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Community Structure of Marine Gastropod at Taruy Coastal Waters, Tutuk Tolu, East Seram, Maluku

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ABSTRACT

Background: Intertidal zone is located between high and low tide in the marine coastal waters. This zone has high diversity of marine resources, inclucing marine gastropods.
Aims: The objective of this research was to analyze gastropod community structure namely ecological density, abundance, and ecological indices such as diversity index, evenness index, and dominance index at the coastal waters of Taruy Village, East Seram in May 2023.
Methods: The ecological data of marine gastropods using line transect method in which was perpendicular to the coastline. Twelve transects were placed with the distance between transect is 50-m, and 5 meters between quadrates. Each gastropod in the quadrate was counted and preserved by 70% alcohol. Identification was done in Marine Science Laboratory, Faculty of Fisheries and Marine Science, Pattimura University, Ambon.
Results: A total of 41 marine gastropods species found in this area, which is grouped into 5 order, 16 families, and 29 genera. *Clypeomerus battilariaeformis* has the highes ecological densisty and abundance. There were 19 species of marine gastropods which have lowest density and abundance. Species diversity of marine gastropods in this area is moderately categorized (H` = 2.97), while evenness index is highest (J`= 0.80), and there is no dominance species in the community (D = 0.08). Nineteen species of marine gastropods are rare species, and 13 species are common species.

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1. Introduction

Intertidal zone located between high and low tide in the coastal waters. This area has high diversity of marine resources, including marine gastropods, and suitable for study marine ecology. However, this area is undergoing rapid environmental changes, including ocean warming and ocean acidification. Molluscs species is estimated of 80.000-100.000 species. This is a second class with the species richness after Arthropoda. Gastropods is one of the seven of molluscan classes, which is consisted of more than 80% species (Baharuddin *et al*., 2018; Strong *et al*., 2008).

Pechenik (2016) stated that gastropods are animals that have soft bodies and covered by a single coiled and calcareus shell. Gastropod has various shape, colour and size. This organisms play an important role in marine food chain. It is also being natural food for many fishes and birds. Beside that, gastropod has an economically important as a source of protein, medicine, dye and decoration (Baharuddin *et al*., 2018). Gastropod exhibit an extremely limited mobility or sessil oganisms so it can be used as bioindicator of water quality. Gastropods are algae feeders, carnivore, deposit feeders, detritovores, and scavenger. This organisms are abundant in intertidal zone and widely distribution because of their wide adaptation (Pechenik, 2016; Strong *et al*., 2008).

Gastropods are living organism that sensitive to the change of water quality in the area in which their lives, so it can influence the density and population diversity of this class (Baharuddin *et al*., 2018; Strong *et al*., 2008). Gastropods have special adaptations that enable them to survive in areas subject to physical and chemical stress, such as the intertidal zone. In the intertidal zone, gastropods tend to live attached to rocky substrates, thus adapting to currents and waves. Furthermore, gastropods are slow-moving organisms and lack the ability to move quickly (motile), making them very easy to harves. Considering that the changes or disturbance in the marine environment, it will certainly affect the structure of gastropod community. Abiotic and biotic factors such as food sources, environmental conditions, predators and competition influence the existence and distribution of gastropods strongly. The total family and composition of organisms can be affected by pressure and environmental changes. Changes in the structure of gastropod community can act as an indicator of pressure or disturbance in an ecosystem (Pawar & Al-Tawaha, 2017).

Many research on ecology and biodiversity of gastropod community has been widely carry out in Maluku Province, including Ambon Island (Rumahlatu & Leiwakabessy, 2017; Supusepa, 2018; Supusepa & Hulopi, 2018; Supusepa *et al*., 2022; Haumahu & Uneputty, 2022a; Haumahu & Uneputty, 2022b; Haumahu *et al*., 2023; Haumahu & Uneputty, 2023; Natan *et al*., 2023); Saparua Island (Islami *et al*., 2018); Nusalaut Island (Islami, 2015), and Haruku Island (Persulessy & Arini, 2018; Uneputty *et al*., 2018; Haumahu *et al*., 2014; Haumahu & Uneputty, 2018; Uneputty *et al*., 2019; Uneputty *et al*., 2021; Haumahu & Uneputty, 2021 Marasabessy, 2022; Haumahu *et al*., 2023) both on the rocky shore, sandy shore as well as in seagrass bed. This research shows that gastropods are an important organisms in marine ecosystem especially in Maluku coastal waters.

