THE DAILY FOOD CONSUMPTION OF *SIGANUS FUSCESCENS*, AN IMPORTANT HERBIVORE IN SEAGRASS COMMUNITIES AT BOLINAO, PANGASINAN PROVINCE, PHILIPPINES

by

Homer B. Hernandez
Porfirio H. Aliño
Marine Science Institute
University of the Philippines
Diliman, Quezon City, Philippines

and

Astrid Jarre
International Center for Living Aquatic Resources Management (ICLARM)
MC 3 P.O. Box 1501, Makati
Metro Manila, Philippines

ABSTRACT

The feeding habits of the rabbitfish *Siganus fuscescens* (Pisces: Siganidae) were investigated in the reef flats of Bolinao, Pangasinan, Philippines. A total of 579 specimens were collected from 1989 to 1990. The sampling was done quarterly at approximately bihourly intervals during a 24 hours cycle. The species feeds exclusively during daytime. Examination of diet composition yielded seagrass as the most abundant food item (50-70% by volume). Stomach content weight analysis yielded an average daily ration of 9.46 g for fish of a mean wet weight of 27.9 g, from which population-based consumption was estimated. About 6.4% of the seagrass leaf production of the study site are consumed by this species.
INTRODUCTION

Siganids or rabbitfishes (Pisces: Siganidae) are among the most important fish groups in Bolinao, Pangasinan in terms of their ecological as well as their commercial value. Among the several siganid species present in the area, the most dominant is the white-spotted rabbitfish, *Siganus fuscescens* (sometimes erroneously referred to as *S. canaliculatus* or *S. oramin*). Although about 780 fish species have been reported for this area, the fishery is highly dependent on *S. fuscescens* both for the juvenile and adult stages (Aragones 1987, Del Norte and Pauly 1990), which are locally known as "padas" and "barangen", respectively. *S. fuscescens* is the biggest single species caught (Aragones 1987, Del Norte and Pauly 1990), i.e., contributes around 40% of the total catch of the fishermen (Del Norte et al. 1989). The adults are sold fresh or dried while the juveniles are made into fish paste.

The present study was performed in order to 1) determine the feeding habit and diet composition, 2) estimate the ingestion and evacuation rates, and 3) compare the estimates of the daily food ration of *Siganus fuscescens* during different periods of the year.

**MATERIAL AND METHODS**

Bolinao is situated at the northwestern part of the Philippine Archipelago, near the mouth of Lingayen Gulf, Luzon. The study site is part of the fringing reef along the north eastern side of nearshore Santiago Island on the lagoonal seagrass flats, covering an area of 24 km². This is a site of regular gill net and spear fishing activity for *S. fuscescens*. The site is also known for the biannual catches in fish corrals ("baklad") of big schools of juvenile siganids.

Fish sampling was done four times in the year at approximately quarterly intervals in the periods July-August 1989, November 1989, February 1990 and May 1990. A total of 579 fish were collected at approximately every two hours during a 24 hour cycle. Each bihourly sample was subdivided into two subgroups, a) for the analysis of diet composition and b) from the estimation of feeding rates from the stomach content weights (see also Table 1 for details on the sampling procedure). During the day, samples were taken from gill nets ("tabar"), whereas the fish were speared during nighttime. Different fishing methods were applied due to the fishermen's observations that the subject
species are inactive at night and thus cannot be caught by gill nets. Care was taken to select only nighttime fish samples with guts undamaged by the spearing process. The samples were put on ice immediately, transported to the laboratory and deep frozen there.

From the thawed specimens, various morphometric values were taken prior to any dissection. To determine possible differences relative to size in rates of ingestion and evacuation, size frequency analysis was performed. This did not show any clear bimodal distribution (Fig. 1), so the data were not separated into different size classes. However, the two largest fish from the August-September samples were omitted from further analysis.

The fish were subsequently dissected without damaging the stomach, which was then separated from the fish. The stomach content was removed, its volume obtained by the water displacement method (Hellawell and Abel 1971) and the wet weight taken. To estimate the maximum stomach volume, the empty stomach was sealed by artery forceps at both ends and gently injected to fullness with water using a graduated syringe.

In the samples for the analysis of food composition, contents were taken out and bathed with freshwater in a petri dish. The food was separated into gross categories (e.g. "crustacea", "algae", etc.), the relative proportion (by volume) of which was then estimated and quantified in an arbitrary scale of 0 to 5 where, 0 = 0-1%, 1 = 2-10%, 2 = 11-25%, 3 = 26-50%, 4 = 51-70%, and 5 = 71-100%.
The stomach contents of the fish sampled were recomputed for an "average fish" based on the mean wet weight of the total (24 hours) sample and the values for each sampling time were averaged. Daily ration was estimated according to Jarre et al. (1989) from a slight modification of two models computing the time trajectory of stomach contents presented by Sainsbury (1986). The first ("Model 1") is based on a constant ingestion rate; the second ("Model 2") is based on an ingestion rate decreasing with time, i.e., with increasing stomach contents. For both models, simple exponential evacuation is assumed. We used only Model 1 because the other model, which needs more parameter did not converge in all cases. The daily ration is computed as the integral of the contents trajectory over the feeding period. A population based food consumption estimate was obtained from the daily ration and length-based growth and mortality parameters (Pauly 1986).

