

## Short Communications

# Community Structure of Dragonfly (Ordo: Odonata) in Natural Forest and Tourist Sites Petungkriyono Forest, Central Java, Indonesia

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### ABSTRACT

Petungkriyono forest is a tropical rainforest with high biodiversity. The increasing tourism activities in Petungkriyono lead to land conversion. Dragonfly (order Odonata) is a good bioindicator for aquatic and terrestrial. This study aimed to compare the community structure of Odonata in natural forests and tourist sites. The method of collecting imago Odonata was done by direct searching, samples were captured using sweep netting. The results showed that the dragonflies found in all locations consisted of the same family, 2 families (Gomphidae and Libellulidae) from the suborder Anisoptera and 6 families (Calopterygidae, Chlorocyphidae, Coenagrionidae, Euphaidae, Platycnemididae, and Platystictidae) from the suborder Zygoptera. The total species of dragonflies found in Sokokembang were 15 species with a total of 293 individuals, Tirta Muncar 13 species of 287 individuals, Karanggondang 17 species of 276 individuals, and Curug Lawe 14 species of 242 individuals. The highest relative abundance of individuals was in the natural forest of Sokokembang is *Drepanosticta spatulifera* (26.28%) and in Karanggondang *Vestalis luctuosa* (24.64%), while in the tourist forests of Tirta Muncar and Curug Lawe were *Euphaea variegata* (34.84% and 28.51%). The structure of the Odonata community is based on the Shannon-Wiener diversity index in the natural forests of Sokokembang (2.18) and Karanggondang (2.21) at the tourist sites of Tirta Muncar (1.84) and Curug Lawe (2.11). The results showed that the structure of the Odonata community based on the level of the diversity index value, evenness index, and dominance index in natural forests and tourist sites in Petungkriyono forest was not significantly different.

**Keywords:** community structure, dragonfly, Odonata, Petungkriyono

Indonesia is the world's third largest area of tropical rainforest with high biodiversity terrestrial and a high level of endemism (Cleary & Devantier 2011). The main threat to biodiversity is the practice of deforestation due to land conversion. More than 83% of the world's forest region has been used by humans for various land conversion practices. Land conversion reduces biodiversity and the effectiveness of forests as conservation areas (Hamilton et al. 2013).

Petungkriyono forest is tropical rainforest managed by the Perum Perhutani East Pekalongan, which has high biodiversity. Various rare and endemic flora and fauna can be found there, including the Javan endemic

species that belong to Genus *Drepanosticta* (Nugrahaningrum & Soesilohadi 2018; Damayanti et al. 2018). The increasing of agroforestry and tourism activities in Petungkriyono lead land conversion in Petungkriyono. Some examples of activities that have the potential land conversion in the Petungkriyono forest are planting coffee in the core zone, opening waterfall tours, water rides, agro techno forestry-park, and opening coffee shops or cafes in buffer and transition zones (Mubarok et al. 2019)

Land management based on monitoring indicators needs to assess the function and quality of the Petungkriyono. Community Structure and species richness of invertebrates are trends that can represent an assessment of habitat quality in a location (Samways et al. 2010). Dragonfly (Odonata) is a good bioindicator for aquatic and terrestrial areas (Simaika & Samways 2009; Suhling et al. 2005). Odonata community can be efficiently used as indicators of habitat status through a study of community structure (Simaika & Samways 2011; de Moor 2017). This is related to the function of Odonata in the ecosystem. Odonata are predatory insects, both when they are as nymphs and as adults. The existence of Odonata as predators is important because it restricts the population of herbivorous insects, types of pests, insect vector larvae, and their natural populations, so as to maintain the balance of the community in the ecosystem (May 2019). Ecosystems can be disturbed if the population of the Odonata community decreases.

Recent research has shown that disturbances from human activities in tropical developing countries are a major factor in reducing diversity, community and local species extinctions of various arthropods (Lawton et al. 1998; Clausnitzer et al. 2009; Seidu et al. 2017). The decline in dragonfly diversity occurs in tropical (Clausnitzer 2003) and subtropical (Stewart & Samways 1998) areas from intensive land use. Human activities can disrupt the abiotic conditions of the environment. That condition will only support the existence of tolerant species (Calvão et al. 2018). Intensive land use changes species composition, where specialist species tend to be replaced by generalist species due to habitat disturbance caused by human activities (Rouquette & Thompson 2007). The practice of monitoring an area using dragonflies has been developed in monitoring the quality of conservation areas such as in South Africa called the Dragonfly Biotic Index (DBI) (Simaika & Samways 2011). The purpose of this study was to compare the community structure of Odonata found in natural forests and tourist sites in the Petungkriyono forest.

