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INGESTION LEVEL AND RE-CONDITIONING ONTO FROZEN DIETS BY JUVENILE LARGE-BELLIED SEAHORSES (*HIPPOCAMPUS ABDOMINALIS*)

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ABSTRACT. *The ingestion level and re-conditioning onto frozen diets for 15-month-old juvenile big-bellied seahorses (Hippocampus abdominalis) were investigated. Seahorses (previously fed on frozen amphipods) were fed with frozen unenriched Artemia, enriched Artemia and amphipods. It takes at least two weeks for juvenile seahorses to fully accept newly introduced diets. The ingestion rates calculation of 15 month old seahorses ranged from 9.02 ± 0.31 to 11.62 ± 0.23 % of their body weight (on wet weight basis). It was observed that even when seahorses were offered the same diet they were fed before the trial, the ingestion rate appeared depressed for the same period but at a reduced level. Therefore, transferring the seahorses to the experimental containers appears to have had an impact.*

KEYWORDS. Seahorses, diet, ingestion level

INTRODUCTION

Syngnathids, particularly seahorses, have been traded around the world for decades. These unique marine animals are sold primarily for use as traditional medicine and aphrodisiacs, aquarium fishes, foods and curios (Vincent 1995b). Given their high commercial value and market demand, many species are vulnerable to exploitation and considered as a threatened species (Vincent 1995a). At least 32 nations around the world are involved in trading seahorses, with active involvement of Australia, Belize, Brazil, China, Dubai, Ecuador, India, Indonesia, Japan, Kuwait, Malaysia, Mexico, New Zealand, Pakistan, Singapore, Spain, Sri Lanka, Tanzania, Taiwan, Thailand, the USA and Vietnam (Vincent 1995b). In light of such demand, the development of intensive culture technique may obviate further depletion of wild stocks.

Increasing interest has been shown in the commercial culture of seahorses. *Hippocampus abdominalis* has been identified as a candidate for aquaculture (Forteath 1997). This species, also known as the large-bellied seahorse, are common fish in coastal region of temperate Australia, Bass Strait Islands and along the Tasmanian Coast (Forteath 1997) and coastal New

Zealand (Paulin 1995; Woods 1998). As one of the largest seahorse species known, they have advantage to enter the Asian medicinal market. Furthermore, *H. abdominalis* is not readily available in many aquarium markets due to its geographic restriction and laws regulating its wild capture (Woods 2000). Apart from that, *H. abdominalis* appeared to breed throughout the year (Boyden 1995) and could achieve maturity as early as 4 months old (Forteath, pers. comm.).

One of the major obstacles in the commercial production of seahorses has involved feed. Unlike many marine fish, there is no artificial weaning diet for juvenile seahorses. In addition, seahorses do not have larval stages and are born as juveniles. After being fed on live diets such as *Artemia* nauplii, seahorse growers normally switch to frozen diets such as frozen mysid, krill, amphipods and enriched adult *Artemia* (Seahorse Australia Ltd.). Frozen zooplankton has been used as a weaning diet for early stage marine fish for quite sometime (Fluchter 1980; Grabner et al. 1982). As non-living diets appear to be an easier option for feeding larger juvenile and adult seahorses, knowledge of ingestion rate and acceptability of the frozen diets is important. Prein (1995) stated that some seahorse species could be accustomed to accepting nonliving food, however no further investigation was made on the performance of these frozen diets. Similarly, no ingestion levels have been reported in the literature by facilities using frozen feeds to grow seahorses. Thus, this study was conducted to investigate the consumption rates of larger juvenile *H. abdominalis* when offered different types of frozen diets (frozen amphipods, frozen unenriched *Artemia* and enriched *Artemia*) and to determine the time taken to adapt and fully accept the newly introduced diet.

MATERIALS AND METHODS

Rearing Facilities

This study was conducted in a seahorse research room located at the Key Centre for Teaching and Research in Aquaculture, University of Tasmania, Launceston. The light regime used in this room was 12L:12D (lights on at 0700 h). The room was maintained at 18C. The rearing system used was a recirculating system consisting of 9 x 25L natural colour fiberglass tanks, a 50L settlement tank, a 50L sump, biofilters, solids removal and aeration. A circular air tube was attached to the base of the internal stand-pipe in each fiberglass tank to provide (a tiny stream of bubbles) aeration and to prevent blockage of the screen. A submersible pump, placed in the sump, circulated the water. Substrate for seahorses was provided in each tank in the form of a ring of light-coloured plastic mesh (bar length of 3cm).

