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The Herpetological Importance of Mt. Hamiguitan Range, Mindanao Island, Philippines

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Abstract

We provide the first accounts of the amphibians and reptiles of Mt. Hamiguitan Range in south eastern Mindanao. Three sites were visited: dipterocarp, transitional dipterocarp-montane and mossy-pygmy forests. The combination of transect sampling, pitfall trapping and microhabitat searches produced records of 34 species (15 frogs, 14 lizards and five snakes). We provide information on the herpetofaunal assemblage of Mt. Hamiguitan including data on species richness, elevational distribution and microhabitat preferences. High levels of species richness and endemism were observed especially in the dipterocarp forest site located outside the boundaries of the protected area. Our data suggest that Mt. Hamiguitan range should be considered an important subcenter of herpetological diversity. Future conservation efforts should focus particularly on lowland forests.

Keywords: amphibians, conservation, Mindanao Island, reptiles, species richness

Introduction

The herpetology of Mindanao Island in southern Philippines is moderately understood. Herpetological studies on the island have been few and far in between. Among these are the studies conducted by Taylor (1922), the Philippine Zoological Expedition of the Chicago Natural History Museum of 1946–1947 (Inger, 1954), Brown and Alcala (1986), National Museum of the Philippines-Cincinnati Museum of Natural History "Philippine Biodiversity Inventory" (Brown et al., 2000; Kennedy et al., 1997) and lizard and snake accounts in select areas of eastern Mindanao (Smith, 1993a and 1993b). There are subsequent studies done in the area but these remain unpublished. Therefore, there exists a large gap of knowledge of the Mindanao herpetofauna.

Mindanao island forms the majority of the Mindanao Pleistocene Aggregate Island Complex (PAIC) and is considered as one of the country's major centers for species endemism (Diesmos et al., 2000). Its eastern side is reported to harbor one of the largest remaining forest blocks in the country today. Recent biodiversity conservation priority-setting efforts have identified 34 priority conservation sites within this region (Ong et al., 2002). Because of the presence of these important biodiversity sites and the continuous threat of habitat destruction, Eastern Mindanao is considered an area noteworthy of immediate conservation action. The site was declared an important biological corridor, here referred to as Eastern Mindanao Corridor, bounded by Siargao and Dinagat Island in the north while the western portion encompasses Agusan Marsh and the southern-most portion includes Mount Hamiguitan (Critical Ecosystem Partnership Fund, 2001).

We undertook this project to provide scientific baseline information on biological diversity of two proposed protected areas within Eastern Mindanao (Mt. Hilong-Hilong, and Mt. Tagub-Kampalili), and the existing protected area Mt. Hamiguitan.

This study provides baseline information on species richness and composition of the herpetofauna of Mt. Hamiguitan. Additionally, we include new information on natural history and microhabitat preference for several species.

Materials and Methods

Study area

Mt. Hamiguitan is located in southeastern Mindanao. This range is a combination of rugged mountains and plains including Agustin Peninsula with a peak of about 1650 m.a.s.l. (Mallari et al., 2001). Aside from having lowland, montane and mossy habitat types, this range also includes an extensive "bonsai forest," a product of ultramafic soils. The range receives adequate rain throughout the year with the highest rainfall between November and January. Average annual rainfall is between 1500 to 2500 mm. By virtue of Republic Act 9303 of 2004, a total of 6954 ha of Mt. Hamiguitan had been declared as a Protected Area under the category Wildlife Sanctuary (Supreme Court E-Library, 2004).

Our surveys were conducted in the municipalities of San Isidro and Mati, Davao Oriental Province (Figure 1). Surveys were conducted in the same areas where faunal (birds and mammals) and floral surveys were conducted. Descriptions of each site are given below.

Site 1

The site (N 06° 44'3.4", E 126° 09'3.4") is a secondary growth dipterocarp forest with an elevation of 545–785 m a.s.l. located at *Purok* Palo X, *Sitio* Tumalite, *Barangay* La Union, Municipality of San Isidro, Davao Oriental. The site is dominated by "malabayabas," trees of the family Myrtaceae which have a diameter at breast height (DBH) range of 6 to 86 cm. The forest floor had a thick layer of dry leaf litter with tree stumps and abundant rotting logs; streams and creeks were also present (both dried-up and active). Habitat disturbance includes selective logging in the past and more recently slash and burn agriculture. Our sampling plot was outside the wildlife sanctuary and is part of a Community Based Forest Management site (CBFM), accessible by a 3 to 4 h hike through a forest trail. Sampling for this site was conducted from 17 to 24 May 2005.

