Feeding rates and food preferences of the amphipods present on macroalgae *Ulva* sp. and *Padina* sp.

Tasas de alimentación y preferencias alimenticias de los anfípodos presentes en las algas *Ulva* sp. y *Padina* sp.

I. Ortega [1], Y. J. Díaz [2] & A. Martín [2]

[1] Postgrado en Ciencias Biológicas. Universidad Simón Bolívar, A.P. 89000, Caracas, Venezuela. E-mail: ili703@hotmail.com

[2] Laboratorio de Crustáceos Peracáridos. Centro de Biodiversidad Marina. Dpto. de Estudios Ambientales - INTECMAR. Universidad Simón Bolívar, A.P. 89000, Caracas, Venezuela, E-mail: yusdiaz@usb.ve, amartinz@usb.ve

Recibido el 13 de septiembre de 2010. Aceptado el 15 de diciembre de 2010.

ISSN: 1130-4251 (2010), vol. 21, 45-53.

Special Issue: Amphipods: Trends in systematics and ecology (Guest editor: J. M. Guerra García)

Key words: Ulva, Padina, feeding rates, food preferences, Ampithoe.
Palabras claves: Ulva, Padina, tasas de alimentación, preferencias alimenticias, Ampithoe.

ABSTRACT

Differences on algae palatability and food preferences of herbivores play an important role on the algae biomass, being the amphipods and gastropods the most abundant mesoherbivores. The aim of this study was to determine the feeding rates and food preferences of the amphipods present on *Ulva* sp. and *Padina* sp., with emphasis on *Ampithoe ramondi*. We took 3 samples of each alga with 10x10cm quadrats to determine the amphipod assemblage. Fifteen amphipods were placed between 0.3 and 1.0cm in 5L tanks for each treatment. About 2g of fresh algae was placed in each tank and left for 8 days. We make 3 treatments (*Ulva*, *Padina* and both). In the first trial, four replicates were performed for each treatment and randomly placed the 5 most representative species of amphipods on field. For the second one, 3 replicates were carried out with *A. ramondi*. In field, *A. ramondi* was the most abundant specie on *Padina* and *Hyale pygmaea* on *Ulva*. The feeding rate was higher on *Padina* than *Ulva* for the first trial (0.010 – 0.013g algae wet weight/amphipod/day *vs*. 0.003 – 0.005g algae wet weight/amphipod/day, respectively). For the trial 2, there was an also higher feeding rate on *Padina* than *Ulva* (0.009 - 0.013g algae wet weight/amphipod/day *vs*. 0.003 - 0.007g algae wet weight/amphipod/

day, respectively). Feeding rates were similar in both trials, suggesting that *A. ramondi* probably have more impact than others. When offered both algae, *Padina* was preferred, although brown algae were considered unpalatable to many herbivores due the presence of chemically-induced defenses.

RESUMEN

Las diferencias en la palatabilidad de las algas y las preferencias alimenticias de los herbívoros juegan un papel importante en la biomasa de éstas, siendo los anfípodos y gasterópodos, los mesoherbívoros más abundantes en estas comunidades. El objetivo del presente trabajo fue determinar las tasas de alimentación y preferencias alimenticias de los anfípodos presentes en las algas *Ulva* sp. y *Padina* sp., con énfasis en el anfípodo *Ampithoe ramondi*. Se tomaron 3 muestras de cada alga con cuadrículas de 10x10cm para determinar la estructura de la comunidad de anfípodos. Quince anfípodos con tamaños entre 0,3 y 1,0cm fueron colocados en acuarios de 5L para cada tratamiento. Se colocaron aproximadamente 2g de alga fresca en cada acuario y se mantuvieron durante 8 días. Se realizaron tres tratamientos (*Ulva, Padina* y ambas). En el primer experimento, se llevaron a cabo cuatro réplicas de cada tratamiento y se colocaron aleatoriamente 5 anfípodos de las especies más representativas de la comunidad. Para el segundo, se consideraron 3 réplicas con *A. ramondi.* En el hábitat natural las especies más abundantes fueron *A. ramondi* en *Padina* y *Hyale pygmaea* en *Ulva*. La tasa de alimentación fue mayor sobre *Padina* que en *Ulva* para el primer experimento (0,010 – 0,013g peso húmedo del alga/anfípodo/día *vs*. 0,003 – 0,005g peso húmedo del alga/anfípodo/día, respectivamente). Para el segundo experimento, también hubo una mayor tasa de alimentación sobre *Padina* (0,009 – 0,013g peso húmedo del alga/anfípodo/día *vs*. 0,003 – 0,007g peso húmedo del alga/anfípodo/día, respectivamente). Las tasas de alimentación fueron similares en ambos experimentos, sugiriendo que *A. ramondi* tiene mayor impacto que las otras especies. Cuando se le ofrecieron las dos algas prefirió *Padina*, a pesar de que las algas pardas han sido consideradas poco palatables para muchos herbívoros debido a la presencia de defensas químicas inducidas.

