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Abundance and biomass of *Thalassia hemprichii* (Ehrenberg) Ascherson in the seagrass bed of Kauswagan, Lanao del Norte, Mindanao, Philippines

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Abstract. The abundance and biomass of *Thalassia hemprichii* (Ehrenberg) Ascherson was determined in seven coastal barangays of Kauswagan, Lanao del Norte, namely: Poblacion, Bagumbayan, Tacub, Libertad, Tugar, Kawit Oriental and Kawit Occidental, over a two month period December 2013 - January 2014. Shoot density, above and belowground biomass and ratio of above to belowground biomass were highest in Barangay Tacub and the values were comparable to other studies. It appears, therefore, that this intertidal seagrass contributes significantly to coastal productivity of the shallow coastal marine ecosystem in Kauswagan, Lanao del Norte.
Key Words: Turtle grass, marine seagrass, shoot density, productivity, marine ecosystem.

Introduction. Seagrasses are unique group of flowering plants that have adapted to exist fully submersed in the sea (Wright & Jones 2006) forming dense vegetation communities in shallow-water coastal and estuarine environments throughout the world (Burrell & Schubell 1977). They grow in sediment on the sea floor with erect, elongate leaves and a buried root-like structure or rhizomes (Short et al 2006). Seagrass meadows are of great ecological importance and have been recognized as one of the most productive marine ecosystems (Mann 1973; McRoy & McMillan 1977; Brouns & Heijs 1985; Duarte & Chiscano 1999). It has an estimated biomass of 460 g DW m^{-2} and has a net primary production of about 1,012 g DW m^{-2} yr^{-1} throughout the world (Duarte & Chiscano 1999). On the other hand, it is classified as one of the most valuable habitats for ecosystems services on a per hectare basis, preceeded only by estuaries and swamp or flood plains (Costanza et al 1997). In the tropics, particularly in the Philippines, seagrasses reach their highest species diversity and abundance, forming extensive, dense mixed meadows that are a major component of the coastal zone (Tomasko et al 1993; Vermaat et al 1995).

There were approximately 60 species of seagrasses (Green & Short 2003) that form beds or meadows along all continents except Antarctica (Robertson & Mann 1984) and are belonging to five families (Hydrocharitaceae, Posidoniaceae, Cymodoceae, Zosteraceae and Ruppiaceae) and twelve genera (Kou & McComb 1989). Six of the said genera, namely: *Thalassia, Enhalus, Syringodium, Halodule, Halophila* and *Cymodocea* are characteristics of tropical seas while the four genera, namely: *Posidonia, Amphibolis, Zostera* and *Phyllospadix* are exclusive to the temperate regions and the remaining two (*Thalassodendron* and *Ruppia*) are found in both tropical and temperate regions (Short et al 2007). In the tropical Indo-West Pacific Region as well as in the western and eastern Indian Ocean, *Thalassia hemprichii* (Ehrenberg) Ascherson is among the most widely-distributed seagrass species dominating in many mixed meadows (den Hartog 1970; Brouns 1987; Vermaat et al 1995; Gullström et al 2002; Prathep 2003). It is typically found in the sublittoral zone on depths down to five meters (den Hartog 1970; Phillips & Meñez 1988) and occurs as pure stands in the tidepools and common on mud-coral-sand or coarse coral-sand substrates (den Hartog 1970). This seagrass species is an important food source for dugongs and sea turtles and provides critical grazing habitat for fish (Phillips & Meñez 1988). In addition, several studies have shown that this intertidal seagrass species produced a comparable amount in terms of growth and biomass (Agawin et al 2001; Brouns 1985; Estacion & Fortes 1998; Erftemeijer & Herman 1994; Lanyon & Marsh 1995; Lin & Shao 1998; Uku & Bjork 2005; Paula et al 2001; Jagtap 1998). Several studies have been conducted on seagrass abundance and distribution in Iligan Bay (Jumawan 1997; Rocillo 2002; Milo 2003; Chan 2003; Malugao 2009; Orbita & Gumban 2013) however no particular study has been done on *T. hemprichii.* Therefore, this study have been undertaken to investigate the shoot density and biomass of seagrass *T. hemprichii* in the seagrass bed of Kauswagan, Lanao del Norte. The data gathered from this study were expected to be valuable in the understanding of the dynamics and contribution of this intertidal seagrass species in a shallow marine coastal ecosystem of Kauswagan, Lanao del Norte.