Site 2

The site (N 6° 43'56", E 126° 10'41") is a transitional dipterocarp-montane forest near *Tinagong Dagat* (a wide area covered by *cogonales* that accumulates rain and ground water) with an elevation of 950 to 1200 m.a.s.l. and straddles right at the political boundaries of *Barangay* La Union of San Isidro and *Barangay* Macambol of Mati, Davao Oriental. Vegetation was dominated by species belonging to the Families *Podocarpaceae* (*Dacrydium elatum*), *Sapotaceae* (*Palaquium* sp.), *Araucareaceae* (*Agathis philippinensis* or Almaciga) and *Myrtaceae*

(*Syzigium* sp.). Climbing vines such as *Freycinetia* sp., tree ferns and pitcher plants were abundant and fruiting *Medinilla* sp. was observed. The forest floor had a thick leaf litter with a substrate consisting of a layer of humus. The area is accessible by a ca. 6 hour hike through a forest trail that passes the Alog river from *Sitio* Magum. The site was visited from 18 to 31 July 2005.

Site 3

The site (N 6° 43'3", E 126° 11'1.9") is a mossy-bonsai forest on the eastern slope of Tumadgo peak with an elevation of 1128 to 1435 m.a.s.l., locally referred to as Camp 3 in *Sitio* Tumalite, *Barangay* La Union, Municipality of San Isidro, Davao Oriental. Vegetation was dominated by *Agathis* stands, with moss covering tree branches and trunks extending even down to the ground. Forest floor was covered by a thin layer of leaf litter; substrate was clay with a reddish color possibly due to the high mineral content. Flowering and fruiting trees were observed. Sampling for this area was from 4 to 14 May 2006.