INTRODUCTION

Marine mesoherbivores include amphipods, gastropods and isopods within others. They can be found in a great variety of marine environment, often associated to living substrates like macroalgae and seagrasses. This living substrates provide mesoherbivores from a variety of resources that includes food and shelter, as from predators as environment stress (Huang *et al*., 2006; Jacobucci *et al*., 2008).

These organisms are primary consumers and play an important role in marine grass systems, because they are the main responsible for the transfer of energy to higher trophic levels (Jacobucci & Pereira Leite, 2008). In addi-

tion, mesoherbivores are important structural elements in these communities because they may control macrophytes biomass by the intake of preferred algae as is demonstrated in stomach contents studies. Those studies have shown that different algal species are apparently not consumed in equal frequency to their relative abundance (Huang *et al*., 2006).

The effect of mesoherbivores in macroalgae communities can be complex as they feed of macroalgae and epiphytes, in the first growing stage as well as in adults. When there is a preference for macroalgae resulting in substantial changes in biomass and species composition in the algal community, it may reduce the biomass of the algae species preferred to alter the competitive relationships within a community producers (Hauxwell *et al*., 1996; Kamermans *et al*., 2002; Huang *et al*., 2006; Jacobucci *et al*., 2008). However, this effect may vary according to various mesoherbivores and their diets, for example, herbivorous gastropods are more energy efficient compared to epiphytic amphipods, but because the last ones are more selective and show greater mobility and abundance have greater effects on the structure of algal communities (Jacobucci *et al*., 2008). Although it is known that mesoherbivores can consume large amounts of algae, the degree to which they can control these assemblies has not yet been established (Hauxwell *et al*., 1996).

The amphipods are very abundant in macroalgal communities and may constitute a high percentage of the macrofauna in these communities (Huang *et al*., 2006), being in Venezuela the most common genera *Hyale* Rathke, 1837 and *Ampithoe* Leach, 1814. Within gammarids, tube dweling ampithoids are frequently herbivorous and detritivores and the free living hyalids are omnivores (Jacobucci *et al*., 2008).

Based on the above and the lack of studies on herbivory by amphipods in Venezuela, the aim of this study was to determine feeding rates and food preferences of amphipods in *Ulva* and *Padina* algae, with emphasis on the amphipod *Ampithoe ramondi* Audouin, 1826.

MATERIAL AND METHODS

Amphipods were collected on intertidal zone of a rocky shore in Chirimena, Venezuela (10°36.472'N, 66°09.726'W). Dominant algae were *Padina* sp. and *Ulva* sp., also being present other species (Fig. 1).