Water Quality Management

Salinity was measured daily while all other parameters were measured once a week. Experimental conditions were temperature (17.74±0.12°C), dissolve oxygen (7.30±0.12mg/l), pH (8.4±0.00) , total ammonia (0.35±0.06 mg/l), nitrite (1.64±0.36 mg/l), and nitrate (9.00±1.00 mg/l).

The animals

Cultured seahorses were 15 months old at the start of experiment. These animals were raised in the same research room and exposed to the same environment as the trial system and were fed frozen amphipods (thawed) before being used for this trial. Treatments were randomly assigned to the 9 tanks of the rearing to give three replicates of three treatments. Ninety seahorses were weighed and randomly distributed among these 9 tanks with a sex ratio of 1:1 (10 seahorses each tank). Initial and final wet weights were recorded. Animals were weighed individually and excess moisture was removed using paper towel prior to weighing the animals. Wet weight was measured by placing the seahorse in a beaker of water to minimize handling stress.

The Diet

Three different diets were tested in this trial i.e. frozen unenriched *Artemia* instar II as a control diet, frozen enriched *Artemia* instar II and frozen amphipods. *Artemia* were enriched for 16h with Super Selco at 0.6 g/l. Seahorses were fed twice daily, at 0830 and 1700 h for 28 days. Frozen *Artemia* and amphipods were thawed before being given to the animals. Diets were weighed prior to distribution to the tanks. A set feeding time of 30 min used for each meal. After 30 minutes, uneaten feed was siphoned from each tank and was weighed to determine consumption rate of the seahorses (weight feed delivered weight uneaten feed).

Calculations

1. The total amount of different diets consumed per seahorse from day 0 to 28 were determined as follows:

   Total amount of food (g)/seahorse
   = Amount eaten (g)d_0 + amount eaten (g)d_1 +……..+ amount eaten (g)d_{28}

   with d_0, d_1 … d_{28} are in days.

2. Ingestion rates were determined when the seahorses started to feed at a stable rate (after week 2) :

   Ingestion rates (% of body weight/seahorse/day on a wet weight feed to wet weight seahorse basis)

   = (Amount of food (g)/wet weight seahorse) x 100

Statistical Analysis

Appropriate one-way ANOVA were used to compare daily food intake, total food consumed over 28 days, final wet weight of seahorses, and consumption rates (tank means) among dietary treatments. Homogeneity of variances was tested using Lavene's test and multiple comparisons among treatments were performed with Tukey HSD post-hoc test. The probability level of significance was set at $p=0.05$. The statistics package SPSS v9.0 for Windows was used for all statistical analyses.

RESULTS

It took at least two weeks for 15 months old *H. abdominalis* (previously fed on amphipods) to fully accept newly introduced diets, unenriched and enriched *Artemia* as compared with less than two weeks when given the same diet, amphipods (Figure 1). There was significant difference ($p=0.008$) between the total amounts of three different diets consumed over 28 days. However, the total amounts of enriched and unenriched *Artemia* consumed over 28 days were not significantly different ($p>0.05$). The highest amount of food consumed was the amphipod diet (10.75 ± 0.46 g), followed by enriched *Artemia* (9.51 ± 0.55 g) and unenriched *Artemia* (7.76 ± 0.22 g) (Figure 2). This is reflected in their wet weight at the end of trial (day 28), where wet weight of juveniles fed amphipods was highest compared to those fed enriched *Artemia* and unenriched *Artemia* (Figure 3). There was no significant difference ($p=0.188$) in ingestion rates among dietary treatments. Juvenile *H. abdominalis* consumed unenriched *Artemia*, enriched *Artemia* and amphipods about 9.02 ± 0.31, 11.62 ±1.47 and 10.26 ± 0.14 % body weight per day when they settle down after week two (Figure 4).