Material and Method. Kauswagan is the second coastal municipality of the Province of Lanao del Norte. It lies on the mid-central portion of the Northwestern Mindanao coastline (8° 9' 35'' N, 124° 5' 51'' E). It comprised 13 barangays, 7 of which are coastal barangays (Poblacion, Bagumbayan, Tacub, Libertad, Tugar, Kawit Oriental and Kawit Occidental) and were considered as the sampling areas (Figure 1). Kauswagan has a long tidal flat, approximately 250 m from the shore. A mixed stands of seagrasses on sandy muddy bottom substrates was found in this area. Seagrass species such as *T. hemprichii, Cymodocea rotundata, Cymodocea serrulata, Halodule pinifolia, Halodule uninervis, Enhalus acoroides* and *Halophila ovalis* were found. Among these, *T. hemprichii* was the dominant species (per observation).

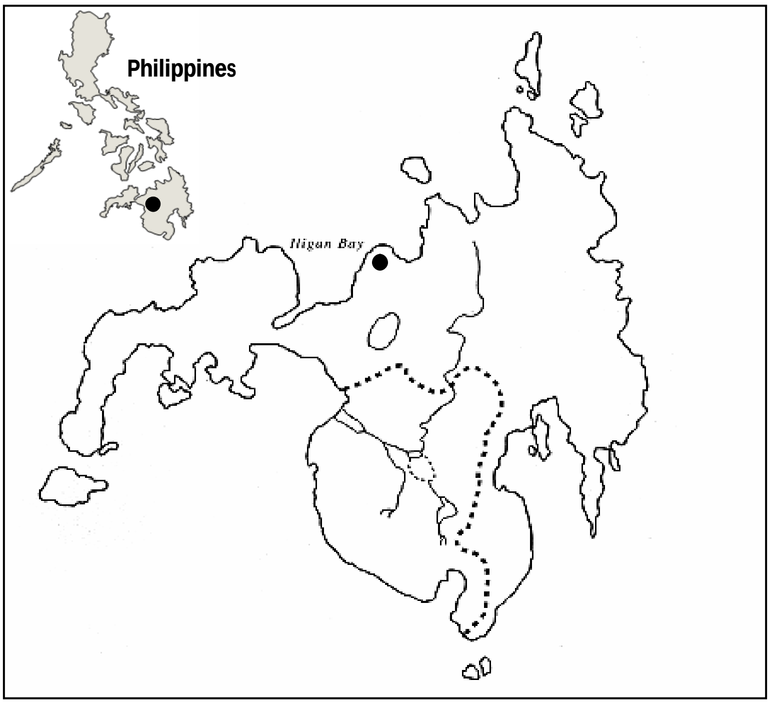

Figure 1. Map of Mindanao showing the sampling area of Kauswagan, Lanao del Norte.

The study was conducted from December 2013 to January 2014 during the northeast monsoon. Prior to the actual sampling, visual observation was conducted in order to have a general view of the marine vegetation. The shoot density and biomass (aboveground and belowground) of *T. hemprichii* was determined using the transect-quadrat method (English et al 1997). A 100 m transect line was pegged perpendicular to the shore with a 100 m interval between transects. A 50 cm x 50 cm quadrat divided into 25 equal squares was laid down at the right side of the transect line. Without moving the quadrat, shoots were counted and numbers were expressed as density (shoot/m^2). For biomass study, all living materials inside a 30 cm x 30 cm quadrat were collected and brought to the laboratory for analysis. Collection of seagrass samples for biomass analysis was randomly done outside the transect lines (about 0.5 m landward of the quadrat). Three replicates were collected from each sampling area. In the laboratory, seagrasses collected by quadrats were rinsed with freshwater and divided into an aboveground part (leaf blades and sheaths) and a belowground part (rhizomes and roots). Epiphytes were gently scraped off the leaf by hand. Seagrass samples were then dried in the oven at 70^0C to constant weight for 48 hours to obtain dry weight (DW). The data on biomass were expressed in terms of production per unit area (g DW m^{-2}). All data were taken following the method proposed by Short et al (2006). The difference in shoot density, aboveground and belowground biomass and ratio of the above to belowground biomass of *T. hemprichii* among sampling sites was analyzed through One-Way Analysis of Variance (level of significance, P of 0.05) in SPSS (version 8.0).

Results and Discussion. The shoot density, above and belowground biomass and ratio of above to belowground biomass of *T. hemprichii* varied significantly among sampling sites ($p<0.05$, Table 1). Among the 7 coastal barangays studied, only 6 were found to have growth of *T. hemprichii*.