We took three samples of each alga with 10 x 10 cm quadrats, which were preserved in 70% ethanol for subsequent separation and identification of organisms in the laboratory. For the experiments, the amphipods were collected by shaking the algae in salt water. Then these were transported in

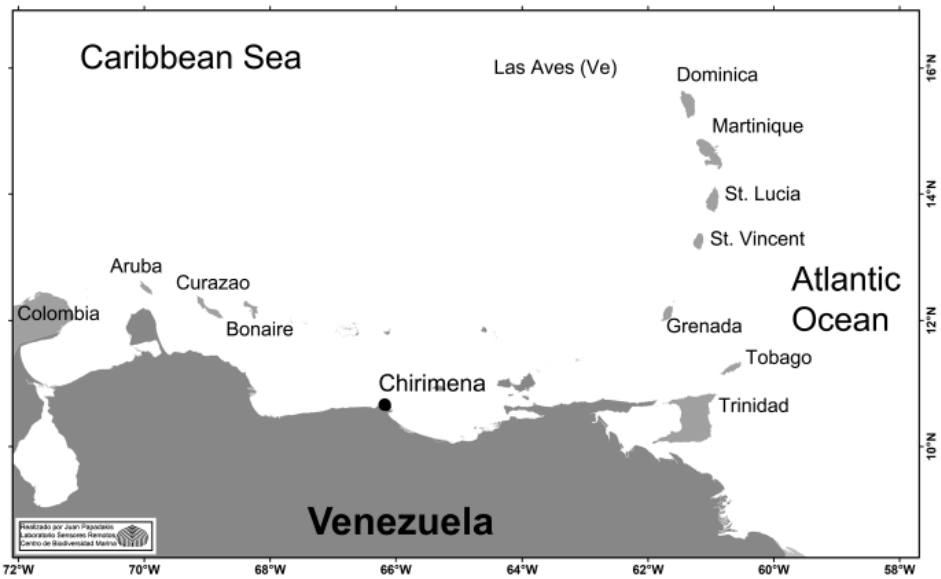

Fig 1.—Sampling site map.
Fig 1.—Mapa de la ubicación geográfica del sitio de muestreo.

plastic bottles to the laboratory and immediately aerated. Amphipods measures were done in their natural curved form, using a size range from 0.3-1.0cm.

Feeding rates and preferences experiments were done following a modification of Goeker & Kall (2003) and Huang *et al.* (2006) protocols.

Fifteen amphipods were placed in 5L tanks for each treatment with 12h of starvation. About 2g of fresh algae was placed in each tank and left for 8 days. We make 3 treatments, two with just one alga (*Padina* or *Ulva*) per tank to see feeding rates and the third one with the both algae in the tank to study the food preferences. In the first trial, four replicates were performed for each treatment and randomly placed the 5 most representative species of amphipods on field. For the second one, 3 replicates were carried out with *A. ramondi*.

Salinity was maintained on 35ppm, pH between 7.5-8.0 and temperature between 22.3-28.0°C.

RESULTS

The dominant group associated to algae was amphipods with densities of 1.44 ± 0.67 amphipods/g *Padina* and 4.98 ± 3.28 amphipods/g *Ulva* (Table I).

The dominant species were *Ampithoe ramondi* (0.79 ± 0.40 ind/g algae wet weight) on *Padina* and *Hyale pygmaea* Ruffo, 1950 (2.17 ± 1.43 ind/g algae wet weight) on *Ulva* (Fig. 2).

Average feeding rates and food preferences from amphipod community shows a high preference by *Padina*, being the intake an order of magnitude higher (Table II). We also observed that the algae besides of being a food source was used as a shelter and ampithoids folded the fronds of the alga with some mucus to make their shelter (Fig. 3) or used fragments of algae to make its refuge at the bottom of the tank.

Table I.—Organisms average (individuals/g ± standard deviation) on each alga.
Tabla I.—Promedio de organismos (n.º individuos/g ± desviación estándar) presentes en cada especie de alga.