RESULTS

The time trajectory of relative stomach fullness of the fish is given in Fig. 2. Initial findings showed that seagrasses were the dominant diet component (Table 1).

The time trajectory of stomach contents and the estimated feeding parameters are given in Fig. 3 and Table 2, respectively. Feeding time seems to be inversely proportional to daylength.

A program for IBM compatible microcomputers called "MAXIMS", implementing these and related routines for estimation of daily ration and population food consumption Q/B, is available from the last author.
Likewise, the estimated daily food ration (4-14 g/day) shows a similar trend.

From the 543 fish selected for stomach weight analysis (Fig. 1), the length-weight relationship

\[ \text{Wet weight} = 0.014 \times \text{Total length}^{2.877} \]

was derived. Based on this, the population parameters provided by Del Norte and Pauly (1989) and our estimates of daily ration of 9.5 g for an "average" specimen of 27.9 g wet weight, the population food consumption (Q) over biomass (B) was computed. The average daily Q/B of the four sampling periods was 0.35 (Table 3), i.e. the *S. fuscescens* population consumes 35% of its weight per day. With a biomass estimate of approximately 40 t for the study area (Del Norte and Pauly 1990), this results in a total consumption of 14 t/day. According to our observation, an average 64% of this is seagrass, i.e. *S. fuscescens* consumes 9 t.day\(^{-1}\) of seagrass in the study area, or 0.38 t.km\(^{-2}\).day\(^{-1}\), respectively.

Based on the estimated average evacuation rate of about 1.8 g.hr\(^{-1}\), about 84% of the stomach contents is evacuated per hour. Integrated over a 24 hours cycle, this leads to a total evacuation of about 4.6 g of a single specimen of 27.9 g (to detritus), and hence to an estimate of egestion of about 48% of the daily ration. The rest is respiration, excretion, and growth.
DISCUSSION

Seagrass has a low nutritive value (Klumpp and Nichols 1983). Considering that it is the major food item of *S. fucscens*, this may explain the relatively high estimates obtained for ingestion and egestion rates and, accordingly, daily ration. The fish have to consume a lot of seagrass relative to their body weight in order to satisfy their nutritional requirements. Hence, they put a considerable grazing pressure on the seagrass. However, with the high seagrass leaf production of 0.52 g.m⁻².day⁻¹ (ash free dry weight), corresponding to 5.92 t.km⁻².day⁻¹ (wet weight) (R. Rol'lonb, pers. comm.), the estimated consumption by *S. fucescens* amounts to only 6.4% of the new seagrass production.

With the wide cover of seagrass in the area, it cannot be assessed whether it is the "availability" and not the "palatability" which guides the fish to eat seagrass. Von Westernhagen (1973) mentioned that the abundance of food item determines the choice of food, in that the most abundant food item is the most likely to be eaten though not necessarily the most palatable. Bryan (1975) also emphasized that it is pointless to compare food habit and food preference because the stomach content of the wild fish reveal not the feeding preference but the particular grazing area immediately prior to capture. In one fish sample where seagrass was absent in its stomach, the green algae *Dictyota* sp. was the most dominant component of its

bMSTI, University of the Philippines, Diliman, Quezon City, Philippines
contents. Also, in an experiment done in rearing tanks, the fish preferred algae (von Westernhagen 1973). In this respect, our results are also consistent with those of Palomares and Pauly (1989) for *Siganus canaliculatus* and *S. spinus*, who estimated a Q/B of 16.9 % and 11.5 % per day, respectively. These results are lower than our overall average results, although the May, 1990 (12.7%) sample is within this estimated range. On the other hand, the above fish investigated by Palomares and Pauly (1989) were fed on algae, invertebrates and "boiled squash", a diet which is more nutritious. Invertebrates were also present in our field samples, though not in great proportion relative to the other food items. With the frequency of occurrence observed (Table 2), these invertebrates can be either incidentally ingested with the seagrass, or they may be ingested selectively to compensate for the nutrients not available in seagrasses; our present knowledge does not allow a decision on this matter.