The coastal waters of Taruy, located in Tutuk Tolu District, East Seram, Maluku, serve as a transportation and residential area. Most people rely on the sea for their livelihood. Gastropods, known as sea snails, are often used as food by the Taruy Village community, commonly called *faranguru*. At low tide, residents flocked to the Taruy coastline to search for gastropods. The gastropods community in the waters of Taruy could be threatened by numerous community activities that exploit the surrounding marine ecosystem for other needs, such as fishing with *bubu* (traps), dumping garbage into the surrounding waters, sand extraction, stone (gravel) extraction, and smuggling. These activities have the potential to damage the seagrass and coral reef ecosystems that serve as habitats for gastropod communities.

The information of marine gastropods in the intertidal zone of Taruy Village is currently unknown. Furthermore, no scientific research has been conducted in this area. Therefore, this study was conducted to provide preliminary information on the structure of the gastropod community in the waters of Taruy

Village, Tutuk Tolu District, East Seram, Maluku Province. The objectives of this research are to identification gastropod species composition, its abundance, and to analyze its ecological indices, namely Shannon- Wiener diversity index (H`), Pielou`s evenness index (J`), and Simpson dominance index (D). This research is useful as initial information about the gastropod community in the coastal waters of Taruy Village and is expected to add more information on the diversity of gastropod species in Maluku waters.

2. Methods

2.1 Research location

The reseach was conducted at intertidal zone of Taruy coastal waters, Tutuk Tolu, District, East Seram, Maluku Province in Mei 2023, with 12 transect line (Figure 1). Sampling was done using line transect methods (Khouw, 2016) at the low tide during daytime. Transect line was placed perpendicular to the coastline. All the specimens of gastropods were identified, enumerated and recorded in the field. The specimen was collected, fixed with 70% alcohol, placed in a labeled plastic bag, and brought to the Marine Science Laboratory, Faculty of Fisheries and Marine Science, Pattimura University, Ambon, for further identification. The gastropods were identified to species level following keys by Dharma (2005) and the World Register of Marine Species (WoRMS, https://www.marinespecies.org/) were referred for the correct gastropod names.