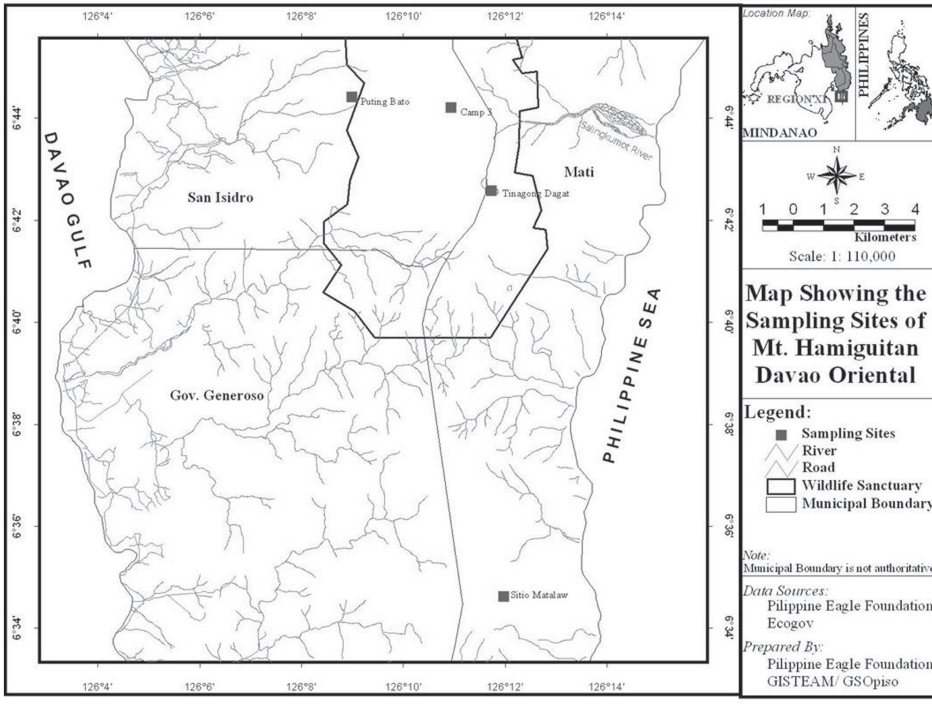

Figure 1. Map of Mt. Hamiguitan showing sampling sites

Sampling techniques

We employed belt transect sampling, pitfall trapping and microhabitat searches (Heyer et al., 1994). A total of 50 transect lines and 50 pitfalls were established in all sites. With the exception of Site 1, 20 transect lines and 20 pitfalls were stationed per site. Each transect was 100 m long and 10 m wide and each 10 m interval was marked with ribbons and was walked twice: morning (0900 to 1200 hours) and evening (1800 to 2100 hours). In order to minimize observer disturbance, a one-day interval allowed to elapse between transect walking (transects that were traversed in the morning were not walked in the evening for the same sampling day). Searchers relied on sight and calls to locate species. Samples were then hand-captured whenever possible. An average of 0.57 km per sampling day (10.5 person-h/day) was sampled. For pitfall trapping, dry-type pitfall traps with drift fences utilizing both straight and array designs (Heyer et al., 1994) were used; these were checked thrice daily. Transects and pitfalls were randomly stationed in each of the sites in an effort to cover all possible areas where amphibians and reptiles reside. To evaluate adequacy of sampling effort employed, species effort curve plots were made (Brower et al., 1990).

Seven sampling days were allotted for each of the sites. Five samples per species per transect were collected as vouchers for identification purposes. Amphibian and reptile species were keyed out using Alcala and Brown (1998), Brown and Alcala (1978), Brown and Alcala (1980) and Inger (1954). Liver samples of preserved specimens were also taken. Tissue samples (liver) are currently deposited at the Molecular Biology Laboratory of the University of the Philippines in Mindanao, Davao City and voucher specimens were deposited at the National Museum of the Philippines and Central Mindanao University Museum of Natural History.

Ecology and life history

Information on altitudinal distribution, relative abundance and microhabitat preferences of species was recorded. Activity of individual species was also noted. For relative abundance, encounter rates were calculated by dividing the total number of captures of all the searchers by the total number of hours spent for sampling. Encounter rates were then evaluated using an ordinal scale formulated by Lowen et al. (1996 as cited in Bibby et al., 1998).

Microhabitats where specimens were captured/observed were also classified into three broad categories: aquatic, arboreal and terrestrial. The microhabitats were differentiated based on vertical

distance from the ground and proximity to water bodies. Aquatic microhabitats referred to those areas in or near banks of water bodies and pools. Terrestrial microhabitats included locations 0 to 5 m above ground and below the ground (burrowing species). Areas of more than 5 m above ground were treated as arboreal microhabitats.

Results and Discussion

Species richness, composition and relative abundance

Thirty four species of amphibians and reptiles were recorded for the first time on Mt. Hamiguitan, including 15 frogs, 14 lizards and five snakes (Table 1). Endemism appears high with 25 species (74%) classified as Philippine endemics, and 38% (13 species) are confined to Mindanao PAIC. The data also account for the presence of poorly-known and site-specific endemic species previously reported from parts of Davao (*Tropidophorus davaoensis*); and Mt. Hilong-Hilong (*Philautus poecilius* [Alcala and Brown, 1998; Brown and Alcala, 1994], and *Brachymeles gracilis hilong* [Brown and Alcala, 1980]). Samples were collected appearing to be representative of two species known to occur in Mt. Hilong-hilong: *Limonectes* cf *diautus* (Brown and Alcala, 1977) and *Sphenomorpus* cf *diwata* (Brown and Alcala, 1980). Six of the anuran species are classified as *Vulnerable* and one is considered *Near Threatened* (Global Amphibian Assessment, 2004).

Two of the species sampled will require further taxonomic study; they may either represent new species or new country records. One is a lizard that has close resemblance to *Sphenomorphus diwata*, a scincid recorded from Mt. Hilong-hilong. Our samples are distinct from published data for *S. diwata* by having smaller snout-vent-length (SVL) measurements and our samples were caught at lower elevations, contrasting with published data (Brown and Alcala, 1980). Future study will be required to determine if our specimens are new species or simply an extension of the normal range of variation in *S. diwata*. Interestingly, about 20 specimens of ranid frogs initially identified as *Starois natator* appear to be representative of *Meristogenys*, a genus not currently recognized in the country (Alcala and Brown, 1998; Inger, 1954). Our tentative claim on the samples as potential *Meristogenys* representatives rely on the habitat as well as morphological similarities of established species. The clear rocky stream with swift flowing water where we took our samples is similar to the habitat of most *Amolops* (=*Meristogenys*) species (Inger and Kotellat, 1998). The slender body, long head as well as

