# MANGROVE BRACHYURAN CRABS IN WORI, NORTH SULAWESI, INDONESIA

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**ABSTRACT**

The study of faunal diversity from mangrove sites in Wori was limited, especially on brachyuran crab taxa. Healthy mangrove forests provide a critical habitat for many species of crabs in intertidal and estuarine areas and the key to healthy marine ecology. Mangroves are the most suitable feeding, breeding and nursery grounds for crabs and other crustaceans. In this study, the habitat distribution and diversity of crabs in Wori mangrove environment was recorded between October 2015 and August 2016. Three stations with different habitat specifications were selected: Wori Seaward (WSW), Wori Middle zone (WMZ) and Wori Landward (WLW). A total of 14 species and 307 individuals of brachyuran crabs were recorded belonging to ten genera and six families, wherein the family Sesarmidae was most dominant with seven species. The other major outcome of the study was maximum diversity found at Wori Landward (WLW) site with 12 species, followed by Middle Zone (WMZ) site with 10 species and Wori Seaward (WSW) site with 9 species.

**Keywords**: Brachyuran crabs, mangroves, Wori, North Sulawesi, Indonesia.

## INTRODUCTION

Mangrove ecosystems have significant ecological functions and high economic value for coastal community areas (Kathiresan and Bingham., 2001; Khan *et al.*, 2005; Kamalakkanan, 2015), They are one of the most diverse ecosystems in the world, there special attention is required to understand their processes and functions. Healthy mangrove forests provide critical habitats for many species of crabs in intertidal and estuarine areas and are keys to healthy marine ecology. Mangroves are the most suitable feeding, breeding and nursery grounds for crabs and other crustaceans (Giddins *et al.*, 1986; Kamalakkannan, 2015).

Crustaceans are the important part of macrobenthic fauna, especially the Infraorder Brachyura, the most crucial groups of tropical benthic communities. Brachyura have a rich diversity: a total of 5.000 to 10.000 species belonging to 700 genera have been identified worldwide; and due to their great abundance of biomass and community structure (Ng *et al.,* 2008; Shukla *et al.,* 2013; Kamalakkannan, 2015). The existence of crustaceans in the study site confirmed mangroves as the primary producer supporting a food chain. Crabs are the predominant animal groups of the mangrove ecosystem (Macintosh, 1984; 1988; Naiman *et al.*, 1986) and are thought to play a significant ecological role in the structure and function of the mangrove ecosystem (Lee, 1999). They form important links between the primary detritus at the base of the food web and consumers of higher trophic levels (Macintosh, 1984, 1988; Kamalakkannan, 2015). And because of their large abundance and biomass (secondary production), the energy assimilated by the macrofauna plays a significant role in nutrient recycling (Kumaralingam *et al.,* 2012; Mahalaxmi *et al.*, 2016).

Ecological studies, especially on crustacean fauna, has not been undertaken in the territorial waters of North Sulawesi, Indonesia. Wori is located in the southern waters of North Minahasa Regency, North Sulawesi. These waters are famous for its coral reefs, seagrass, and mangrove forest. Wori coastal tidal waters have highly dense mangrove communitiess. Crabs are the dominant macrofaunal group within the tropical tidal mangroves forests of Wori in North Sulawesi. Within Indo-Pacific mangrove forests, over 40 species of crabs are found (Frusher *et al.,* 1994). Recent studies in Wori have shown that Sesarmid crabs (Sesarmidae) and Grapsid crabs (Grapsidae) are important components and dominance of mangrove ecosystems. They probably act as keystone species in that their activities exert a major influence on ecosystem-level parameters (Hartnoll, 1965; Smith *et al.*, 1991; Frusher *et al.*, 1994). The Sesarmidae, in particular, constitutes a significant component of the intertidal mangrove macrofaunal biomass (Jones, 1984; Macintosh, 1984; Lee and Kwok, 2002). Because most Sesarmidae crabs are detritivorous and feed mainly on either mangrove leaf litter or detritus, theses crabs play a significant role in nutrient recycling in the mangrove ecosystem.

The main purpose of the study was to generate the information on brachyuran crab diversity and domination of the species in the mangroves of Wori waters.

