TROPHIC ECOLOGY OF LIMPETS AMONG ROCKY INTERTIDAL IN BAHIA LAREDO, STRAIT OF MAGELLAN (CHILE)

ECOLOGÍA TRÓFICA DE LAPAS EN EL INTERMAREAL ROCOSO DE BAHÍA LAREDO, ESTRECHO DE MAGALLANES (CHILE)

Claudia Andrade[1,2] & Thomas Brey[2]

ABSTRACT

Diet composition and food sources of the limpets *Nacella deaurata* and *Nacella magellanica* were studied in a subantarctic rocky-boulder intertidal system in the Magellan Strait, on the basis of gut contents and stable isotope analyses. Green microalgae (32.5 %), brown algae (22.2 %) and red algae (21.3 %) constituted the main food items in *N. deaurata* while green microalgae (28.3 %), micro-bivalves (27.4 %) and foraminiferans (20.9 %) were dominant food components in *N. magellanica*. Relative food items contribution indicated a generalist-type trophic strategy in both species, albeit *N. deaurata* exhibited a more pronounced herbivory. Stable isotope ratios confirmed this omnivorous / grazer lifestyle. Our results coincide with other studies that report green microalgae to be the major food item for other *Nacella* species but they also contradict the common view that these limpets are herbivorous animals.

Key words: Diet composition, stable isotopes, Gastropoda, *Nacella*, omnivorous, Magellan Strait.

RESUMEN

Se estudió la composición de la dieta y la fuente de alimentos de las lapas *Nacella deaurata* y *Nacella magellanica* en un ecosistema intermareal rocoso subantártico en el estrecho de Magallanes, sobre la base del contenido estomacal y los análisis de isótopos estables. Los principales ítems alimenticios encontrados en *N. deaurata* fueron microalgas verdes (32.5 %), algas pardas (22.2 %) y algas rojas (21.3 %) mientras que los componentes alimenticios dominantes en *N. magellanica* fueron microalgas verdes

[1] Instituto de la Patagonia, Universidad de Magallanes, Punta Arenas, Chile. Claudia.Andrade@Awi.de
[2] Alfred Wegener Institute, Helmholtz Center for Polar and Marine Research, Bremerhaven, Germany

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(28.3 %), micro-bivalvos (27.4 %) y foraminíferos (20.9 %). La relativa contribución alimenticia indica una estrategia de tipo trófico generalista en ambas especies. Aunque *N. deaurata* exhibió una herbivoría más pronunciada. Las proporciones de isótopos estables confirmaron este estilo de vida omnívoros / ramoneadores. Nuestros resultados coinciden con otros estudios que reportan a las microalgas como el mayor ítem alimenticio para otras especies de *Nacella* pero estos trabajos también contradicen la idea general que estas lapas son animales herbívoros.

Palabras clave: Composición de la dieta, isótopos estables, Gastropoda, *Nacella,* omnívoro, Estrecho de Magallanes.

INTRODUCTION

Mollusks constitute a conspicuous part of the epifauna of shallow water rocky habitats in the subantarctic Magellan region (Ríos & Gerdes, 1997; Mutschke *et al.* 1998; Ríos & Mutschke, 1999; Ríos *et al.* 2007; Aldea & Rosenfeld, 2011). Besides dense assemblages of sessile filter feeding bivalves (Ríos & Gerdes *op. cit*.; Cattaneo-Vietti *et al*. 1999), limpets are the most characteristic representatives of this fauna, particularly the two species *Nacella deaurata* (Gmelin, 1791) and *N. magellanica* (Gmelin, 1791) (Thatje & Ríos, 2010). Locally they can attain comparatively high abundances, *e.g*. in Bahía Laredo (Strait of Magallanes) up to 7 ind m^{-2} for *N. deaurata* (Andrade, 2009)[1] and up to 9 ind m^{-2} for *N. magellanica* (Guzmán & Ríos, 1987).