This research was conducted in September 2020, November 2020, and January 2021 at 4 locations in Petungkriyono, Pekalongan Regency, Central Java Province (Sokokembang, Tirta Muncar, Karanggondang, and Curug Lawe). The selection of locations includes natural forest (Sokokembang and Karanggondang) and tourist sites (Tirta Muncar and Curug Lawe). Map of Odonata data collection and habitat condition in the Petungkriyono forest is shown in Figures 1 and 2.

The tools used in this study include a thermo hygrometer, lux meter, anemometer, sweep net, specimen box, Garmin GPS, camera (CANON 700D), and digital endoscope A005+ 500x. Data collection was done by the purposive sampling method. Sampling was carried out using the line transect method which has a length of 100 m, a width of 5 m on the right, and 5 m on the left. Each data collection location consists of 5 line transects. The method of collecting imago Odonata was done by direct searching method (Sutherland 2006). Imago Odonata samples were captured using the sweep netting technique (Samways et al. 2010).

Observations were made at 08.00 am-16.00 pm. Community structure was analyzed from Shannon-Wiener Diversity Index, Shannon-Evenness Index, Simpson's Dominance Index, and Relative Abundance (Samways et al.

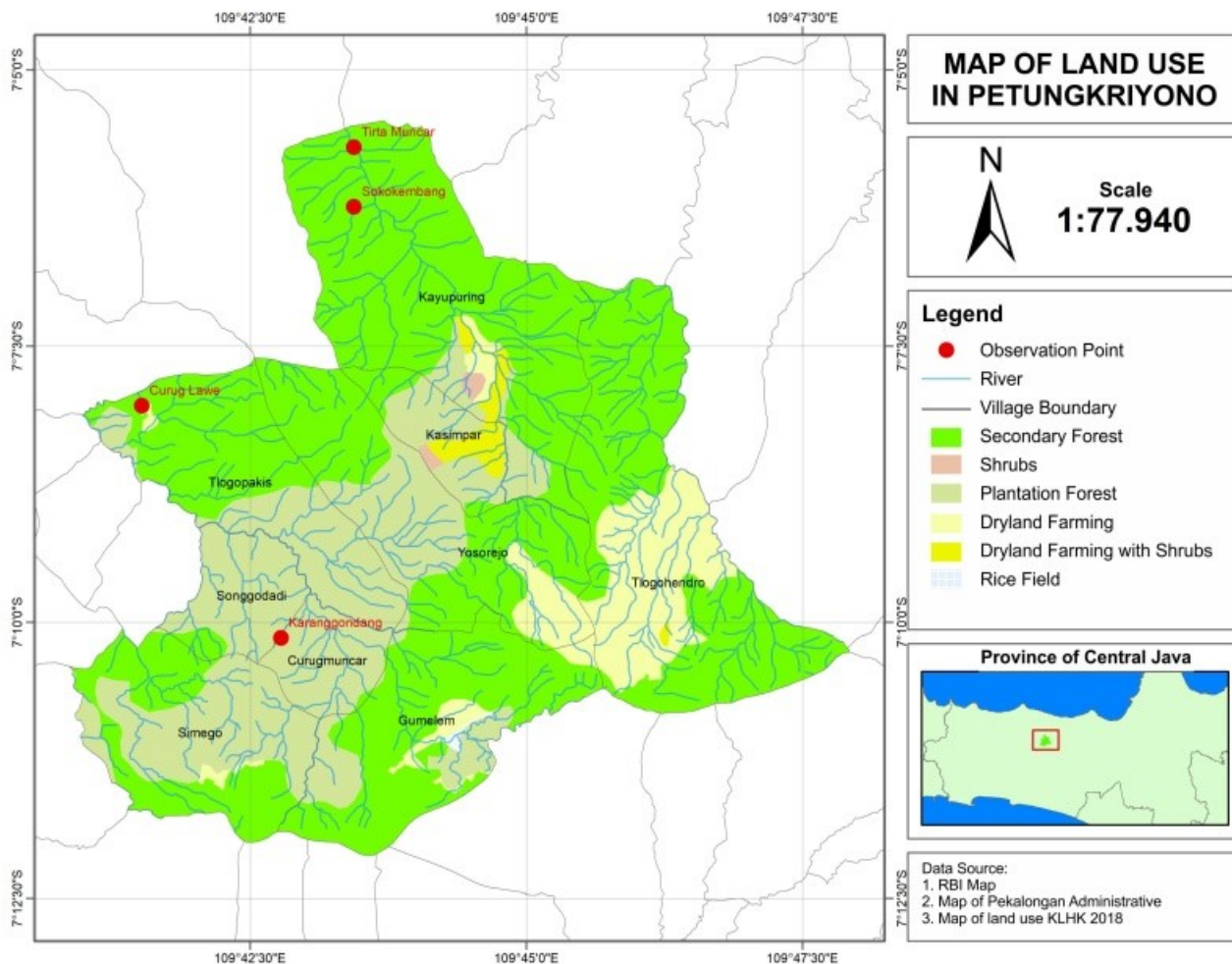


Figure 1. Map of Odonata data collection in the Petungkriyono forest.



Figure 2. Habitat condition of data collection in the Petungkriyono forest.

2010). Environmental parameter variables were analyzed by Canonical Correspondence Analysis (CCA) using the PAST3 software.

The result of this research is an approach that could describe the structure of a community is species diversity. The diversity of species in an area depends on species richness and evenness in the community (Scholwalter 2006). The results show that the total species from all locations were 19 species. The Odonata species found consisted of 2 families (Gomphidae and Libellulidae) of the suborder Anisoptera and 6 families (Calopterygidae, Chlorocyphidae, Coenagrionidae, Euphaidae Platycnemididae, and Platystictidae) of the suborder Zygoptera with a total of 1.098 individuals found. The total species of dragonflies found in Sokokembang were 15 species with a total of 293 individuals, Tirta Muncar 13 species of 287 individuals, Karanggondang 17 species of 276 individuals, and Curug Lawe 14 species of 242 individuals.

