A short note on a euphausiid, *Euphausia pacifica*, an important food source to demersal fishes in Uljin area, the eastern coast of Korea

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(Received: February 22, 2007; Revised received: December 27, 2007; Accepted: January 11, 2008)

**Abstract:** Gut contents of two species of demersal fishes, Pleurogrammus azonus and Dasycttus steiger were examined to understand the importance of a euphausiid, *Euphausia pacifica* as prey of demersal fishes at coastal waters off Uljin, the eastern Korea where aggregations of large amounts of the euphausiids were found. Euphausiids were significantly important food source to the species of fishes examined. All of the stomachs of *P. azonus* examined contained euphausiids (% of a food item frequency occurred, \( F = 100\% \)) in March and June 2003. Individual numbers of euphausiids in the guts ranged from 10 to 540 individuals per gut. Percents of individual number of food item were 99.60 and 99.96 for euphausiids in March and June 2003, respectively. The guts of *D. steiger* also frequently contained euphausiids (\( F = 86.67\% \) and 79.20\%) in October 2002 and June 2003, respectively), while amphipods (\( F = 36.67\% \) and 16.17\%) and other fishes (\( F = 33.33\% \) and 45.80\%) were also often observed. Pleurogrammus azonus preferred larger euphausiids with size range 16.9-28.4 mm, while the range of euphausiids distributed in the ambient water column was much broader (from eggs to adults).

**Key words:** Demersal fishes, Dasycttus steiger, Pleurogrammus azonus, Gut contents, Euphausia pacifica

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**Introduction**

A large amount of euphausiids, *Euphausia pacifica*, has been found in the eastern Korean water adjacent to Uljin in the study using a scientific fishfinder w/ 200 kh transducer and multiple horizontal-towing nets (Hwang et al., 2005). They often formed near-bottom aggregation in the depth of 100-200 m approximately during the day and performed diel vertical migration actively with ontogenic changes in distributional area. High-density demersal layers of euphausiids have been also detected in the submarine canyons off Geoges Bank where high estimates of squid and demersal fish production attributed to the ecosystem (Greene et al., 1988). This study area off Uljin shows resemblance in bottom topography with Geoges Bank in terms of submarine canyons developed off the extension of Hupeo Bank with 200 m in approximate depth. The submarine canyons may cause a tunneling effect that would further concentrated the animals at the bottom (Greene et al., 1988).

Euphausiids in general play an important role in pelagic marine ecosystem, providing link in the food chain between lower trophic level plankton and higher trophic level consumers such as pelagic invertebrates, fishes, birds and mammals (Mauchline, 1980; Greene et al., 1988). Although euphausiids are preferable food item to commercially important fishes (Yang, 1996; 1999), little attention has been paid to fish-euphausiid interaction in eastern Korean coast.

We examined gut contents of commercially important and dominant demersal fishes in the water of Uljin, eastern Korea to understand the role of euphausiids as prey in contribution to the ecosystem.

**Materials and Methods**

Samples were captured near the area where euphausiids aggregations were observed with using an ecosounder and nets, or nets in the previous study (Hwang et al., 2005, Fig. 1). Among the fishes commercially caught in fishery nets set close to the region of euphausiids aggregations, only two fish species, *Pleurogrammus azonus* (arabesque greenling or Okhostk atka mackerel) and *Dasycttus steiger* (spinyhead sculpin) were available with sufficient amounts for data in the collection of October 2002 (only in *D. steiger*), March 2003 (only in *P. azonus*) and June 2003, while other species captured with small amounts also often included euphausiids in their guts. We fixed dissected guts or only food items with 5% of formaldehyde solution from 30 and 68 individuals of *P. azonus* in 25 March and 7 June, 2003, and 30 and 25 individuals of *D. steiger* in 29 October, 2002 and 7 June, 2003, respectively, then counted the food items using a stereomicroscope (MZ 12.5, Leica, Germany). Because most of the food items were *Euphausia pacifica* in *P. azonus* and *D. steiger* guts, we show the data only as% of the occurrence frequency of a food item to all examined gut samples (\( F \)) and% of number of individuals of a food item to that of whole food items (\( Cn \), Godon et al., 1985). Gut contents of some specimens of *D. steiger* were digested in much progress, and data of \( Cn \) were not available.
We used a multiple set of closed-open-close nets (mesh aperture 300 μm, mouth diameter 0.6 m) for collecting samples of euphausiids in 4-5 June, 2003 and compared the body-lengths of the Euphausia pacifica from the net collection with those of gut contents of the Pleurogrammus azonus captured in 7 June, 2003. The body length was measured from the anterior tip of the rostrum (cephalothorax for calyptopis) to the distal end of the telson.

Results and Discussion

Euphausiids were significantly important food source to the species of fishes examined (Fig. 2). All of the stomachs of Pleurogrammus azonus examined contained euphausiids (F = 100%) in March and June 2003 (Table 1). Individual numbers of euphausiids in the guts ranged from 10 to 540 ind / gut, probably according to feeding rhythm of fish and/or different capturing time which may have influence on progress of digestion. Squids were the only alternative of food item found in P. azonus (Cn = 99.60 and 99.96 for euphausiids in March and June, 2003, respectively). The guts of Dasyctonus steiger also frequently contained euphausiids (F = 86.67 and 79.20% in October 2002 and June 2003,
Table 1: Gut contents of two species of demersal fishes, Pleurogrammus azonus, Dasycottus steiger. F is % of the occurrence frequency of a food item to all examined gut samples and Cn is % of number of individuals of a food item to that of whole food items.

