Diet Composition and Feeding Strategy of Nemipterus japonicus Bloch, 1791 from Tha-baw-seik, Myanmar.

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Abstract: Food composition of Nemipterus japonicus was studied by analyzing about 600 specimens from Tha-baw-seik (Lat. 14° 05’ and long. 98° 05’ E), Myanmar during October 2016 to September 2017. Based on the stomach content analysis, the relative importance index (IRI) value was calculated, and the predator feeding strategies were conducted during the study period. This study showed that N. japonicus is a generally demersal carnivore, and its trophic spectrum was composed of 23 food items. Among them, algae had not been described as a food item for N. japonicus in the other previous studies. Crustaceans were the most dominant diet in the guts in term of the IRI value. Also, fish items were commonly the most dominant food followed by prawn, crab, and Acetes spp in all length groups but sex variation had no significant food changes with their IRI value.

Key words: Relative importance index, feeding strategies, Tha-baw-seik and Nemipterus japonicus.

Introduction

Nemipterid fishes are a demersal fish resource, found on mud or sand bottoms, usually in schools, feeds mainly on small fishes, crustaceans, molusks (mainly cephalopods), polychaetes and echinoderms. Nemipterid fishes have a small mouth opening, villiform teeth only on the jaws, soft gill racker with bristles, small stomach and long intestine adapted for small preys. The adaptation is also significant in preventing the escape of the prey.

The nemipterid fishes are one of the most important economic groups of marine fishes in Myanmar. From the commercial point of view, all species are treated as one group under the name ‘Threadfin’, locally known as ‘ShweNgar or Ngar Ni.’ It yields 3040.45 tonnes, and by percentage, it had 5.89% of the Myanmar marine fish landings in Yangon, the business city of Myanmar.

The study of the feeding habits of fish and other animals based upon the analysis of stomach content has become a standard practice. Stomach content analysis provides important insight into fish feeding patterns, and quantitative assessment of food habits is an important aspect of fisheries management. Moreover, food and feeding habit of fish are important biological factors for selecting a group of fish for culture among themselves and live in association and to utilize all the available food.

It is virtually impossible to gather sufficient information about food and feeding habit of fish in their natural habitat without studying its gut contents. All knowledge on the food and feeding habit of fishes provides keys for the selection of species in culture and the importance of such information is necessary for successful fish farming. The food habit of different fish varies from month to month. This variation is due to changes in the composition of food organisms occurring at different seasons of the year.

The threadfin breams constitute an important group of commercial fishes in Tha-baw-seik, Myanmar. Tha-baw-seik is one of the large fishing landing areas in the southern part of Myanmar and it is located in Lat. 14° 05’ and long. 98° 05’ E. Some observations on the feeding habits of Nemipterids were made from different parts of the world; nevertheless the available information is rather meager and scanty.

In Myanmar, there was only one literature available about food and feeding habits of N. japonicus: Sabal Soe 2014 observed on gut contents of threadfin breams (genus-nemipterus) in myeik waters, Myanmar. In this study, seven species of Nemipterus were observed during the study period.

The objectives of the present study were to provide information on the diet composition and feeding strategy of N. japonicus in Tha-baw-seik landings mainly based on their general stomach content analysis.

Materials and methods

Sample collecting and laboratory procedures

Around 600 specimens of N. japonicus were collected during October 2016 to September 2017 from the fish landings at Tha-baw-seik (Lat. 14° 05’ and long. 98° 05’ E) (figure 1). The standard length of the samples was recorded and ranged 100-140 mm in length and 141-190 mm in length and 191-220 mm in length. The stomach of the fishes was dissected with the help of simple scissors. The stomach contents were taken into a Petri dish, and the food items were identified under the binocular microscope, and they were counted and weighted in an electronic balance.

The relative importance index (IRI)

Several methods employed for analyzing the food habits of fishes reviewed by Bowen to quantify the feeding preference of fishes were applied in the present study.

For the nemipterid fishes, the relative importance index was found most suitable and hence is adopted in the present study.

The methods used in the present study are:

Frequency of Occurrence, \( O_i = \frac{1}{P} \)

Where \( I \) is the number of fish containing prey \( i \) and \( P \) is the number of fish with food in their stomach.