The dragonflies found in Sokokembang were higher (15 species) than the previous study which only found 8 species in Sokokembang (Utari 2018). The difference in the results may be due to various factors, such as the location of the sampled area and the time of the study. Based on Table 1, the highest species abundance was different for each location. The highest relative abundance in Sokokembang was *Drepanosticta spatulifera* (26.28%), in Karanggondang *Vestalis luctuosa* (24.64%), in Tirta Muncar and Curug Lawe were *Euphaea variegata* (34.84% and 28.51%).

**Table 1.** Diversity and relative abundance of Odonata in Petungkriyono forest.

TAXA		Relative Abundance (%)			
Suborder & Family	Species	SK <sup>a</sup>	KR <sup>b</sup>	TM <sup>a</sup>	CL <sup>b</sup>
		382-583 m asl		777-1236 m asl	
<b>Suborder Anisoptera</b>					
Gomphidae	<i>Heliogomphus drescheri</i>	-	-	1.05	-
	<i>Leptogomphus lansbergei</i>	1.71	3.99	-	1.65
Libellulidae	<i>Neurothemis ramburii</i>	-	2.17	-	-
	<i>Neurothemis terminata</i>	1.02	1.81	-	1.24
	<i>Orthetrum glaucum</i>	1.02	1.45	-	4.96
	<i>Orthetrum pruinosum</i>	1.37	1.45	-	3.72
	<i>Orthetrum sabina</i>	9.22	1.45	1.74	2.07
	<i>Pantala flavescens</i>	12.97	1.09	2.44	-
	<i>Potamarcha congener</i>	-	1.09	-	-
	<i>Zygonyx ida</i>	7.17	14.13	5.23	2.48
<b>Suborder Zygoptera</b>					
Calopterygidae	<i>Vestalis luctuosa</i>	16.72	24.64	22.65	11.98
Chlorocyphidae	<i>Heliocypha fenestrata</i> *	1.02	-	1.39	-
	<i>Rhinocypha heterostigma</i>	2.05	3.62	1.74	6.20
Coenagrionidae	<i>Pericnemis stictica</i>	-	1.09	1.05	1.24
Platycnemididae	<i>Coeliccia membranipes</i>	2.05	2.54	3.14	24.38
Platystictidae	<i>Drepanosticta gazella</i> *	2.39	2.90	1.39	2.89
	<i>Drepanosticta spatulifera</i> *	26.28	15.94	20.21	6.61
	<i>Drepanosticta sundana</i> *	1.71	1.09	3.14	2.07
Euphaeidae	<i>Euphaea variegata</i>	13.31	19.57	34.84	28.51