Table 1. The amphibians and reptile species documented on three sampling sites within Mt. Hamiguitan Range from May 2005 to May 2006

Species	Endemism[a]	Site[b]	Diet[c] activity	Relative[d] abundance	Microhabitat/s[e]	Status/Remark[f]
Anurans (Bufonidae)						
Ansonia muelleri (Mueller's toad)	**	1	N, D	Rare	Rocks of clear (Aq) mountain streams	Vulnerable
Megophryidae						
Leptobrachium cf *hasselti*		1, 3	N, D	Rare	Atop leaf litter (G); creek bank (Aq)	Least Concern
Megophrys stejnegeri (Mindanao horned frog)	**	1, 2	D, N	Rare	Atop leaf litter (G)	Vulnerable
Ranidae						
Limnonectes cf) *diuatus* (Tagibo warty frog	**	1	N	Rare	Swimming on river (Aq)	Vulnerable Identification needs further verification
Limnonectes magnus (Mindanao fanged frog)	**	1, 3	N, D	Rare	Creek bank (Aq);	Near Threatened Consumed as food
Platymantis corrugatus (Rough-backed forest frog)	*	1	N, D	Rare	On heap of forest leaf litter (G)	Least Concern
Platymantis guentheri (Guenther's forest frog)	**	2	N	Rare	Interior of branches that crossed (A)	Vulnerable
Rana everetti (Everett's frog)	*	2	N	Rare	Pool of water (Aq)	Data Deficient
Rana grandocula (Big eyed frog)	*	1, 2	N	Rare	Pool of water and river (Aq)	Least Concern
Starois natator (Rock frog)		1	D, N	Rare	Rocks on stream (Aq)	Identification needs verification as 20 of the samples appear to be representative of the genus *Meristogenys*, which is not from the Philippines
Rhacophoridae						
Philautus acutirostris (Pointed-snouted tree frog)	**	2, 3	N	Rare	One sample on forest floor (G); atop fern fronds (G)	Vulnerable
Philautus surdus (Common forest tree frog)	*	2, 3	N	Rare	Axils of tree leaves (A)	Least Concern
Philautus poecilius (Mottled tree frog)	**	2	N	Rare	Axils of tree leaves (A)	VulnerablePotentially new distribution record
Philautus sp.		2, 3	N	Rare	Axils of tree leaves (A)	Identification needs further verification
Polypedates leucomystax (Common tree frog)	1, 2	N, D	Rare	Axils of leaves (A)		Least Concern
Lizards (Agamidae)	*	1	D	Rare	Basking on tree branches (A)	
Draco bimaculatus (Two-spotted flying lizard)						
Gekkonidae						
Cyrtodactylus annulatus (Small bent-toed gecko)	*	1	D	Rare	Bark of a dead tree (<5 m from the ground) (G)	
Cyrtodactylus philippinicus (Philippine bent-toed gecko)	*	1	D	Rare	Bark of rotting tree (G); forest duff near river (G)	