Table 1

Statistial analysis (One-Way ANOVA) on the effects of sampling area on shoot density (shoots m^{-2}), above and belowground biomass (g DW m^{-2}) and ratio of above to belowground biomass of *Thalassia hemprichii* in Kauswagan, Lanao del Norte

Dependent variables	*d.f.*	*F statistics*	*p*	*Analysis*
Shoot density	5	42.00	0.000	Significant
Aboveground biomass	5	8.16	0.001	Significant
Belowground biomass	5	9.64	0.001	Significant
Ratio of above and belowground biomass	5	6.66	0.050	Significant

Barangay Tacub had the highest mean shoot density (274 ± 94.84 shoots m^{-2}) followed by Barangay Bagumbayan (272 ± 173.84 shoots m^{-2}, Figure 2) and the value was within the range observed for the same species in the Philippines [65-1,853 shoots m^{-2} (Vermaat et al 1995; Agawin et al 2001; Rollon et al 2001; Gacia et al 2003)] and in India [150-1,300 shoots m^{-2} (Jagtap 1998)]. On the other hand, Abu Hena et al (2004), Uku & Bjork (2005) and Huang et al (2006) recorded higher shoot density for the same species in the seagrass bed of Malaysia (632.14 shoots m^{-2}), Kenya (733 shoots m^{-2}), and China (1,024 shoots m^{-2}). Nienhuis et al (1989) stated that the shoot number per surface area is species dependent and the range of the shoot numbers is extremely variable. This statement was found to be consistent with the results obtained in this study. Moreover, shoot density is a parameter of the community structure, which is often used as a rough estimation for standing stock (Jacobs 1984). It was found that the aboveground biomass (AGB) increases with shoot density ($r = 0.518$, $p<0.05$). Belowground biomass (BGB) also showed positive correlation ($r = 0.659$, $p<0.05$) with shoot density. This relationship revealed that any natural stresses on these parameters may affect the biomass and productivity of *T. hemprichii* in this marine ecosystem. Backman & Barilotti (1976) found a linear relation between dry biomass and shoot density in the seagrass *Zostera marina* bed of Southern California and likewise in *T. hemprichii* in the seagrass bed of Port Dickson, Malaysia (Abu Hena et al 2004).

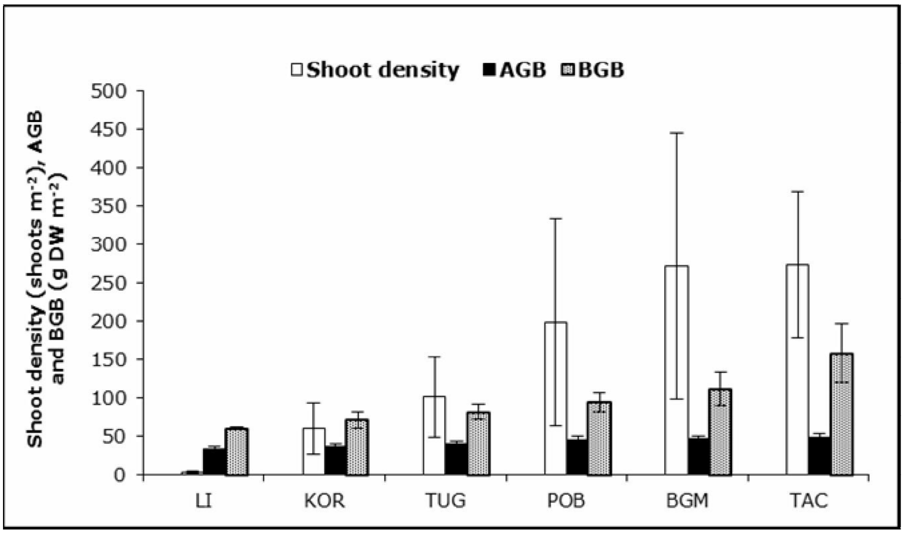

Figure 2. Shoot density (shoots m^{-2}), aboveground biomass (g DW m^{-2}) and belowground biomass (g DW m^{-2}) of *Thalassia hemprichii* in 6 coastal barangays of Kauswagan, Lanao del Norte. Legend: LI (Libertad), KOR (Kawit Oriental), TUG (Tugar), POB (Poblacion), BGM (Bagumbayan) and TAC (Tacub).