Note: Sokokembang (SK), Tirta Muncar (TM), Karanggondang (KR), Curug Lawe (CL), natural forest(a), tourist sites (b), Javan endemic species (\*).



**Figure 3.** Species with highest relative abundance (A) *Drepanosticta spatulifera* male, (B) *Vestalis luctuosa* male, (C) *Euphaea variegata* male.

The difference in species abundance in each of these locations can be influenced by several factors that limit the abundance of these species, including the abundance of food sources, mortality caused by predators (including cannibalism), and stress responses to the presence of predators in each location. In addition to biotic factors as already mentioned, abiotic factors of environmental physical conditions such as temperature, light intensity, air humidity also affect the abundance of a species population. This is because different species have different ecological requirements to maintain a population abundance of more than zero (McPeck 2008).

Species with high abundance in Sokokembang there are *Drepanosticta spatulifera* male, *Vestalis luctuosa* male, *Euphaea variegata* male (Figure 3). *Drepanosticta spatulifera* relatively high abundance in Sokokembang is related to the environmental conditions at the Sokokembang location that support the existence of this species. *D. spatulifera* is quite often found around rivers with small flows and covered by a canopy. They perch under shady riparian vegetation. Based on data on environmental factors, the air temperature in Sokokembang ranges from 23.8-31.8°C with a humidity of 60-96% and a light intensity of 875-53500 lux (Table 2). Sokokembang is an unspoiled forest covered with a canopy and little human activity. *D. spatulifera* is one of the endemic Javan dragonflies that has a specific microhabitat and is dominantly found in canopied rivers (Diniarsih 2016; Irawan et al. 2017). *Vestalis luctuosa* and *Euphaea variegata* have the same habitat type, both species are often found together in forest rivers with fast and small flows. However, although the two species are often found together, their roosting sites are different, *V. luctuosa* prefers to perch on shady riparian vegetation, and *E. variegata* is more often found perching on river rocks with high light intensity. The high abundance of *E. variegata* in Tirta Muncar and Curug Lawe could be caused by the nearly same (forest) condition in both locations, which are tourist sites that have waterfalls with rocky rivers. *E. variegata* is species of Odonata that is quite common in forest river habitats with rocky streams and breeds in slightly open to dense vegetation (Liefinck 1954). The air

**Table 2.** The environmental factors during September 2020 – January 2021.

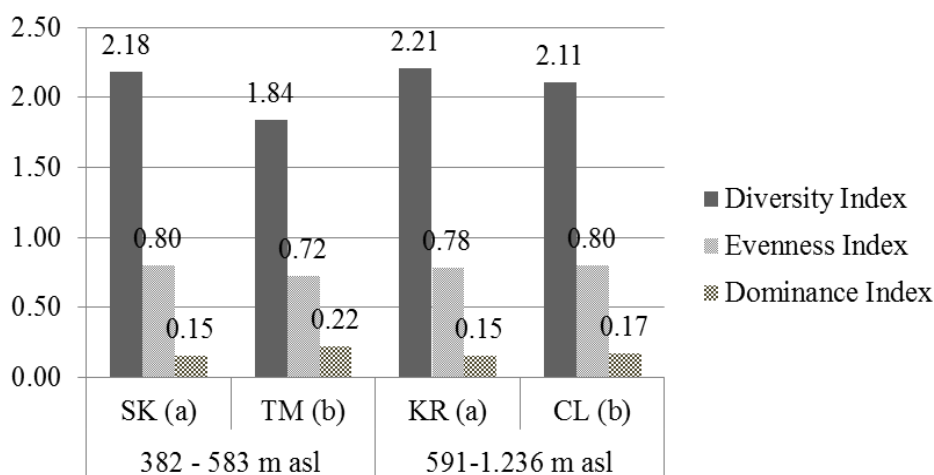
Location	Air temperature (°C)	Humidity (%)	Light intensity (lux)	Wind speed (m/s)	Elevation (mdpl)
Sokokembang <sup>a</sup>	23.8-31.8	60 - 96	875-46.600	0-1.5	458-553
Tirta Muncar <sup>b</sup>	23-30.4	65-91	285-55.000	0-2.1	382-583
Karanggondang <sup>a</sup>	22-34.6	50-90	432-34.370	0-1.2	777-848
Curug Lawe <sup>b</sup>	21.9-35	40-83	466-48.700	0-2.2	591-1236