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Species	Endemism[a]	Site[b]	Diet[c] activity	Relative[d] abundance	Microhabitat/s[e]	Status/Remark[f]
Scincidae						
Brachymeles gracilis hilong(Common burrowing skink)	**	1	D	Rare	Caught in pitfall in an area with thick leaf litter and loose soil (G)	Potentially new distribution record
Brachymeles schadenbergi orientalis (Southern burrowing skink)	**	1	D	Rare	Caught in pitfall in areas with logs and thick leaf litter (G)	
Lamprolepis smaragdina (Green tree skink)		1	D	Rare	Thicket of vegetation (G)	
Lipinia pulchella (Yellow-striped slender tree skink)	*	1	D	Rare	Leaf litter on forest floor (G)	
Lipinia quadrivitatum (Black-striped slender tree skink)		1	D	Rare	Grounds near the camp (G)	
Sphenomorphus coxi (Cox's sphenomorphus)	*	1, 2, 3	D, N	Rare	Duff on forest floor (G)	
Sphenomorphus decipiens (Black-sided sphenomorphus)	*	1	D	Rare	Duff on forest floor (G)	
Sphenomorphus cf *diwata* (Diwata sphenomorphus)	**	1, 3	D	Rare	Duff on forest floor	Identification needs further verification Potentially new distribution record
Sphenomorphus fasciatus (Banded sphenomorphus)	*	2	D	Rare	Rotting logs near camp (G)	
Sphenomorphus variegatus (Black spotted sphenomorphus)	**	1	D	Rare	On tree branches (A); forest litter on floor (G)	
Tropidophorus davaoensis (Waterside skink)	**	2	D	Rare	Caught in snap traps located on dead creek with boulders (G)	Potentially new distribution record
Snakes						
Colubridae						
Psammodynastes pulverulentus (Dark-spotted mock viper)		1, 2, 3	D, N	Rare	Coiled in a shrub or near the ground on low vegetation (G)	
Rhabdophis auriculata (White-lined watersnake)	**	1, 2, 3	D	Rare	On low lying vegetation (G); creek (Aq)	
Rhabdophis lineata (Zigzag-lined water snake)		1	D	Rare	Crawling atop leaf litter on floor (G)	
Elapidae						
Maticora intestinalis philippina (Striped coral snake)		3	D	Rare	Crawling near low lying vegetation (G)	
ViperidaeTrimeresurus flavomaculatus (Philippine pit viper)	*	1, 3	D, N	Rare	Ground near creek (Aq)	

a Endemism: ** - Mindanao Faunal Region Endemic; * - Philippine Endemic
b Site: 1 – Tumalite; 2 – Tinagong Dagat; 3 – Camp 3
c Diel Activity: D – diurnal; N – Nocturnal
d Relative Abundance is based on the calculated encounter rate
e Microhabitats: A – arboreal; G – terrestrial, Aq – Aquatic
f Status conforms with CITES 2006, IUCN 2006 and Global Amphibian Assessment (globalamphibiansassessment.org)

presence of structures inside the mouth appearing as vomerine teeth, which are typical of *Meristogenys* species from Borneo (Malkmus et al., 2002), were also found in our samples. If future comparison with specimens from Borneo validates this tentative finding, the samples from our study may represent a new country record of *Meristogenys*.

A distinct plateau in the species accumulation curve was not reached for all sites (Figure 2) and encounter rates for the species appear too low so they were graded as either uncommon or rare. This is probably a product of the non-asymptotic effort curve. Future studies should extend the days of sampling in an effort to increase the number of species and individuals for each species. With the observed pattern for species effort curve and low encounter rate, it is highly possible that the species list presented here is incomplete. Thus, all three study sites certainly warrant additional survey works before one can say that all resident species have been identified.

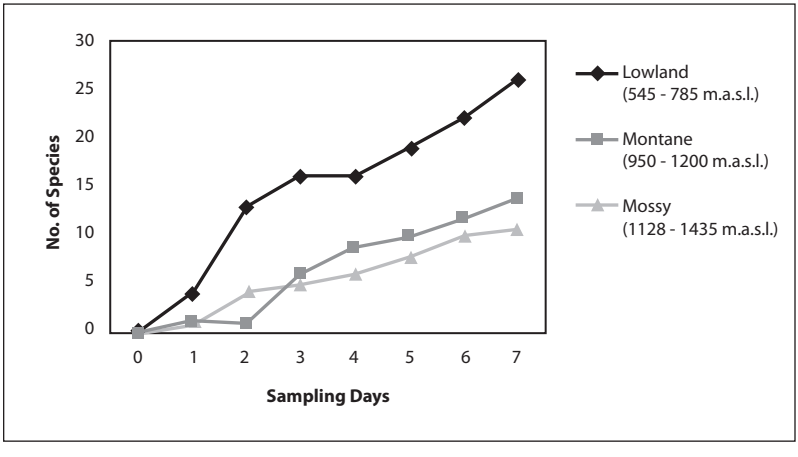

Figure 2. Relationship of sampling effort (days) and the number of species encountered at Mt. Hamiguitan Range.