## MATERIALS AND METHODS

### *Study Sites*

The research was conducted in Wori tidal waters, North Sulawesi with three sampling sites: Wori Seaward (WSW), Wori Middle zone (WMZ), and Wori Landward (WLW). Crab burrow density was recorded in three randomly placed one square meter quadrates. The field study was carried out in October 2015 and August 2016. The mangrove species recorded

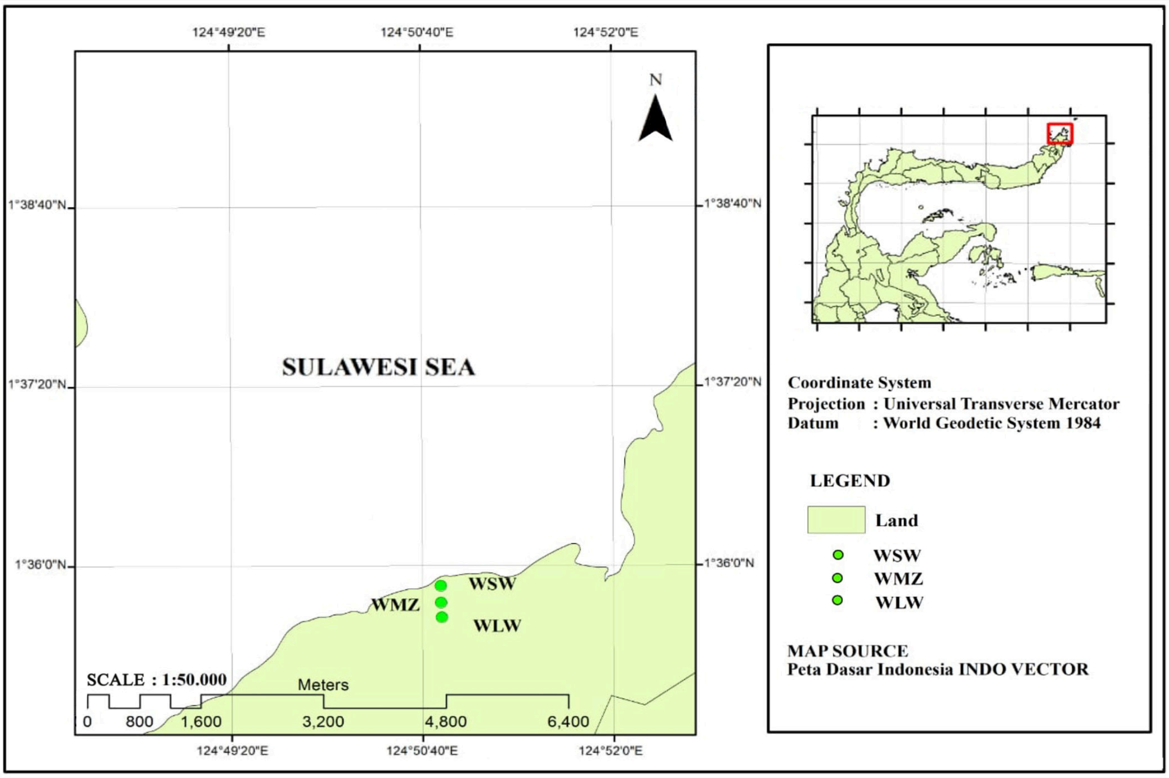


**Figure 1**. The map of sampling locations of mangrove crabs in Wori, North Sulawesi.

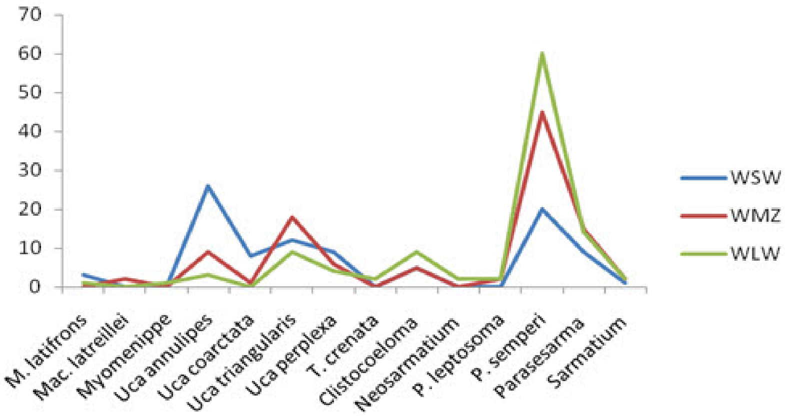


**Figure 2.** The number of species of crabs recorded on Wori Mangrove

with the order of zoning from outside to inside of the selected zones were: *Rhizophora apiculata, Bruguiera gymnorriza, Avicennia lanatta, Sonneratia alba, Xylocarpus granatum, Nypa fruticans,* and *Heritiera littoralis.* The stations of sampling mangrove crabs are shown in Figure 1.