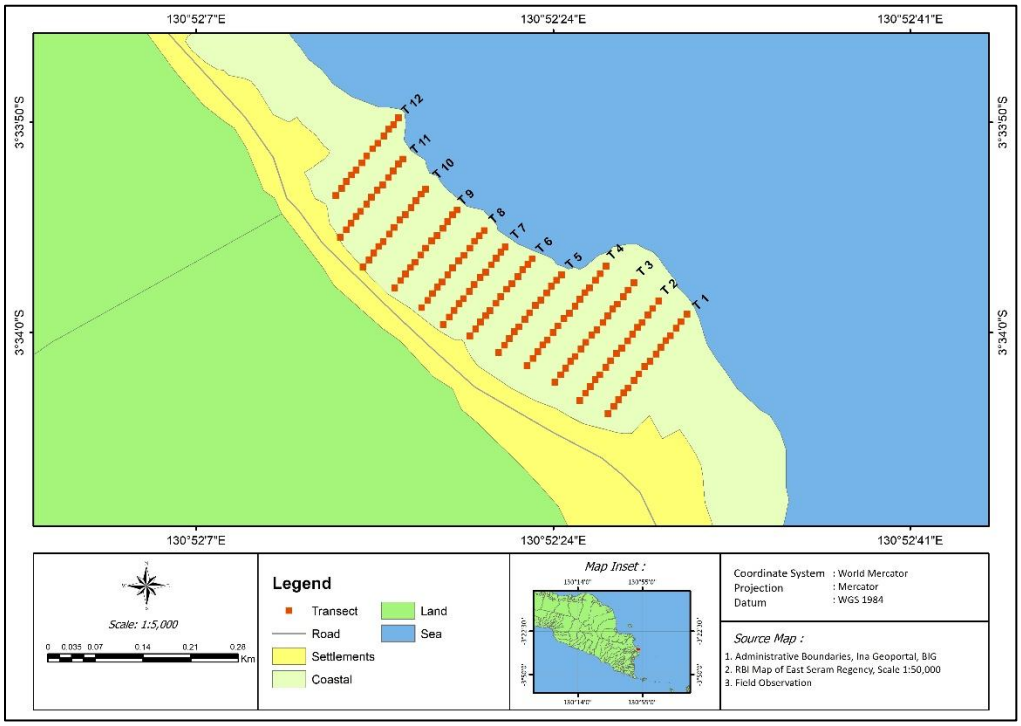

Figure 1. Map of Sampling Sites

2.2 Data Analyis

Ecological density and abundance of marine gastropoda were calculated based on Khouw (2016) as follows:

$$Ecological\ density\ (ind.m^{-2}) = \frac{Number\ of\ individual\ of\ i\ species}{Total\ area\ of\ plot\ where\ species\ i\ was\ found}$$

$$Abundance\ (ind.) = number\ of\ individual\ of\ i\ species\ x\ total\ area$$

Ecological indices of marine gastropod in this area were analyzed by Shannon-Wiener diversity index (H`), Pielou`s evenness index (J`) and Simpson`s dominance index (D). The Shannon-Wiener diversity indices (H') used to describe species/genera diversity and species/genera richness within marine gastropod of research (Krebs, 2009; Odum & Barrett, 2005) as follow:

$$H` = \sum_{i=1}^{s} Pi \ln Pi$$

In the above, H` is the value of the Shannon-Wiener diversity index, Pi is the proportion of $i^{th}$ species, ln represent natural logarithm of Pi and s represents the number of species in the community. The Shannon diversity is classified as three categories: low (H`<1); moderate (1<H`<3); and high (H`≥3) (Magurran, 2005).

The evenness index of the species was calculated using Pielou`s evenness indeks (Bakus, 2007; Magurran & McGill, 2011), as written as:

$$J` = H`/H`_{max}$$

where: H` is the Shannon-Wiener diversity index and $H`_{max}$ is the natural logarithm of species richness. Species evenness index ranges from zero to one, with sero signifying no evenness, and one is a complete evenness.

The dominance index of marine gastropods was calculated using Simpson dominance index (Magurran & McGill, 2011) as follow:

$$D = \sum (\frac{ni}{N})^2$$

In the above, D is the value of Simpson dominance index, ni is the number of individu of i^{th} species, and N is the total number of individu of gastropod found

3. Results and Dicussion

3.1 Marine Gastropod Species Composition

There were 41 species of marine gastropods found in the intertidal zone of Taruy coastal Waters, East Seram (**Table 1**). These species belong to 5 ordo, 15 families and 29 genera. Strombidae has the highest number of species (5 species), followed by Neritidae and Nassaridae (each has 4 species, respectively). The highes number of species from these families is due to the type of substrate found in this area. The substrate is dominated by sandy substrate associated by coral rubble. Strombidae, Neritidae and Nassaridea are commonly found in this substrate (Haumahu *et al*. 2023).

Table 1. Marine gastropods species composition at intertidal zone of Taruy coastal waters.

No.	Ordo	Family	Genus	Species	Number of individuals
1	Cycloneritida	Neritidae	*Nerita*	*Nerita chamaeleon Linnaeus, 1758*	70
2				*Nerita exuvia Linnaeus, 1758*	19
3				*Nerita albicilla Linnaeus, 1758*	74
4				*Nerita signata Lamarck, 1822*	24
5	Trochida	Turbinidae	*Lunella*	*Lunella cinerea (Born, 1778)*	6
6			*Turbo*	*Turbo bruneus (Röding, 1798)*	8
7		Trochidae	*Tectus*	*Tectus fenestratus (Gmelin, 1791)*	2
8			*Trochus*	*Trochus stellatus Gmelin, 1791*	2
9			*Monodonta*	*Monodonta labio (Linnaeus, 1758)*	3
10	Caenogastropoda incertae sedis	Cerithiidae	*Clypeomorus*	*Clypeomorus subbrevicula (Oostingh, 1925)*	85
11				*Clypeomorus bifasciata (G. B. Sowerby II, 1855)*	11
12				*Clypeomorus batillariaeformis T. Habe & Kosuge, 1966*	136
13			*Rhinoclavis*	*Rhinoclavis sinensis (Gmelin, 1791)*	30