DISCUSSION

This study has endeavored to establish the basic knowledge on ingestion levels and re-conditioning on diets for juvenile seahorses in captivity. Unlike other marine fish, weaning diets for seahorses is unknown or rather unavailable. After being fed with live *Artemia* nauplii or other zooplankton nauplii such as copepods, seahorse growers usually switch to frozen diets (eg. frozen mysids, krill, amphipods, adult *Artemia* etc.) at the later stages (larger juveniles and adults). However, there is no published data on the ingestion levels of frozen diets and their acceptance of newly introduced diets. In the present study, seahorses took about two weeks to fully accept newly introduced diets (unenriched and enriched *Artemia*). As very low amounts of unenriched and unenriched *Artemia* were consumed during the first two weeks, these juveniles did not grow very well during the trial. The result suggests re-conditioning on diets may take a long time and could affect growth rates of juvenile seahorses. The ingestion rate obtained on amphipod revealed that ingestion rate of seahorses was also affected by environmental factor.

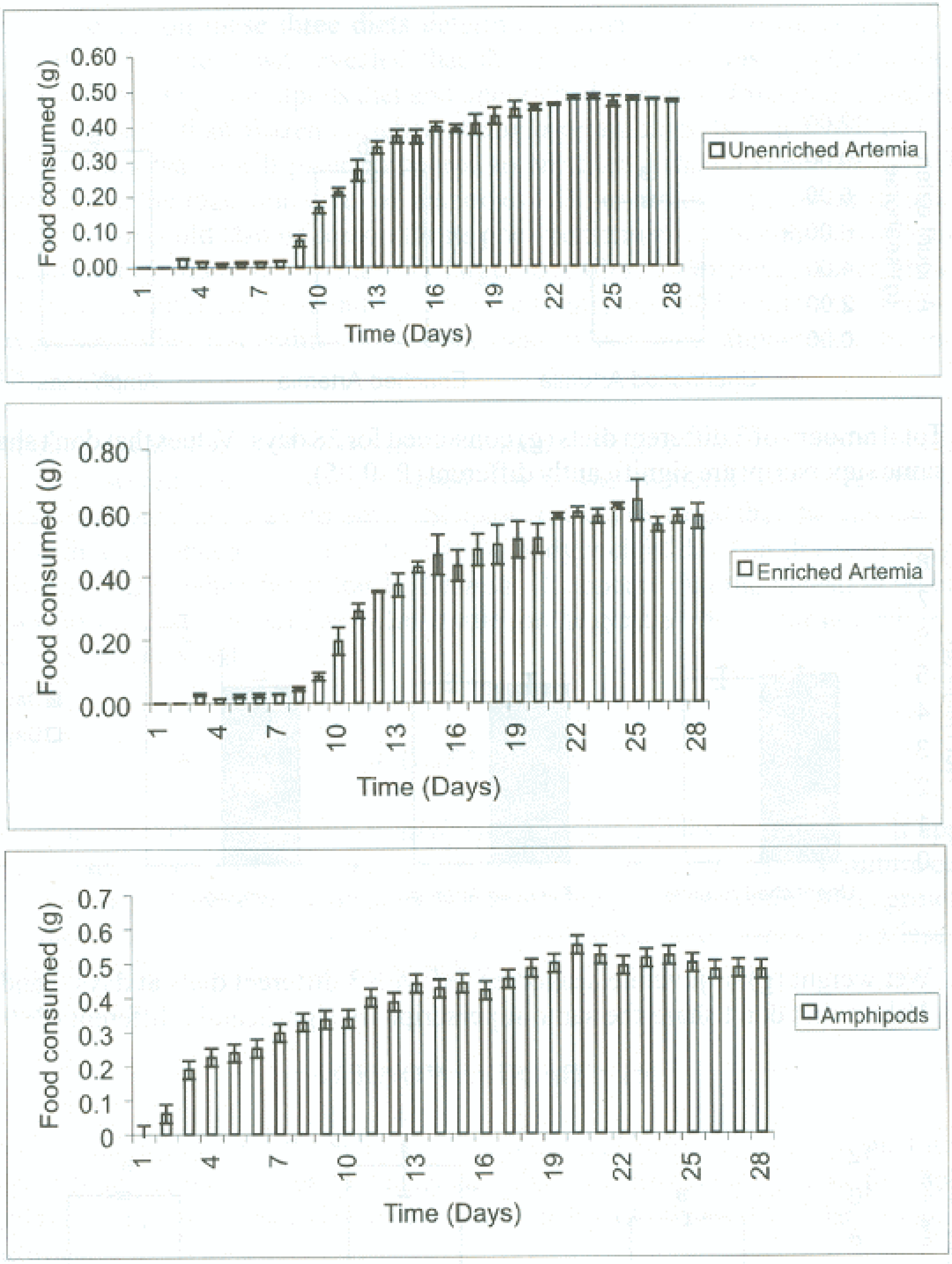

Figure 1. Daily consumption (g/seahorse) of unenriched *Artemia,* enriched *Artemia* and amphipods for 28 days

It was observed that even when seahorses were offered the same diet they were fed before the trial, the ingestion rate appeared depressed for the same period but at a reduced level. Therefore, transferring the seahorses to the experimental containers appears to have had an impact.