Algae	Gasteropoda	Polychaeta	Decapoda	Amphipoda	Isopoda
Padina	0.89±1.18	0.02±0.04	0.2±0.08	1.4±0.67	0.18±0.29
Ulva	1.28±1.32	0.13±0.11	0.08±0.07	4.98±3.28	—

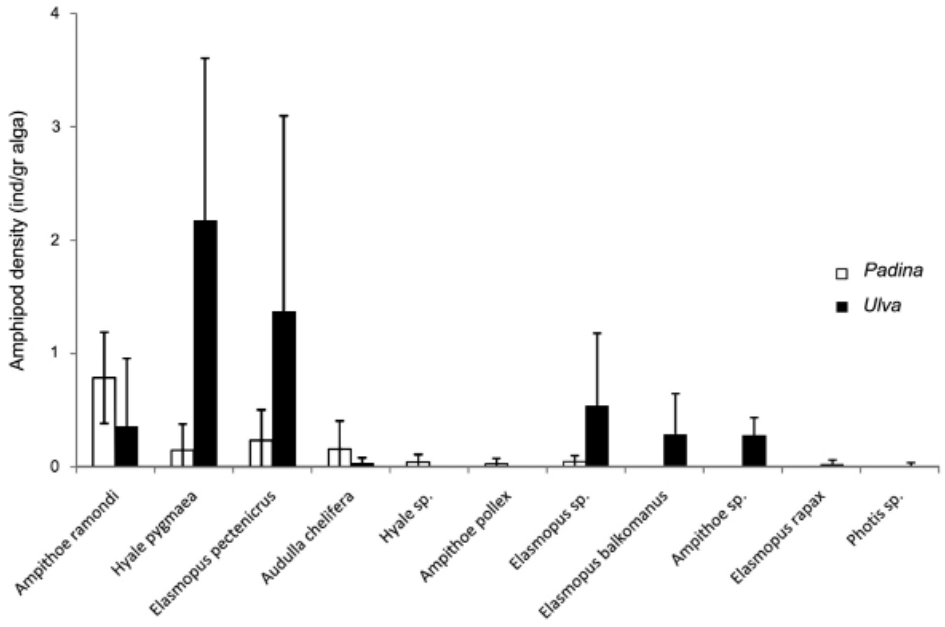

Fig 2.—Density (ind /g wet weight of alga) of amphipods found in each alga. Bars indicate standard deviation.
Fig 2.—Densidad (ind /g peso húmedo del alga) de anfípodos encontrados en cada alga. Las barras indican la desviación estándar de los resultados.

Table II.—Feeding rates and food preferences of amphipod community in both algae (g alga wet weight/amphipod/day± standard deviation).
Tabla II.—Valores de las tasas de alimentación y preferencia alimenticia de la comunidad de anfípodos en ambas algas (g de alga húmeda/anfípodo/día ± desviación estándar).

	Treatment 1 and 2: Feeding rates experiments		**Treatment 3: Food preference experiment**	
	T1: *Ulva*	**T2: *Padina***	***Ulva***	***Padina***
g alga wet weight/ amphipod/day	0.003 ± 0.002	0.011 ± 0.001	0.004 ± 0.001	0.010 ± 0.002

