo community-based forest.

The Primates were the most abundant orders recorded, and all belongs to a family Cercopithecidae*. Pabio anubis* and *Chlorocebus aethiops* were the most abundant mammal species in the study area. Similarly, several studies have also reported a higher relative abundance of Primates than other orders from different parts of Ethiopia (e.g., Legese et al., 2019; Qufa and Bekele, 2019; Atnafu and Yihune, 2018; Geleta and Bekele, 2016; Gonfa et al., 2015; Girma et al., 2012b). This could be due to the high reproductive successes, their more adaptive nature to different habitats, diversified foraging behavior, and high tolerance level of primates to human disturbances (Dereje et al., 2015). From primates, the most dominant species in the study area was *P. anubis*, this result was consistent with the study conducted by Worku and Girma (2020), Qufa and Bekele (2019) and Atnafu and Yihune (2018) in different parts of Ethiopia. This could be attributed to the feeding behavior as the species is adapted to feed on a variety of food items and survive different climatic and topographic variations. The presence of spotted hyaena was confirmed by droppings in the two habitats and by footprints only in the river forest.

The number of mammals individuals recorded during the dry season 352 (52.77%) surpassed the number of mammals recorded during the wet season 315 (47.2%). This is in line with the work of Kasso and Bekele (2017) in the fragmented forest, Ethiopia. The possible explanation for this could be the high number of people and livestock that were encroaching more during the wet season than during the dry season.

The species index of diversity showed that there is a variation in species diversity among habitats. For example, the forest has the highest diversity of species diversity (H'=1.869) while the least diversity of species diversity was recorded from the river forest (H'=1.327). Similarly, studies conducted by Qufa and Bekele (2019) and Kasso and Bekele (2017) showed that variation in the number and abundance of mammal species among different habitats is related to the quality of the habitat and preference of the species. The general species index of the diversity of the study area showed species richness (H=1.705; 1-D=0.7475). Possible contributing factors might be due to human disturbance (Fig. 3).

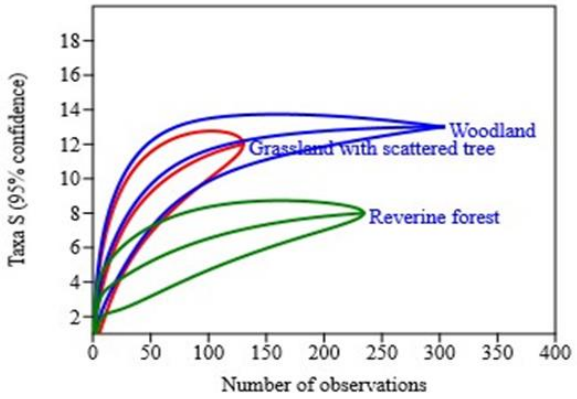

Fig. 3. Mean number of species richness computed by the rarefaction curve among the three habitat types.

The highest species similarity between grassland with scattered trees and river forest in the current study during both seasons could be because of resources availabilities such as food, water cover, and habitat conditions. This result agrees with the similarity of the species of mammal species between the riverine forest and the forest forest in Borena Saint national park (Chane and Yirga, 2014) and the Baroye Control Hunting Area (Dereje et al*.,* 2015). However, it contradicts the similarity of species similarity recorded in Dhati Wolel National Park (Gonfa et al*.,* 2015) and in Alatish National Park (Mengesha and Bekele, 2008).

The most common anthropogenic activities observed during the study period were agricultural expansion, illegal logging of trees for fuel wood, construction materials, livestock grazing, invasion, cutting of giant trees for timber production, and settlement in the forest surrounding. This is in line with the results of different scholars in different localities (Legese et al., 2019; Geleta and Bekele, 2016; Woldegeorgis and Wube, 2012; Fetene et al., 2011).

Conclusion

The findings of the study reveal baseline information about the presence of medium- and large sized mammals identified and documented 13 medium and large-sized mammalian species of Guda forest. This is the first ecological information on the diversity in mammals of the Guda forest, which would serve as a valuable baseline information for managers to make effective conservation decisions and for researchers wishing to conduct related ecological studies. The diversity, distribution and relative abundance of mammalian species in the study area showed a marked difference between habitat types in relation to the difference in habitat preference. Anthropogenic activities affect the distribution and abundance of species in study area. Therefore, to minimize the impact of human activities and to gain the importance of the forest, there should be strong law enforcement activities on protection of the forest from different interference through local communities, and awareness should be created for the local people about the impact of human activities on wildlife in the area.

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Conflict of Interest

The authors declare that they have no competing interests.

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