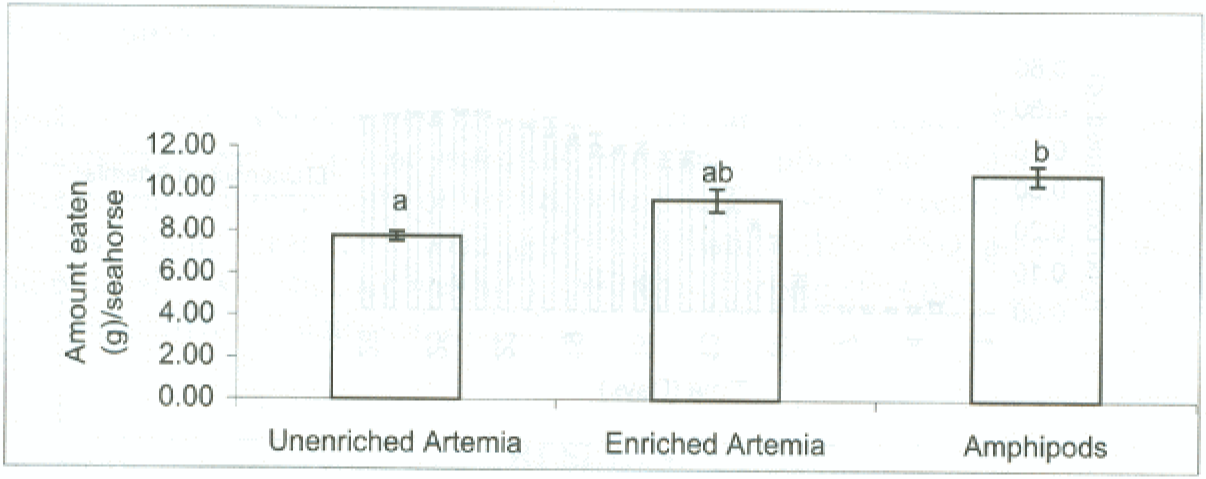

Figure 2. Total amount of 3 different diets (g) consumed for 28 days. Values that don't share the same superscript are significantly different (P<0.05).

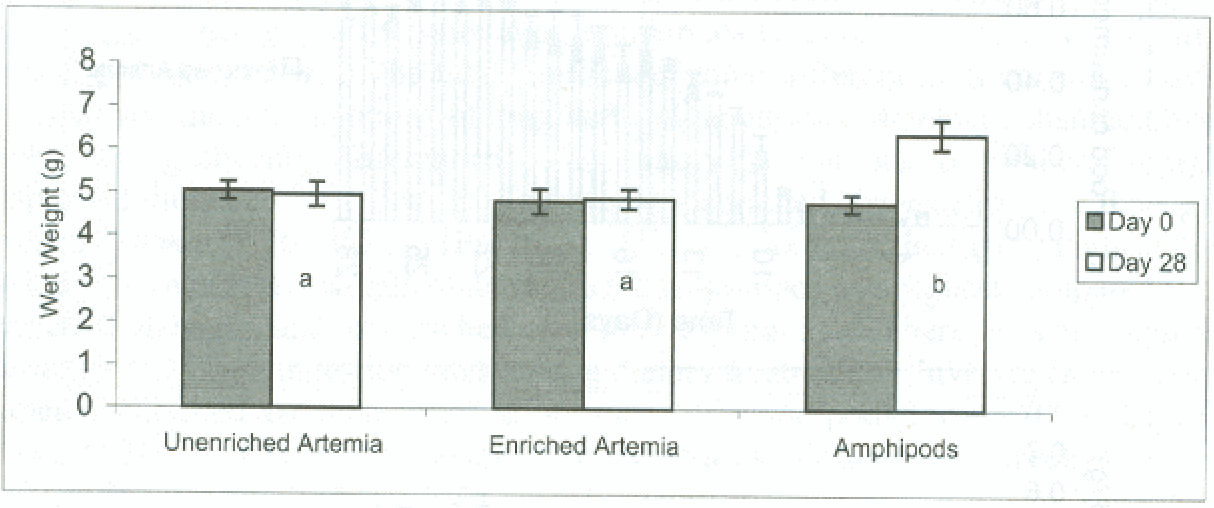

Figure 3. Wet weight (g) of juvenile seahorses fed with 3 different diets at days 0 and 28. Values that don't share the same superscript are significantly different (P<0.05).