The significance of such mobile gastropods for rocky intertidal community structure has been documented in various systems (see Underwood, 1979, 1980; Hawkins & Hartnoll, 1983; Vadas, 1985) and their feeding activity appear to be a major structuring agent. Limpets of the genus *Nacella* have been reported to feed on microphytobenthos (Shabica, 1976[2]; Brand, 1980[3]; Picken, 1980; Kim, 2001; Peck & Veal, 2001) calcareous rhodophytes (Brand *op. cit.*, Iken *et al.* 1998), and seaweeds (Iken, 1996), but also on bryozoans and sessile spirorbid polychaetes (Brand *op. cit.*). Alimentation of *N. deaurata* and *N. magellanica*, however, has not yet been studied systematically. The diet of these limpets has only been suggested qualitatively (Guzmán & Ríos, 1986), albeit knowledge of diets are generality essential for studies of it is nutritional requirements and it is interactions with other organisms.

This study analyses the trophic significance of *N. deaurata* and *N. magellanica* by combining stomach content analysis and stable isotope ratio determination in order to evaluate nutritional requirements and likely interactions with other species.

MATERIAL AND METHODS

Sample origin and preparation

Limpets (*N. deaurata* and *N. magellanica*) were randomly collected from an intertidal boulder-cobble field at Bahía Laredo located in the eastern part of the Strait of Magellan (52°56.5´S; 70°50´W). *N. deaurata* is abundant in the lower intertidal zone while *N. magellanica* is present in the middle and upper intertidal zone. Sampling for gut content analysis was carried out during 2008/2009. Ten individuals of each species were hand-picked, preserved in 4% formaldehyde-seawater solution, placed in labeled plastic bags and transported to the laboratory at the Instituto de la Patagonia (Universidad de Magallanes) in Punta Arenas, Chile. Sampling for stable isotopes analysis was performed between January and February 2009 (austral summer). Five individuals for each species were collected and placed in labeled plastic bags and transported frozen to the laboratory at the Instituto de la Patagonia where they were stored at -20 °C prior to analysis at the Alfred Wegener Institute (AWI), Germany.

[1] Andrade, C. 2009. Estructura trófica del ensamble de moluscos en el intermareal de bloques y cantos (Bahía Laredo, Estrecho de Magallanes) Tesis de Magíster, Facultad de Ciencias, Universidad de Magallanes, Chile.

[2] Shabica, S.V. 1976. The natural history of the Antarctic limpet *Patinigera polaris* (Hombron and Jacquinot). Ph. D thesis, Oregon State University, Corvallis, Oregon, USA.

[3] Brand, T. E. 1980. Trophic interactions and community ecology of the shallow marine benthos along the Antarctic Peninsula. Ph. D thesis, University of Davis, California.

Gut content analysis

In the laboratory, the specimens were dissected and their gut contents separated. Stomachs and intestines were cut open; the content flushed into petri dishes and identified them to the finest possible taxonomic resolution under stereoscope and recorded as dietary items separately for each individual. Limpets diet was quantified using a points method (Hynes, 1950) modified by Brun (1972), Fratt & Dearborn (1984) and Dearborn *et al*. (1986). This method combines information on stomach fullness and volumetric contribution to diet of each food items. For further details see http://www.thomas-brey.de/science/virtualhandbook/consum/dipoints.html

Stable isotope analysis

Samples were lyophilized and subsequently ground to an ultra-fine powder using mixer mill. Each sample was acidified to remove $CaCO_3$ in accordance with Fry (1988) and Jacob *et al.* (2005). Stable isotope analysis including the determination of carbon and nitrogen concentrations was carried out at the stable isotope laboratory of the Museum für Naturkunde in Berlin using a Delta V Plus isotope ratio mass spectrometer.

Isotope ratios are expressed in conventional δ notation in per mil (‰) relative to universal standard:

$$\delta X_{sample} = (R_{sample}/R_{standard}) - 1 \times 1000$$

where X is ^{13}C or ^{15}N and R is the corresponding $^{13}C/^{12}C$ or $^{15}N/^{14}N$ ratio. All results are reported with respect to VPDB (PeeDee Belemnite) for $\delta^{13}C$ and atmospheric nitrogen for $\delta^{15}N$.