### *Methodology*

All the study sites were searched randomly for crab collection. Collection method included: hand picking for surface crabs and for burrowing crabs, a shovel was used to dig the hole and catch the crab by hand. All the collected specimens were preserved in 70% ethanol for identification purposes. The preserved specimens were identified at the species level using different identification keys available in the published literature: Apel and Türkay (1999); Crane (1975); George and Jones (1982); Ng *et al.,* 2008; Lee *et al.,* (2013); Sakai (1976a, b); Rahayu and Davie (2002); Rahayu and Ng (2009, 2010); Shahdadi and Schubart (2017). For the further confirmation about the identification of the species, all the specimens were examined and compared with the photo and information available on the Marine Species Identification Portal Website. The latest scientific names and classification of the species were based on Ng *et al.*, (2008). All the specimens were deposited in the Research Centre for Oceanography, Indonesian Institute of Sciences in Jakarta.

The general survey involved collection of various species of crabs from fringe mangrove vegetations to describe the species richness. The density of the crabs was estimated random sampling in the Wori by some crabs active on the substrate enclosed within the quadrant or by digging the crabs from their burrows. To assess the species diversity of the crabs in the environment, the formula of Shannon and Wiener (1949) was used, and the species richness was calculated by Simpson's evenness or equitability.

## RESULTS

### *Species Composition*

In the study, 14 species of crabs belonging to 9 genera and 6 families were listed from Wori coastal area. The Sesarmid crabs were most abundant at the terrestrial border where they dig burrow networks. This highly motile, semiterrestrial crab is often found 100 m inland from the marsh or climbing in vegetation, like some mangrove Grapsid crabs. A total of 14 species of crabs was recorded from three sites (Table 1 and Figure 2). The number of crab species recorded was maximum in station WLW (12) and minimum number (9) at station WSW (Table 1). Among crabs species, *Parasesarma semperi*, *Parasesarma sp.*, *Uca annulipes*, and *Uca triangularis* and were the most dominant species in all stations.

Distribution of macrobenthos is controlled by sediment grain size, salinity, and groundwater. Hence, the most successful benthic species in mangrove habitats are those organisms that can adapt to environmental properties of these ecosystems (Safahieh *et al.*, 2012).

**Table 1.** Checklist and the total number of brachyuran crabs recorded from Wori, North Sulawesi, Indonesia.

| No | Species | WSW | WMZ | WLW |
|---|---|---|---|---|
| | **GRAPSIDAE** | | | |
| 1 | *Metopograpsus latifrons* | 3 | 0 | 1 |
| | **MACROPHTHALMIDAE** | | | |
| 2 | *Macrophthalmus (Venitus) latreillei* | 0 | 2 | 0 |
| | **MENIPPIDAE** | | | |
| 3 | *Myomenippe* sp. | 0 | 0 | 1 |
| | **OCYPODIDAE** | | | |
| 4 | ***Uca annulipes*** | **26** | **9** | **3** |
| 5 | *Uca coarctata* | 8 | 1 | 0 |
| 6 | ***Uca triangularis*** | **12** | **18** | **9** |
| 7 | *Uca (Paraleptuca) perplexa* | 9 | 6 | 4 |
| | **PORTUNIDAE** | | | |
| 8 | *Thalamita crenata* | 0 | 0 | 2 |
| | **SESARMIDAE** | | | |
| 9 | *Clistocoeloma* sp. | 5 | 5 | 9 |
| 10 | *Neosarmatium* sp. | 0 | 0 | 2 |
| 11 | *Parasesarma leptosoma* | 0 | 2 | 2 |
| 12 | ***Parasesarma semperi*** | **20** | **45** | **60** |
| 13 | ***Parasesarma* sp.** | **9** | **15** | **14** |
| 14 | *Sarmatium* sp. | 1 | 2 | 2 |
| | | **93** | **105** | **109** |

## *Population Density*

The crab population density varied between 93 and 109 individuals among the three stations. Minimum (93) was documented at station WSW and the maximum (109) in station WLW (Table 1). *Parasesarma semperi*, *Parasesarma sp.*, *Uca annulipes*, and *Uca triangularis* crabs are the dominant species among the crab taxa and are the dominant soil macrofaunal group within tropical, tidal forests in the Wori mangroves in North Sulawesi.