No.	Ordo	Family	*Genus*	*Species*	Number of individuals
14			*Cerithium*	*Cerithium tuberculatum (Linnaeus, 1767)*	167
15				*Cerithium columna G. B. Sowerby I, 1834*	2
16		Potamididae	*Terebralia*	*Terebralia sulcata (Born, 1778)*	7
17	Littorinimorpha	Littorinidae	*Littorina*	*Littorina scabra (Linnaeus, 1758)*	6
18			*Nodilittorina*	*Nodilittorina pyramidalis (Quoy & Gaimard, 1833)*	19
19	Littorinimorpha	Strombidae	*Conomurex*	*Conomurex luhuanus (Linnaeus, 1758)*	13
20			*Gibberulus*	*Gibberulus gibberulus (Linnaeus, 1758)*	2
21			*Lentigo*	*Lentigo lentiginosus (Linnaeus, 1758)*	1
22			*Canarium*	*Canarium labiatum (Röding, 1798)*	26
23			*Maculastrombus*	*Maculastrombus mutabilis (Swainson, 1821)*	5
24		Cypraidae	*Monetaria*	*Monetaria annulus (Linnaeus, 1758)*	20
25		Naticidae	*Tanea*	*Tanea lineata (Röding, 1798)*	1
26			*Mammilla*	*Mammilla melanostoma (Gmelin, 1791)*	4
27		Bursidae	*Bursa*	*Bursa tuberosissima (Reeve, 1844)*	4
28	Neogastropoda	Muricidae	*Drupella*	*Drupella margariticola (Broderip, 1833)*	33
29			*Oppomorus*	*Oppomorus funiculatus (Reeve, 1846)*	6
30		Nassariidae	*Nassarius*	*Nassarius pullus (Linnaeus, 1758)*	105
31				*Nassarius globosus (Quoy & Gaimard, 1833)*	45
32				*Nassarius reeveanus (Dunker, 1847)*	21
33				*Nassarius olivaceus (Bruguière, 1789)*	8
34		Mitritidae	*Strigatella*	*Strigatella pica (Dillwyn, 1817)*	11
35		Conidae	*Conus*	*Conus miles Linnaeus, 1758*	25
36				*Conus marmoreus Linnaeus, 1758*	1
37				*Conus ebraeus Linnaeus, 1758*	1
38		Pisaniidae	*Pollia*	*Pollia fumosa (Dillwyn, 1817)*	6
39		Pisaniidae	*Engina*	*Engina zonalis (Lamarck, 1822)*	12
40				*Engina alveolata (Kiener, 1835)*	8
41		Vasidae	*Vasum*	*Vasum turbinellus (Linnaeus, 1758)*	17

Species richness of marine gastropod in this study was lowest compared to the previous study conducted in Maluku province. There were about 65 species and 78 species of marine gastropod found at intertidal zone of Ambon Island, respectively (Rumahlatu & Leiwakabessy, 2017; Haumahu & Uneputty, 2022b), in Saparua Island, 85 species of marine gastropod found by Islami *et al*. (2018). Moreover, a total of 92 species of marine gastropod found in Haruku Island (Oma village) (Haumahu, Uneputty, *et al*., 2023). Haumahu & Uneputty (2022a) found only 23 species of marine gastropod in Rutong intertidal zone in November 2020. Natan *et al*. (2023) also found 47 genera of marine gastropod which consisted of 74 species from Rutong village at sampling May to December 2016. This difference is because of the different sampling time and environment conditions. In addition, the high and low level of species richness of marine gastropod found in this sampling area indicating that the adaptibility of marine gastropod to varying environmental conditions. Gastropod is an organism that has high adaptibility, so that these animals can survive in various habitats or locations with wide distribution. The various habitats are very important factors in ecology that affected the distribution of organisms. Distribution and agregation pattern are strongly influenced by physical and biological factors such as sediment characteristic, water movement, seasonal, competition, predation, reproduction and recruitment (Shou *et al*., 2009).