<table>
<thead>
<tr>
<th>Fish species</th>
<th>Date of capturing</th>
<th>No. of individual examined</th>
<th>Body length (cm) Mean</th>
<th>Range</th>
<th>Food organisms</th>
<th>Euphausiids</th>
<th>Cephalopods</th>
<th>Amphipods</th>
<th>Fish</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pleurogrammus azonus</td>
<td>25 March, 2003</td>
<td>30</td>
<td>29.3</td>
<td>17.8-35.4</td>
<td>100.00</td>
<td>99.60</td>
<td>3.33</td>
<td>0.13</td>
<td>13.33</td>
</tr>
<tr>
<td></td>
<td>7 June, 2003</td>
<td>68</td>
<td>27.1</td>
<td>19.7-32.4</td>
<td>100.00</td>
<td>99.96</td>
<td>1.47</td>
<td>0.04</td>
<td>0.00</td>
</tr>
<tr>
<td>Dasycottus steiger</td>
<td>29 October, 2002</td>
<td>30</td>
<td>35.6</td>
<td>29.4-39.4</td>
<td>86.67</td>
<td>na</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>7 June, 2003</td>
<td>25</td>
<td>32.8</td>
<td>24.2-38.5</td>
<td>79.20</td>
<td>na</td>
<td>0.00</td>
<td>0.00</td>
<td>16.67</td>
</tr>
</tbody>
</table>

Fig. 3: Size range of Euphausia pacifica in the gut of Pleurogrammus azonus and ambient water column in June 2003.

respectively), while amphipods (F = 36.67% and 16.17%) and other fishes (F = 33.33 % and 45.80%) were also often observed.

The fishes showed great preference to euphausiids, even though they can feed on much larger squids (60mm - 80mm approximately) or fishes. The most of fishes or some euphausiid samples found in the gut of Dasycottus steiger were much digested and not adequate to measure body lengths and even number of individuals, while compound eyes or prey fish-bone were often found (Fig. 2). Cannibalism of D. steiger was also observed in an individual in June 2003. On the other hand, Pleurogrammus azonus was preferred larger euphausiids which size range was 16.9 - 28.4 mm, while the range of euphausiids distributed in the ambient water column was much broader according to life stages from nauplius to adults (Fig. 3).

Pleurogrammus azonus is distributed widely in Northwest Pacific from Primorski Krai in Russia, the Sea of Okhotsk, the Kuril Islands to Ibaraki Prefecture and Tsushima in Japan to the Yellow Sea (Yabe, 1983; Shinhara and Amaoka, 1994; Shinhara et al., 1994; Sokolovskaya et al., 1998; Mecklenburg and Eschmeyer, 2003). The adults are benthic, while the fry often forms epipelagic schools (Mel’nikov, 1996a,b). Even though it is very important commercially in Korea and Japan, and may be an important food source to other fishes such as chum salmon (and vice versa) and seabird (Volkov et al., 1995; Nagasawa and Kaeriyama, 1995; Nagasawa, 1998; Takahashi et al., 2001), its role as predator is little known in recent studies. Closely related species called as atka mackerel, Pleurogrammus monopterygius, is known to be planktivore (Oriol, 1997). The populations distributed off Amchitka Island feed on crustacean plankton such as hyperiid amphipods, calanoid copepods, planktonic larvaeceans (Simenstad et al., 1977). The most important food source of the populations off Aleutian Islands was euphausiids, while benthic crustaceans, chaetognaths, tunicates were also found in the guts (Yang, 1996; 1999).

Dasycottus steiger is epibiont to bathydemersal and widely distributed in the coastal area of the North Pacific, the East Sea, the Bering Sea, Aleutian chain, Strait of Georgia, Burrard Inlet, English Bay, east coast of Vancouver Island, west coast of Graham Island and southeast Pacific to Washington (Hart, 1973; Eschmeyer et al., 1983; Lamb and Edgell, 1986; Allen and Smith, 1988; Shinhara et al., 1994). Jewett et al. (1989) found crustaceans are the most preferred prey among benthic invertebrates and fishes.

The results of this study that feeding of Pleurogrammus azonus concentrated to Euphausia pacifica may lead to several possible explanations. The investigated fishes were all demersal, and may encounter the near-bottom aggregation of euphausiids. However, we have no information about feeding time and vertical diel movement of the fishes and the fish captures were made from daytime to early morning of next day. Thus, there is another possibility that P. azonus fed on the euphausiids in mesopelagic or epipelagic zone at night where dense Deep Scattering Layers (DSLs) of ecosounder were recorded by euphausiid population (Hwang et al., 2005). Regardless whether the feeding occurred near-bottom or not, the euphausiids were the most preferable food item, and their abundance may provide so enough amounts that other food items were little chosen. Size preference of P. azonus may be explained that euphausiid adults formed aggregation more nearer to bottom than larvae, otherwise size-selective.
predation of the fish on euphausiids prey occurred for their optimal energy usage, even though they could encounter prey animals of broad range in size.

Acknowledgments
This study was supported by Nuclear R & D Program of MoST (Ministry of Science and Technology), Prevention of bio-impingement against power plant intake (PN52700). We thank Captain M. S. Yoon, the skipper of a fishing boat, Wonyoung-Ho, and Mr. J. S. Kim in Korea Institute of Coastal Ecology for their help in sampling at sea. We also thank Dr. J. G. Myong for his encouragement and comments on this publication.

References