RESULTS

Gut content

Six food items contributed to the diet of. *N. deaurata*, green microalgae (32.5 %), brown algae (22.2 %), red algae (21.3 %), bivalves (11 %), forams (9%), and miscellaneous (<4 %) while the diet of. *N. magellanica* included five items, green microalgae (28.3 %), bivalves (27.4 %), foraminifera (20.9%), red algae (15.7 %), and miscellaneous (*e.g.* crustaceans, gastropods, all < 4 %, see Figures 1 and 2).

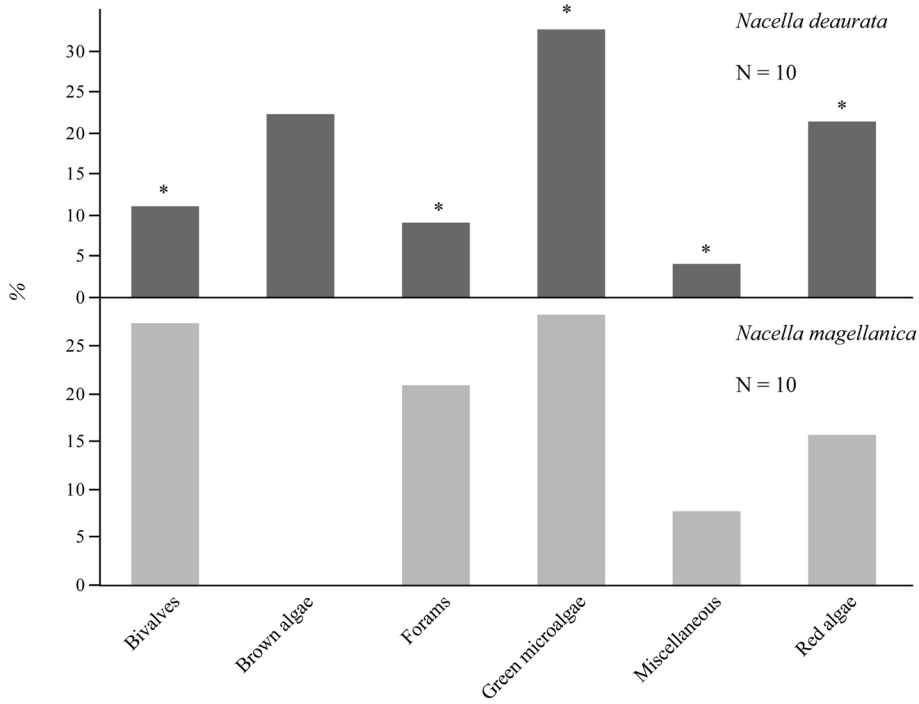

Fig. 1. Percentage contribution of food items to the diet of the limpet *Nacella deaurata* and *N. magellanica*. (*) indicates significant differences ($P < 0.05$) between species.