3.2. Ecological Density and Abundance of Marine Gastropods

Ecological density is density which refers to a total area of habitat available to the species. Natural biotic components are characterized by a few species that are common, which are represented by large number

of individuals or biomass, and large number of species that are rare in time and space (Krebs, 2009b). Ecological density of marine gastropods at intertidal zone of Taruy village varied between 1.00 ind.m^{-2} and 15.11 ind.m^{-2} (**Figure 2**). *Clypeomorus battilariaeformis* has the highest ecological density in this area (15.11 ind.m-^{2}), followed by *R. sinensis, C. labiatum*, and *C. bifasciata*. This is because these species are usually inhabited by coral rubble asociated with sandy substrate.

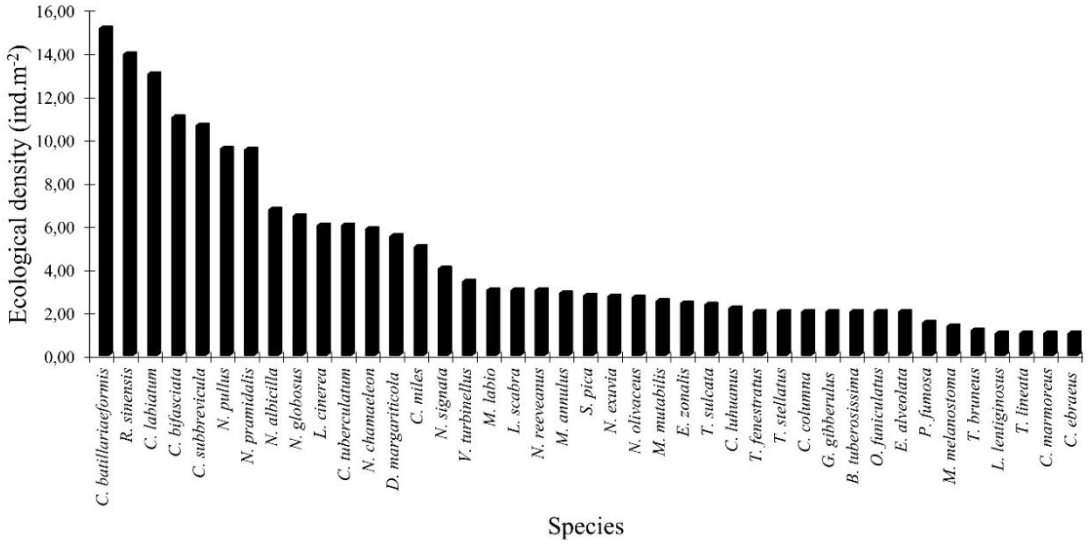

Figure 2. Ecological density of marine gastropods at Taruy coastal waters

The abundance of gastropod varried between 736 individuals and 81600 individuals in total area of 43800 m^{2} (**Figure 3**). Cerithidae has the greatest value of abundance in this study area (170970 individuals). This family was represented by *Clypeomorus batillariaeformis, Clypeomorus subbrevicula, Clypeomorus bifasciata, Cerithium tuberculatum, Cerithium columna*, and *Rhinoclavis sinensis*. The second family with high abundance is Neritidae (112200 individuals), followed by Nassaridae and Strombidae. Cerithidae is marine gastropod family commonly inhabited the substrate consists of coral mixed with sand. Neritidae is always found at the upper intertidal zone (Haumahu *et al*., 2023). Strombidae is marine gastropod commonly found with high abundance at the shallow water of seagrass ecosystems (Poutiers, 1998).

3.3. Ecological Index of Marine Gastropods

There are two factors which influenced species diversity namely the number of species (species richness) and the distribution of total number of individuals among those species (species evenness).