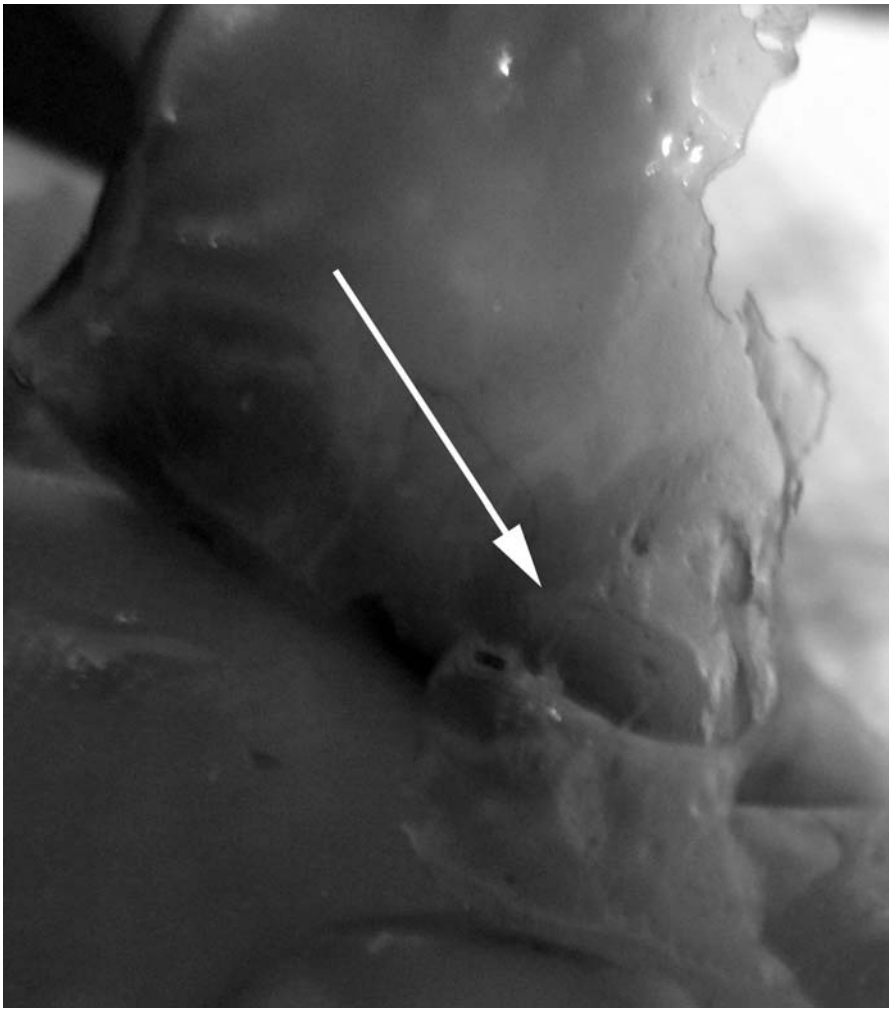

Fig 3.—Shelter made by an *Amphitoe* on *Ulva sp.*
Fig 3.—Refugio construido por un *Amphitoe* sobre *Ulva sp.*

When we analize only the specie *A. ramondi*, it had a clear preference for *Padina* (Table III) showing feeding rates similar to those observed when tested the whole amphipod community, suggesting that this species is one of the main contributors to the first results. The ampithoids from *Ulva* died, so we were unable to perform the experiment.

In almost all experiments amphipods survivor was high, with a maximum mortality of 3 individuals per tank. Many of the amphipods that died during the experiments were eaten by the survivors, as these were not observed in the tank to make the final count.

Table III.—Feeding rates and food preferences (g alga wet weight/amphipod/day± standard deviation) of *Ampithoe ramondi.*
Tabla III.—Tasas de alimentación y preferencia alimenticia (g peso húmedo alga/anfípodo/día± desviación estándar) de *Ampithoe ramondi*.

Amphipod precedence algae	**Treatment 1 and 2: Feeding rates experiments**		**Treatment 3: Food preference experiment**	
	T1: *Ulva*	**T2: *Padina***	***Ulva***	***Padina***
Ulva	—	—	0.37 ± 0.11	1.23 ± 0.15
Padina	1.50 ± 0.10	1.20 ± 0.95	0.90 ± 0.20	1.60 ± 0.05

— there were no results due of amphipods dead

DISCUSSION

The amphipods and gastropods were the dominant group in the studied macroalgae as proposed by Tanaka *et al.* (2003) and Huang *et al.* (2006).

Just as found by Ortega *et al.* (2007) in the same rocky shore, the most abundant genera on *Ulva* was *Hyale*, and on *Padina* was *Ampithoe*. While Ayala (2002) found that the largest number of amphipods present in *Sargassum, Padina, Ulva* and *Laurencia* corresponds to the genus *Hyale*, and its abundance was always greater than 60%, due to presence of morphological adaptations for living in places where wave action is very high.

We could corroborate the use of both algae as a food source by amphipods in general and by the ampithoids in particular, showing a clear preference for *Padina*, despite the loss of biomass by decomposition of this species. Consumption rates were very different depending on the algae species, such as suggested by Goecke & Kall (2003), who argue that intrinsic differences in the palatability of different algae and herbivore preferences play a role in the algae biomass present in the environment. Brown algae

have been described as having the highest number of induced chemical defenses, making them less palatable, while green algae has deterrents secondary metabolites, but has not been reported to present induced defenses (Rothausler *et al.,* 2005).