temperature range in Tirta Muncar is 23-30.4 °C with a humidity of 65-91% and a light intensity of 285-55.000 lux, while in Curug Lawe the air temperature ranges from 21.9-35 with a humidity of 40-83% and a light intensity of 466-48.700 lux.

Species richness in tourist sites (Tirta Muncar and Curug Lawe) is lower than in natural forests, this can occur because of the probability of the presence of more diverse species being found in unspoiled locations compared to locations that have changed, such as urban or rural areas. tourist sites (Ball-Damerow et al. 2014). Assemblages of species found in pristine forest areas will be able to stabilize extinctions and have a positive effect on changes in species composition (Koch et al. 2014).

The most common species from the suborder Anisoptera are the family Libellulidae and from the suborder, Zygoptera is the family Platysticidae. The Libellulidae family is a family that has the most members of the species group in the suborder Anisoptera and its distribution is widespread throughout the world. While most of the family Platysticidae (Zygoptera)'s members have a specific microhabitat. Several species of Zygoptera dragonflies found were endemic to Java, including *Heliocypha fenestrata*, *Drepanosticta sundana*, *Drepanosticta gazella*, and *Drepanosticta spatulifera* (Setiyono 2014). *H. fenestrata* species were only found in Sokokembang and Tirta Muncar. The three species belonging to the genus *Drepanosticta* were found throughout the site.

The level of diversity index values, evenness index, and dominance index in the 4 research sites (Figure 4) shows values that are not much different between locations. The Shannon-Wiener diversity index in Sokokembang, Tirta Muncar, Karanggondang, and Curug Lawe ranged from 1.84 - 2.21. Evenness index values in the four locations also have values that are not much different (0.72 – 0.80). Likewise with the dominance index value, where the four locations have values ranging from 0.15 - 0.22.



**Figure 4.** Index of diversity, evenness, and dominance at Sokokembang (SK), Tirta Muncar (TM), Karanggondang (KR), Curug Lawe (CL), natural forest(a), tourist sites (b).

The diversity, evenness, and dominance index values indicate that the diversity and abundance of species in the four locations are still in good condition, this is supported by the relative abundance values between species in each location where there is only slight variation (Table 1) so that each species in the Odonata community is evenly distributed (Nasiruddin & Barua 2018).

Environmental parameters were analyzed using Canonical Correspondance Analysis (CCA) to determine the effect of environmental