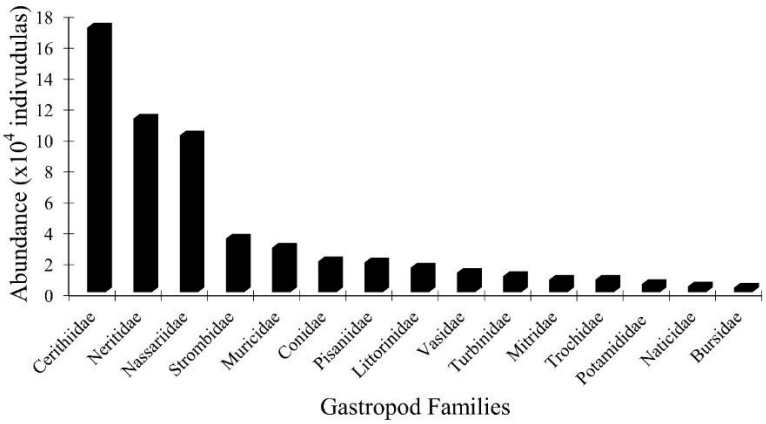

Figure 3. Abundance of marine gastropoda at Taruy coastal waters

High species diversity represents both high number of species and high species evenness. High species diversity is an indicator of stability of marine environments and communities (Magurran, 2005; Bakus, 2007) and unpolluted water (Panggabean *et al*., 2020).

Ecological index of marine gastropoda at Taruy intertidal zone (Table 2) showed that Shannon-Wiener diversity index (H`) was H` = 2.97. This value of diversity index was categoryzed as moderate to high diversity. This is because the highest number of species and the proportion of an individual of each species were moderate to uniform distribution (Magurran & McGill, 2011).

Table 2. Ecological index of marine gastropod at Taruy intertidal zone

Parameters	Ecological index
Number of species (S)	41
Number of individual (N)	1046
Evenness Index (J`)	0,80
Diversity index (H`)	2,97
Simpson dominance index (D)	0,08
Number of rare species (N_1)	19
Number of common species (N_2)	13

Evenness index (J`) of marine gastropoda at Taruy intertidal zone is J` = 0.80. Generally, this evenness index of marine gastropod in this study is in the high category or in a stable community. This means that the distribution of an individual of each marine gastropoda species are nearly uniform distributed (Magurran, 2005; Odum & Barrett, 2005). Evenness index (J`) ranges from zero to one. If J` is close to one means that the distribution of an individual between species is uniform, while the value of J` is close to zero means no uniform distribution of the species (Bakus, 2007; Krebs, 2009).

Marine gastropods at Taruy intertidal zone have the value of Simpson dominance index (D) is D = 0.08 According to Krebs (2009), dominance index of marine gastropods in this research is in low category. It means that there is no species that dominated the gastropod community in this sampling site. The Simpson dominance index varied from zero (0) to one (1). If D = 1, means the greatest dominance of gastropod communities, while D = 0, means the lowest dominance (Krebs, 2009).

Table 2 showed that there were 19 species of marine gastropods in Taruy intertidal zone are the rare species. It means that these species determine the diversity of gastropod comunities in this sampling area (Khouw, 2016). These species include *L. cinerea*, *T. fenestratus*, *L. scabra, O. funiculatus, P. fumosa, M. mutabilis, M. melanostoma, B. tuberosissima, M. labio, T. stellatus, C. columna, G. gibberulus, L. lentiginosus, T. lineata, C. marmoreus,* and *C. ebraeus.* Whereas, there were 13 species of marine gastropods in this area are the rare species which determine dominance of marine gastropod communities. Some of this species are *C. batillariaeformis, N. pullus, C. subbrevicula, N. albicilla, N. chamaeleon, D. margariticola*, dan *N. globosus*.

4. Conclusions

A total of 41 marine gastropod species found at the Taruy intertidal zone of East Seram, Maluku Province. These species belong to 5 ordo, 16 families and 29 genera. Strombidae has the highest number of species, followed by Neritidae and Nassaridae. *Clypeomorus battilariaeformis, R. sinensis, C. labiatum*, and *C. bifasciata*haves the highest ecological density in this area. Cerithidae, Neritidae and Nassaridae are marine gastropods that have high abundance in this research study. The diversity index of marine gastropod is a moderate categorized, high evenness index and no species dominance in the communinies. There were 19 species that are determining diversity, and 13 species are determining

dominance species in the marine gastropod communities in this study area. The next study needed to analyze the community structure of marine gastropods related to distribution of type of the substrate and the physical and chemical parameters such as temperature, salinity, pH, dissolved oxygen, and another parameter to get the impact of global warming on these marine resources.

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6. Authors Note
The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

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