During the study period, the mean aboveground and belowground biomass was relatively highest in Barangay Tacub. The value of AGB was recorded as 49.40 ± 5.16 g DW m^{-2}. In comparison with other reported studies of *T. hemprichii*, the AGB value in this study was within the range values recorded in India [25.3-258.3 g DW m^{-2} (Jagtap 1998)] but lower than the values obtained in other parts of the Philippines [148-250.2 g DW m^{-2} (Vermaat et al 1995; Agawin et al 2001; Rollon et al 2001; Gacia et al 2003)]. The mean value of belowground biomass (roots and rhizome) was 158.81 ± 38.45 g DW m^{-2} and was higher compared to that in Port Dickson, Malaysia [49.43 ± 8.83 g DW m^{-2} (Abu Hena et al 2004)]. Also, the aboveground biomass was always smaller than the belowground biomass. This smaller aboveground biomass may be a response evolved to minimize exposure and dessication at low tide and to increase stability when exposed to waves at high tide (Lin & Shao 1998). Similar results were observed in southern Taiwan (Lin & Shao 1998) and in Port Dickson, Malaysia (Abu Hena et al 2004).

The ratio of above to belowground biomass was still highest in Barangay Tacub as shown in Figure 3. The seagrass *T. hemprichii* has a ratio of 1:3.21 and the value was relatively similar with those recorded in the seagrass bed of Sabah, Malaysia [1:3.20 (Ismail 1993)] and in Indonesia [1:3.02 (Kiswara 1992)] for the same species. In contrast, Brouns (1985) and Ogden & Ogden (1982) showed much higher ratio of 1:6.0 and 1:4.68 for the same species in Papua New Guinea and Western Caroline Islands, respectively. Higher biomass of the belowground materials may provide a better anchorage for the plants and a higher storage capacity for carbohydrates and nutrients (Romero et al 1994; Azkab 1992). Besides providing organic detritus and habitats for microorganisms in the marine environment, the above and belowground plant parts served to function in reducing water current velocity and in stabilizing the soft sea bottom. These activities also served to reduce the surface erosion of coastal floor (Nybakken 1997). In this regard, seagrasses have been recognized as suitable natural tool for coastal zone management to prevent sea bottom erosion (Sudara et al 1992).

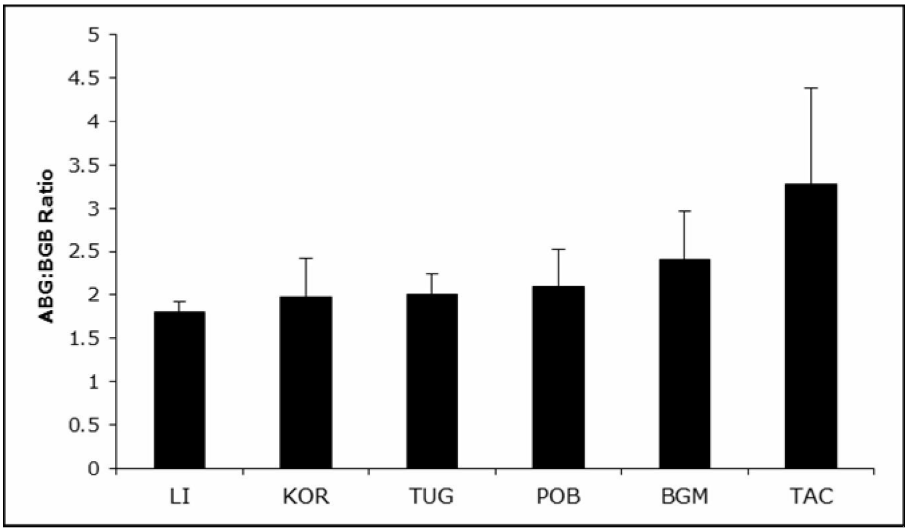

Figure 3. Ratio of aboveground to belowground biomass (AGB:BGB) of *Thalassia hemprichii* in 6 coastal barangays of Kauswagan, Lanao del Norte. Legend: LI (Libertad), KOR (Kawit Oriental), TUG (Tugar), POB (Poblacion), BGM (Bagumbayan) and TAC (Tacub).

Conclusions. The present study reveals that the intertidal seagrass *T. hemprichii* contributes significantly to coastal productivity and stabilizing sea floor sediments in the shallow coastal marine ecosystem of Kauswagan, Lanao del Norte since the abundance and biomass were comparable to other studies. Tropical seagrasses can show large temporal changes in abundance and biomass. Therefore, seasonal variation in abundance and biomass of this particular species should be considered in future studies.

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