The mangrove distribution, substrate suitability, and tidal inundations were found to be possible factors which influence zonation and distribution of crabs in the Wori. This study was also supported by research in Southeast in India (Soundarapandian *et al.*, 2008; Trivedi *et al.*, 2012; Kamalakkanan, 2015).

Habitat distribution and diversity of crabs were based on the substratum, water level, and floral distribution. The crabs were distributed in different vegetation zones. The maximum number of crabs was distributed in the *Rhizophora* zone. *Parasesarma semperi, Parasesarma* sp. and *Metopograpsus latifrons* were present with the high water of neap tides and found to be sheltered amidst *Rhizophora.* This is attributed to the presence of rich nutrients in the *Rhizophora* leaves when compared to other mangrove leaves (Rajendran, 1997; Khan *et al.*, 2005; Kamalakkanan, 2015). While *Uca triangularis* and *Uca annulipes were found in the* open mudflat zone (WLW). Our study shows that among all benthic macrofauna inhabiting the mangrove swamps, brachyuran crabs are the most important taxa.

## *Zonation*

Muddy or sandy sediments of mangrove ecosystems may serve as habitat for a variety of epibenthic, infaunal and meiofaunal invertebrates. Mangrove sediments generally support higher densities of benthic organisms compare to non-vegetated sediments. Mangrove fauna often shows horizontal and vertical zonation. Some of the dominant species found in mud, some on the shrubs and leaves and the others around pneumatophore roots (Mauris, 2005). Crustacean spread can be divided into two spatial zones: 1. Vertical: applicable to crustaceans whose life is attached to the roots, stems, branches and leaves of mangroves, and 2. Horizontal: applicable to the species that live on the substrate either as infauna (in a hole) or epifauna (live freely on the substrate).

The species of crustacean that usually spreads vertically is from the barnacles taxa (*Balanus spp.*), where this animal lives attached to the root and mangrove stems. While the species of horizontal spread usually show a pattern of dominant type zonation parallel to the coastline. This zonation is generally thought to be related to the sharp gradient change of ecological properties from sea to land (Steenis, 1958). The main factors that cause "habitat selection," where certain species can be found in one location but not found in other locations, according to Steenis (1958), are:

1. Soil factor (substrate): dry, wet, soft, hard, containing sand, mud or clay (closely related to tidal);
2. Salinity: daily variation, related to frequency, depth and period of inundation;
3. Type resistance to currents and surf;

4. Food factors; and
5. Protection factors.

This is in accordance with the research conducted by Pratiwi (2006) in the Mahakam Delta, where *Perisesarma dussumieri*, *Sesarmops impressum*, *Uca coarctata,* and *Uca dussumieri* are found in large numbers in all research sites, whereas some crab species are found only in one or two locations only. Although mangrove habitat is of a special nature, according to Steenis (1958), each species of biota has its ecological range and each has a special niche. This leads to the formation of various communities and even zoning, so the composition of the species differs from one place to another.

In this research, the higher number of crab species was observed in the Wori Landward (WLW) (12) and the minimum number at WSW zone (9). Among all the zones, the dominant representative was Sesarmid group of crabs (Table 2).