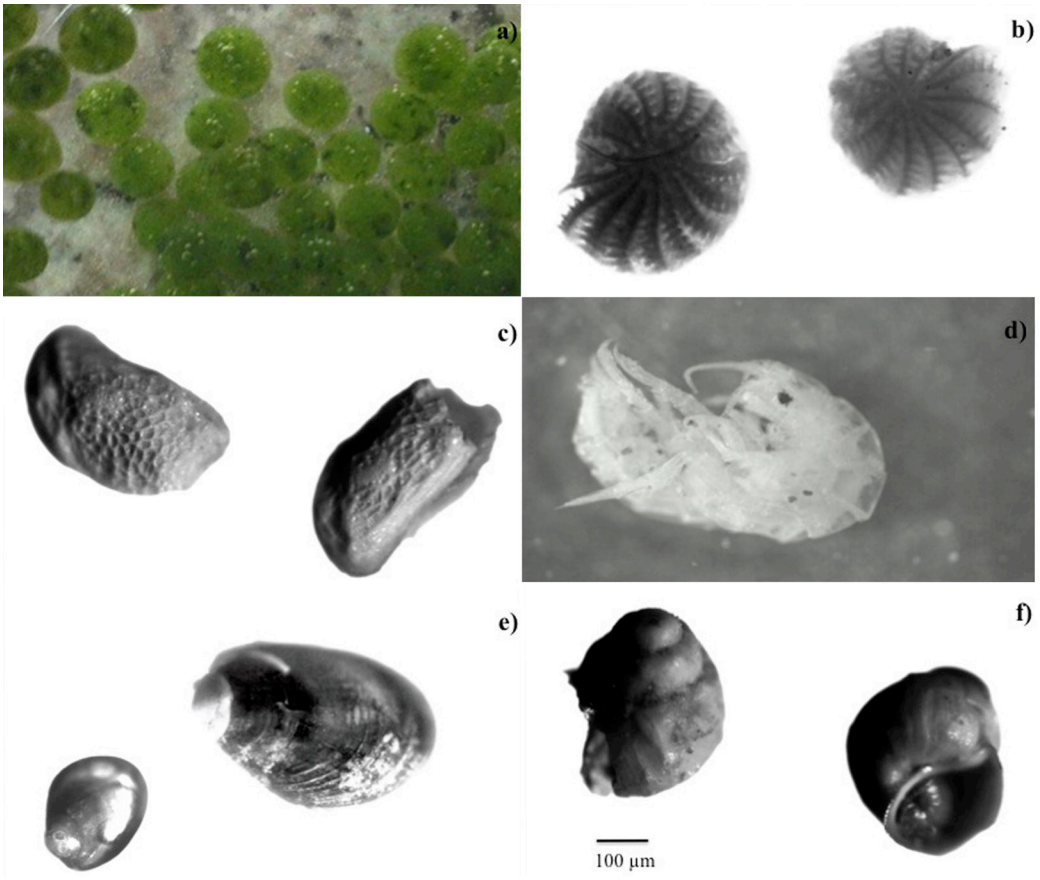

Fig. 2. Food items found in the guts of *N. deaurata* (a – c) and *N. magellanica* (d – f). a) cell agregation green microalgae *Chlorella*, b) forams *Elphidium macellum*, c) ostracoda indeterminada, d) crustacea indeterminada, e) bivalves *Mytilus chilensis* and f) gastropod *Laevilittorina caliginosa*.

Stable isotope composition

Mean $\delta^{13}C$ was significantly lower in *Nacella deaurata* (-18.1 ± 0.1 ‰) than in *N. magellanica* (-16.2 ± 1.1 ‰, one way ANOVA, $F = 14.9050$, $P > 0.0048$) whereas mean values of $\delta^{15}N$ (12.8 ± 0.2 ‰ and 12.9 ± 0.2 ‰) did not differ significantly ($P > 0.05$).

DISCUSSION

The overall share of algae in their diet indicates that both *Nacella deaurata* (76% algae) and *N. magellanica* (44% algae) preferably act as herbivorous grazers. Nevertheless, the presence of meiobenthic organisms such as micro-bivalves and foraminiferans in the guts indicate an ability of omnivorous feeding in both species. Albeit this tendency is more pronounced in *N. magellanica*, it does not show in a higher $\delta^{15}N$ ratio. The stronger preference of *Nacella deaurata* for brown and red algae may explain its distinctly higher $\delta^{13}C$ ratio (-18.1 versus -16.2), as brown algae and particularly read algae tend to have lower $\delta^{13}C$ ratios than green algae (Andrade *et al*. subm.)

Our findings coincide with other studies that report green microalgae to be the major food item for other *Nacella* species (*e.g*. Shabica, 1971; Peck & Veal, 2001) but they also contradict the common view that these limpets are herbivorous animals (*e.g.* Brêthes *et al.* 1994; Ríos & Gerdes, 1997; Mutschke *et al*. 1998). It remains to be seen whether the omnivorous feeding patterns observed here is a response to conditions specific to the site

and/or time of our study or a general feature of these species. Further work on the availability and distribution of food items in Bahía Laredo, particularly of green microalgae, may answer this question.

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