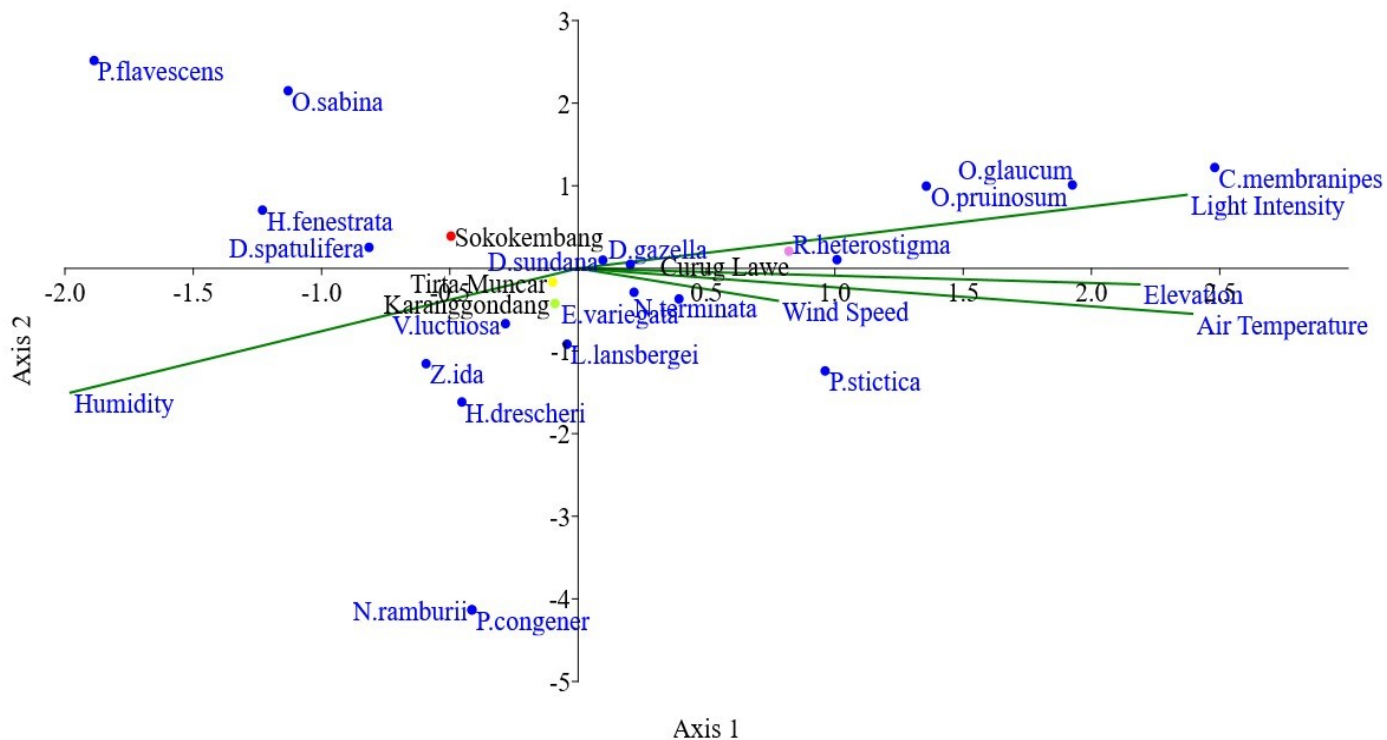


Figure 5. CCA triplot of environmental factors and Odonata community.

parameters on community structure found in 4 locations of Petungkriyono forest. Environmental factors affect the presence of dragonflies. The results of the CCA analysis show that light intensity contributes to the structure of the Odonata community. CCA ordination map at the second axis showed that more of Odonata distributed a long gradient light intensity (Figure 5).

Light intensity strongly influences the distribution and abundance of *D.sundana*, *D.gazella*, *R.heterostigma*, *O.pruinosum*, *O.glaucum*, and *C.membranipes* (Figure 5). Species *D. sundana* and *D. gazella* in Curug Lawe have a strong correlation with light intensity, the abundance of both species is influenced by fluctuations in light intensity because species from the Genus *Drepanosticta* are a group of dragonflies found around rivers with low light intensity canopies (Diniarsih 2016). Zygoptera groups such as those from the genus *Drepanosticta* tend to be more commonly found in areas with low light intensity than Anisoptera such as those from the genus *Orthetrum*. The light intensity can affect air temperature fluctuations related to thermoregulation and the importance of dragonfly flying. Dragonflies need sunny weather and warm temperatures to be able to flap their wings (fly). This is supported by reports from (Lutz & Pittman 1970) that when there is a sudden change in light intensity, the number of species and individuals of dragonflies observed tends to change. such as during rainy weather the number of species and individuals of dragonflies observed will move to areas covered by vegetation.

#### AUTHORS CONTRIBUTION

N.A.N. and H.S. designed the research, N.A.N. collects, analyzed the data, and wrote the initial manuscript. H.S. reviewed and proofread the final manuscript.

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### CONFLICT OF INTEREST

The authors confirm that no conflict of interest. The sponsors had no role in the design of the study, collection data, analysis, and writing the script.

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