Species distribution

Inverse relationship between species richness and increasing elevation was observed as 25 species of the 34 encountered were observed in Site 1 (545 to 785 m.a.s.l.). This was followed by 14 species for Site 2 (950 to 1200 m.a.s.l.) and lastly, 11 species recorded in Site 3 (1128 to 1435 m.a.s.l.). Only three species (*Sphenomorphus coxi*, *Rhabdophis auriculata* and *Psammodynastes pulverulentus*) were encountered in all of the sites and only *P. pulverulentus* is non-

endemic. Results present no distinct pattern for endemism as more than 50% of the species recorded for each site are endemics. Non-direct developing frogs were abundant in Site 1 whereas most direct developing frogs where recorded in higher elevations sites (Sites 2 and 3). Reptiles (mostly lizards) also appear abundant in Site 1. Parallel results were observed in Luzon (Brown and Alcala, 1961; Brown et al., 2000; Diesmos et al., 2003). A congregation of factors best explains these although effects of temperature and humidity affecting egg development and thermal physiology may also be important, especially for reptiles (Navas, 2002).

Ecology and life history

Eighty-six percent of the species recorded are forest dwellers. Many are endemics and were encountered in the lowest elevation site (Site 1). Species were found to occupy various types of microhabitats (Table 1) though the majority was observed on the ground (leaf litter microhabitat was favored by most). For aquatic microhabitats, more species and individuals were found in rivers and streams that have constant, free flowing and clean waters as evidenced by our captures of *A. muelleri*, *L. magnus*, and *L. cf diautus*. In contrast, few individuals of *R. everetti* and *R. grandocula* were captured in small standing water pools near our camp. Arboreal frog species were found in leaf axils of trees in deep forest quite far from disturbances.

The observed abundance of species (mostly endemics) and corresponding low number of individuals in slightly disturbed or undisturbed sites suggests that species abundance is influenced by forest disturbance. Endemics are likely found in areas with minimal disturbance (see also Diesmos et al., 2003; Brown et al., 2000).

Microhabitat data reveal that most reptiles stay on the ground, associated with leaf litter. Presence of reptile species (especially lizards) in leaf litter has been associated with thermoregulation (Alcala and Brown, 1966) and foraging (Inger, 1980). Thus, the dominance of ground microhabitat preference in most reptiles is not surprising.

For anurans, microhabitat preferences varied among sites. In Site 1, species accumulated either near a creek or a river, many of which were non-direct developers while arboreal (mostly direct developers) species abound in high elevation forests of Site 2 and Site 3. Non-direct developers (Alcala and Brown, 1998; Inger, 1954) were found to congregate within close proximity to areas with constantly filled bodies of water (water either flowing such as

rivers and creeks or isolated water pools). Because of their constant need for water, species recorded in Site 1 were found in or close to water. In contrast, most species recorded for Sites 2 and 3 exhibits direct development of their young (Alcala and Brown, 1998; Inger 1954). This developmental mode eliminates the reliance for constant water source and thus most of the species accounted were found in arboreal microhabitats such as leaf axils and branches, which are quite far from water bodies. Direct developing species in these sites were recorded in small, isolated water pools and narrow creeks, which were filled with water only during rainy days.

The current effort in archiving the herpetofaunal assemblage of Mt. Hamiguitan highlights formerly unknown species of amphibians and reptiles that inhabit its forest. Interestingly, the study revealed the presence of species known only from the highlands of Northeastern Mindanao and portions of Southern Mindanao. The majority of these species reside in dipterocarp forest at lower elevations. It is hoped that our data will contribute to ongoing efforts to formulate schemes for conservation efforts. The herpetofauna of Mt. Hamiguitan is far from completely known but our work will contribute to the slowly accumulating pool of available data for conservation and management purposes.

Conclusion

The 34 species of frogs and reptiles accounted in this study highlights the herpetological richness of Mt. Hamiguitan. Our non-asymptotic species accumulation curve implies that more species await discovery especially if other areas can be surveyed in the future such as those located in the Municipality of Governor Generoso. The presence of more than 50% endemism and numerous potentially threatened species further expressed the herpetological importance of this mountain range. Moreover, because diversity is highest at lower elevations, we urge evaluation of new conservation strategies aimed at conserving the unique forests of Mt. Hamiguitan.

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