Moreover, Kamermans *et al.* (2002) studied the effect of herbivory by amphipods and isopods in *Ulva* growth determining that was negligible, even in some cases the growth of algae was higher in cages where they allowed the access to grazers, since stimulated algae growth by removing epiphytes. This supports the fact that we have observed a low rate of consumption of this alga.

Huang *et al.* (2006) report that differences in feeding rates may be due to biological or physical agents. Among physics is the algae morphology, which has been shown to influence the palatability for amphipods, especially the hardness of the stem. In this sense, *Padina* is much softer than *Ulva*.

We also endorsed the use of these algae as a refuge as posed by Huang *et al.* (2006) and Jacobucci *et al.* (2008), having clearly seen the formation of tube-shaped shelter and the individuals within them.

CONCLUSIONS

There is a clear preference for the intake of *Padina* over *Ulva*. There is a higher feeding rate of the first one when we presented separately both algae to the whole community and to *Ampithoe ramondi;* being feeding rates of this specie similar to the feeding rates of the community.

ACKNOWLEDGEMENTS

To Lic. Milagros Ortega for her collaboration and patience in the field trips and help in the tanks maintenance.

REFERENCES

Ayala, Y. 2002. Relaciones entre la comunidad de anfípodos y las macroalgas asociadas a una plataforma rocosa del Litoral Central. Tesis de Licenciatura. Universidad Simón Bolívar. 71p.

Goecker, M. & Kall, S. 2003. Grazing preferences of marine isopods and amphipods on three prominent algal species of Baltic Sea. *Journal of Sea Research*, 50: 309-314.

Hauxwell, J.; McClelland, J.; Behr, P. & Valiela, I. 1998. Relative importance of grazing and nutrient controls on macroalgal biomass in three temperate shallow estuaries. *Estuaries*, 21(2): 347-360.

Huang, Y.; McClintock, J.; Amsler, C.; Peters, K. & Baker, B. 2006. Feeding rates of common antarctic gammarid amphipods on ecologically important sympatric macroalgae. *Journal of Experimental Marine Biology and Ecology*, 329: 55-65.

Jacobucci, G. B & Pereira, F. 2008. Effect of temporal variation and size of herbivorous amphipods on consumption levels of *Sargassum filipendula* (Phaeophyta, Fucales) and their main epiphyte, *Hypnea musciformis. Neotropical Biology and Conservation,* 3(2): 78-85.

Jacobucci, G. B; Ziggiatti, A. & Pereira, F. 2008. Experimental evaluation of amphipod grazing over biomass of *Sargassum filipendula* (Phaeophyta) and its dominant epiphyte. *Nauplius*, 16(2): 65-71.

Kamermans, P.; Malta, E.; Verschuure, J.; Schrijvers, L.; Franca Lentz, L. & Lien, A.T.A. 2002. Effect of grazing by isopods and amphipods on growth of *Ulva* spp. (Chlorophyta). *Aquatic Ecology,* 36: 425–433.

Ortega, I.; Mendez, Y. & Díaz, Y. 2007. Relación entre la pigmentación de las algas y la coloración de los anfípodos presentes en la plataforma rocosa de Chirimena, Estado Miranda. *VII Congreso venezolano de Ecología*. Ciudad Guayana, Venezuela: 428.

Rothausler, E.; Macaya, E.; Molis, M.; Wahl, M. & Thiel, M. 2005. Laboratory experiments examining inducible defense show variable responses of temperate brown and red macroalgae. *Revista Chilena de Historia Natural*, 78: 603-614.

Tanaka, M. & Pereira Leite, F. 2003. Spatial scaling in the distribution of macrofauna associated with *Sargassum stenophyllum* (Mertens) Martius: analyses of faunal groups, gammarid life habits, and assemblage structure. *Journal of Experimental Marine Biology and Ecology*, 293: 1-22.