**Table. 2.** Zonation of crabs based on the environment.

| WSW | WMZ | WLW |
|---|---|---|
| *Metopograpsus latifrons* | *Macrophthalmus (Venitus) latreillei* | *Metopograpsus latifrons* |
| *Uca annulipes* | *Uca annulipes* | *Myomenippe* sp. |
| *Uca coarctata* | *Uca coarctata* | *Uca annulipes* |
| *Uca triangularis* | *Uca triangularis* | *Uca triangularis* |
| *Uca (Paraleptuca) perplexa* | *Uca (Paraleptuca) perplexa* | *Uca (Paraleptuca) perplexa* |
| *Clistocoeloma* sp. | *Clistocoeloma* sp. | *Thalamita crenata* |
| *Parasesarma semperi* | *Parasesarma leptosoma* | *Clistocoeloma* sp. |
| *Parasesarma* sp. | *Parasesarma semperi* | *Neosarmatium* sp. |
| *Sarmatium* sp. | *Parasesarma* sp. | *Parasesarma leptosoma* |
| | *Sarmatium* sp. | *Parasesarma semperi* |
| | | *Parasesarma* sp. |
| | | *Sarmatium* sp. |

Distribution and zonation of crabs are based on the substratum, water levels and floral distribution. The *Uca spp.* was found in dry or elevated muddy substratum and above the high water mark. The *Macropthalmus* species preferred only the muddy substratum. Habitat structural complexity influences the density and diversity of marine organisms and contributes to zonation, where the level of complexity varies significantly with tidal height (Ravichandran *et al.*, 2007). Wori region is divided into five different zones which are *Rhizophora* zone, *Bruguiera* zone*, Avicennia* zone, *Sonneratia* zone and back mangrove zone (*Xylocarpus granatum, Nypa fruticans* and *Heritiera littoralis*), with a muddy substrate and muddy sand.

### *Species Diversity Index*

The biodiversity is important for human survival and economic interests and the environmental purpose and stability. Indonesia's marine and coastal ecosystems constitute an important natural resource for millions of people, as well as play a significant role in the maintenance of the ecosystem.

The species diversity index varied between 1.604 and 1.931 among the three stations. High species diversity index noticed in station WSW and low species diversity index at station WLW. The evenness values varied between 0.6454 and 0.8787, a minimum value (0.6454) was recorded at station WLW and the maximum value (0.8787) at station WSW. The richness index in the stations fluctuated from 1.765 to 2.345 Minimum (1.765) was recorded at station WSW and the maximum (2.345) at station WLW (Table 3, Figure 3).

**Table 3.** Biodiversity indices obtained for crabs at different stations.

| Parameters | WSW | WMZ | WLW |
|---|---|---|---|
| Species diversity | 1.931 | 1.733 | 1.604 |
| Dominance | 1.765 | 1.934 | 2.345 |
| Evenness | 0.8787 | 0.7527 | 0.6454 |

Many species of crabs (14) were recorded in the three different stations of Wori mangrove. The high number (12) of species was found distributed in Wori Lanward (WLW) zone and

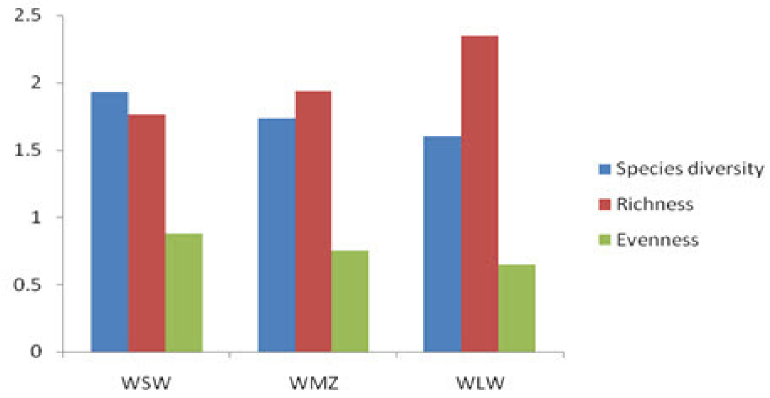


**Figure 3.** The chart of species diversity, richness and evenness at three stations

very less number (9) of species in Wori Seaward (WSW). Sesarmid crabs are common in all the three stations, but they are abundant in WLW is a dense mangrove area, because the Sesarmid crab has the ability to adapt in the mangrove ecosystem well and its presence in the WLW because it has more dense mangrove vegetation compared to WMZ and WSW also has a very preferred sand mud substrate and the presence of rich nutrients in the *Rhizophora* leaves when compared to other mangrove leaves.

## DISCUSSION

Biodiversity studies on crabs in Wori mangroves has shown that there are 14 species from three different station (WSW, WMZ and WLW). *P. semperi*, *Uca annulipes,* and *Uca triangular* have distinct distribution patterns in mangrove dominated estuaries. A species abundance may vary along the mangrove zone and across the intertidal zone. Crabs depend directly on mangrove for survival and are adapted to the special sediment conditions, tidal fluctuations, and varying salinities found in the mangrove.