As mentioned earlier, there seems to be an increasing trend of the daily food ration towards November, 1989 and a decrease is observed thereafter until around May, 1990. This apparent pattern cannot be satisfactorily explained based solely on temperature and seagrass production. What would seem to be the likely explanation is that which relates the feeding rate and the reproductive condition of *S. fuscescens*. At the moment, this proposition is being tested through gonadal analysis of the samples. Our stomach content analysis showed that *S. fuscescens* is a diurnal feeder. The variation in stomach fullness (Fig. 2) as contrasted to the stomach content weight analysis
(Fig. 3) may be explained by the difference in the two approaches (volumetric vs. weight), i.e. a bigger volume may have been accumulated, though not necessarily with a heavier biomass. The overall consistency of the results on the diel feeding rhythm are further supported by several in situ observations of the fish during moonless nights exhibiting a semistuporous state resembling sleep similar to the description of Randall (1961) for Acanthurus triostegus. This is consistent with field observations of spear fishing operation where the fish lay motionless ("asleep") and camouflaged amongst the sandy-with-seagrass substrate thus becoming easy targets for the spear fishermen at night time.

Our results indicate that *S. fuscescens* is indeed an important seagrass consumer of the reef flat complex of Bolinao. Further studies will aim to determine the nutritional basis of this feeding habit and will refine the abovementioned results, such as those referring to its reproductive condition.

**Acknowledgements**

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REFERENCES


List of Figures

Fig. 1. Length frequency distribution of *S. fuscescens* collected at Bolinao, Philippines.

Fig. 2. Relative stomach fullness (by volume) of *S. fuscescens* at Bolinao, Philippines. Standard deviation bars are shown.

Fig. 3. Estimated time trajectory of stomach contents of *S. fuscescens* at Bolinao, Philippines. Datapoints are shown.

List of Tables

Table 1a. Details on the number of fish examined per sampling period.

Table 1b. Details on the stomach contents composition of *S. fuscescens* at Bolinao, Philippines. The relative volume of the food items is quantified in a scale of 0 to 5, where 0 = 0-1 %, 1 = 2-10 %, 2 = 11-25 %, 3 = 26-50 %, 4 = 51-70 %, and 5 = 71-100 %.
Figure 1
Table 1a. Details on the number of fish examined per sampling period.

<table>
<thead>
<tr>
<th>DATE</th>
<th>SAMPLES FOR STOMACH CONTENT WEIGHT ANALYSIS</th>
<th>SAMPLES FOR DIET COMPOSITION ANALYSIS</th>
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<td>September 27, 1989</td>
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<td>February 1-2, 1990</td>
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<td>May 23-24, 1990</td>
<td>120&lt;sup&gt;a&lt;/sup&gt;</td>
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<sup>a</sup>10 bihourly samples  
<sup>b</sup>added samples during corpuscular period  
*see Fig. 2 for further details

Table 1b. Details on the stomach contents composition of *S. fuscescens* at Bolinao, Philippines. The relative volume of the food items is quantified in a scale of 0 to 5, where 0 = 0-1 %, 1 = 2-10 %, 2 = 11-25 %, 3 = 26-50 %, 4 = 51-70 %, and 5 = 71-100 %.

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<tr>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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</table>

<sup>a</sup> Stomachs were empty for the other samples (20-22 and 22-24 h (24.8.1989)), and 2-4 and 4-6 h (23.8.). Total sample size was 13 specimens for every point in time except for the interval 0-2 h (11 specimens). In each case three specimens were taken for food items analysis, and the remaining ones for stomach weight analysis.
Table 2. Summary of estimated parameters for the food consumption of *Siganus fuscescens* in Bolinao, Philippines.

<table>
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<td>Ingestion rate</td>
<td>0.9443</td>
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<td>0.6691</td>
<td>0.2943</td>
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<tr>
<td>Evacuation rate</td>
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<td>1.4012</td>
<td>3.4951</td>
<td>1.3669</td>
</tr>
<tr>
<td>Amount evacuated (%)</td>
<td>55.4</td>
<td>53.6</td>
<td>28.7</td>
<td>55.2</td>
</tr>
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<td>Time feeding begins (hr)</td>
<td>04:70</td>
<td>05:00</td>
<td>06:47</td>
<td>05:38</td>
</tr>
<tr>
<td>Time feeding stops (hr)</td>
<td>17:00</td>
<td>18:90</td>
<td>19:45</td>
<td>17:55</td>
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<tr>
<td>Daily food ration (g)</td>
<td>11.61</td>
<td>13.95</td>
<td>8.69</td>
<td>3.58</td>
</tr>
<tr>
<td>Daily population food consumption (%)</td>
<td>38.05</td>
<td>52.32</td>
<td>35.36</td>
<td>12.71</td>
</tr>
</tbody>
</table>

Mean: 9.46

Mean: 34.61