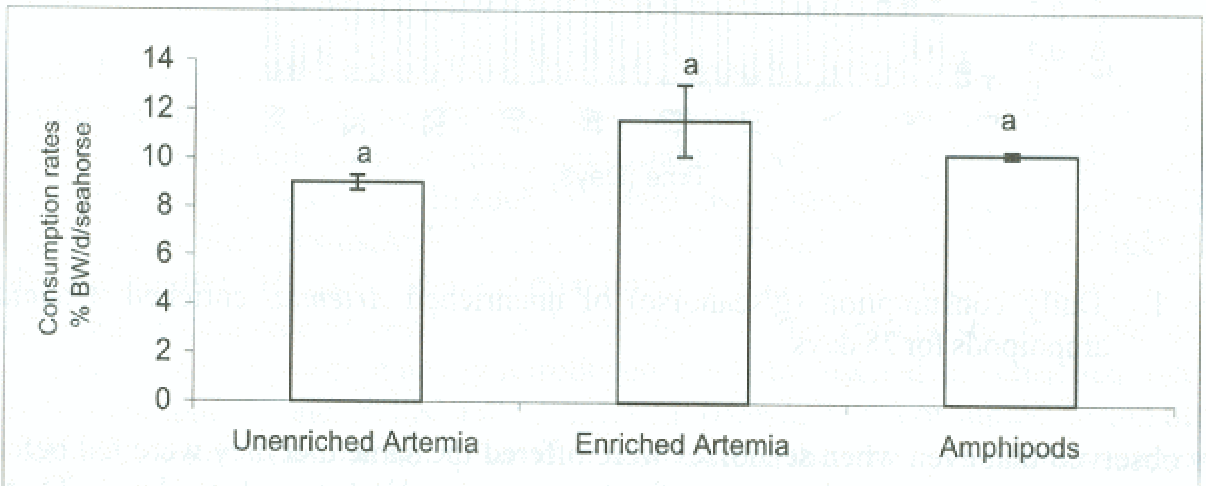

Figure 4. Consumption rates (% of body weight per day on wet weight basis) of juvenile seahorses fed with 3 different diets after week 2. Values that don't share the same superscript are significantly different (p<0.05).

The ingestion levels on these three diets determined after week two (days 16-28) when the juveniles started to settle down revealed that the ingestion rate was highest in the enriched *Artemia* diet, followed by amphipods diet and unenriched *Artemia*. Frozen unenriched *Artemia* appeared less suitable than frozen enriched *Artemia* or amphipods. In terms of colouration, unenriched *Artemia* was much paler compared to enriched *Artemia* (Pers. obs.). This factor could contribute in the ingestion level of seahorses. Other factors such as nutritional value of unenriched *Artemia* could also be reason for its poor performance. Seahorse Australia Ltd. has been using different types of frozen diets for larger juveniles, for example frozen enriched adult *Artemia*, unenriched adult *Artemia* and mysids. The results obtained from the present study have quantitatively identified re-conditioning periods and which diets appeared to be more easily accepted by seahorses.

The ingestion rates calculation of 15 month old seahorses ranged from 9.02 ± 0.31 to 11.62 ± 0.23 % of their body weight (on wet weight basis). There was no significant different ($p>0.05$) in ingestion rates among dietary treatments. Shapawi (2001) reported that the ingestion rates of 4 weeks old seahorses ranged from 1.95 to 2.46 % body weight/day (on dry feed weight to wet seahorse weight basis) when fed instar II *Artemia*. It appears that the ingestion level of larger seahorse was lower than younger one. This is true for the general idea of the decreased feed rates when body weight increased.

CONCLUSION

Re-conditioning on diets for juvenile *H. abdominalis* takes at least two weeks. It appears that juvenile seahorses not only have to adapt to the new diets but also to the new culture conditions. The result suggests re-conditioning on diets may take a long time and could affect growth rates of juvenile seahorses. It was appeared that frozen unenriched adult *Artemia* is a less desirable option for feeding larger juvenile and adult seahorses.

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