Habitat distribution and diversity of crabs were based on the substratum, water level, and floral distribution. Wori mangroves were found in mudflats along its horizontal zone, with dense mangrove vegetation. The crabs were distributed in different vegetation zones. The maximum number of crabs was distributed in *Rhizophora* zone. This is attributed due to the presence of rich nutrients in the *Rhizophora* leaves when compared to other mangrove leaves (Rajendran, 1997; Rajendran and Kathiresan, 2000; Khan *et al.*, 2005; Kamalakkanan, 2015).

The aim of the study was to understand the benthic macrofauna inhabiting the mangrove swamps. The crustacean species were closely associated with specific habitats. Various environmental factors strongly influence the distribution of crabs in mangrove areas. In addition to the salinity, and the texture of substrates was another factor that substantially influences the distribution of crabs. Wori is rich in crab biodiversity, the maximum number of crab species recorded from station WLW mangrove site and the minimum number of crabs were recorded from WSW. The mangrove species found in the in the Wori sites were *Rhizophora apiculata, Bruguiera gymnorriza, Avicennia lanatta, Sonneratia alba, Xylocarpus granatum, Nypa fruticans,* and *Heritiera littoralis.* The WLW mangrove site was very dense with *Rhizophora apiculata* and with a muddy and sandy substrate also far away from the water, whereas, in WSW mangrove site, the condition is reversed with the condition in WLW, where the mangrove is less dense, the substrate is very muddy and very close to the water. The leaves of *R. apiculata* contain rich nutrients and more palatable compared to other mangrove leaves; this may be the reason for the maximum number of *Parasesarma* crabs present in the *Rhizophora* zone.

Zoning that occurred in Wori is clearly visible, unlike Pratiwi's (2006) research in the Mahakam Delta. The occurrence of the zonation is also seen in the crustacean research conducted in the mangrove estuary Delta Mahakam, East Kalimantan. Although it does not look too real, it can still represent the presence of certain species in the zonation. The uncertainty of zoning in the area is due to the fact that mangrove forest in the Delta Mahakam estuary has been damaged, so the existence of mangrove is not too wide anymore and that it has a significant impact on the life of the biota, especially crustaceans that depend heavily on mangroves as their habitat. The same thing is stated by Kartawinata and Soemodihardjo (1977) on their research in coastal areas of Indonesia, where the narrow mangrove forests do not show any real zonation.

The mangroves forests are considered as an important part of coastal ecosystems, because of their high productivity and because they also provide shelter to different kinds of animal communities. Crabs supply important nutrients for the growth of mangrove forest. The mangrove cover observed in Wori is much less compared to mangrove cover in Kema of Bitung, and it is mostly confined to the estuarine region. Though the area has sparse mangroves, cover still supports excellent crab diversity, and further studies are needed to understand the picture of brachyuran crab diversity of Wori region in Bitung North Sulawesi, Indonesia. Therefore Wori mangrove regions are valuable for research and the maintenance of the management, since it represents a more constant crabs diversity and highest abundance and sustains the protection of rare species.

## CONCLUSION

This study presents a reference state of the species composition and zonation of mangrove communities along the Wori coast. Of all the benthic macrofauna inhabiting the mangrove swamps, brachyuran crabs are the most important taxa with regard to the species diversity. It was found that some 14 species of crabs belonging to 9 genera and 6 families were recorded in the three different stations of Wori. The number of species (12) was found distributed in Wori Lanward (WLW) zone and a smaller number (9) of species in Wori Seaward (WSW).

Sesarmid crabs are common in WLW with a dense mangrove area, because the Sesarmid crab has the ability to adapt in the mangrove ecosystem well compared to WMZ and WSW which had a preferred sand mud substrate and the presence of rich nutrients in the *Rhizophora* leaves compared to other mangrove leaves.

Species composition and diversity index (1.931), dominance index (1.765), evenness index (0.8787) were high in species in station WSW and low in species at station WLW and WMZ. This condition shows that the WSW location is more diverse, there are no dominant species, so the distribution of crabs is spread evenly distributed in that location.

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