Percent by number, \( N_i = \frac{N}{\sum N_i} \)

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From these three indices, the relative importance of prey items was calculated using the Index of Relative Importance (IRI). The IRI was calculated for each prey as:

\[ \text{Index of relative importance, IRI} = \left( \frac{\% N_i + \% W_i}{\% O_i} \right) \]

Where, \( N_i \), \( W_i \), and \( O_i \) represent percentages of number, weight or volume and frequency of occurrence prey respectively.

Cluster analysis

A cluster analysis was done to find out the similarities between groups. The most commonly used clustering technique is the hierarchical agglomerative method. The results of this are represented by a tree diagram or dendrogram with the X-axis representing all predators and Y-axis defining the similarity level at which the predators are fused. Bray-Curtis coefficient was used to produce the dendrogram. The following formula calculated the coefficient:

\[ S_{jk} = 100 \left( 1 - \frac{\sum_{i=1}^{n} \left| Y_{ij} - Y_{ik} \right|}{\sum_{i=1}^{n} \left( Y_{ij} + Y_{ik} \right)} \right) \]

Where \( Y_{ij} \) represents the entry with \( i \)th row and \( j \)th column of the data matrix, i.e. the \%IRI for the \( i \)th prey in the \( j \)th predator. \( Y_{ik} \) is the \%IRI for the \( i \)th prey in the \( k \)th predator; ‘min’ stands for, the minimum of two values and \( \sum \) represents the overall rows in the matrix.

Besides, the significance of the difference between the IRI value of male and female was tested by One Way ANOVA.

Predator feeding strategies

Prey- specific abundance is represented by the following equation:

\[ P_i = \left( \frac{\sum S_i}{\sum S_i} \right) \times 100 \]

Where \( P \) is prey- a specific abundance of prey type \( i \), \( S \) is total stomach contents (number) comprised of prey \( i \), and \( S_j \) is the total stomach content of only the fish with prey item \( i \) in their stomach. According to Amundsen et al, the interpretation of the feeding strategy diagram can be obtained by examining the distribution of points along the diagonals and axes of the graph. The diagonal from the lower left to the upper right corner provides a measure of prey importance, with dominant prey at the top, and rare or unimportant prey at the lower end. The vertical axis represents the feeding strategy of the predator in terms of specialization or generalization. Predators have specialized on prey positioned in the upper part of the graph, whereas preys positioned in the lower part have been eaten only occasionally (generalization). Prey points located at the upper left of the diagram would be indicative of specialization by individual predators, and those in the upper right would represent specialization of the predator population. Prey with high specific abundance and low occurrence (upper left) were consumed by a few individuals displaying specialization, whereas prey with a low abundance and a high occurrence (lower right) were eaten occasionally by most individuals.

Results

Prey of \( N. \) japonicus in terms of frequency of occurrence (%FO), gravimetric (% W), numerical (%N), and index of relative importance (IRI).

The total 23 food items which are classified into eight general categories were included in the trophic spectrum of \( N. \) Japonicus. Among them, crustacean with % IRI 70.58 dominated over all other food categories and was comprised of Acetes spp with % IRI 25.06, crab with % IRI 13.69, prawn with % IRI 29.46, lobster with % IRI 0.038 and squilla with % IRI 2.74. The subsequently abundant food category was fish constituted chiefly by immature ones of Nemipterus spp with % IRI 0.148, Bregmaceros spp with % IRI 7.77, Secutor spp with % IRI 0.14, Sauridas spp with % IRI 0.115, Platyccephalus spp with % IRI 0.038, and...
0.332. *Cynoglossus spp* with % IRI 0.08, *Stolephorus spp* with % IRI 2.04, fish larvae with % IRI 0.38 and unidentified fishes with % IRI 3.53. The additional food items were cephalopod comprised of *Loligo* with % IRI 1.722 and *Sepia* with % IRI 0.855 and unidentified squids with % IRI 0.013, polychaetes with % IRI 0.54, nematodes with % IRI 0.892, the brittle star with % IRI 0.521, algae with % IRI 0.348 and Miscellaneous items with % IRI 9.409.

In terms of frequency of occurrence, the prawn was observed 15.8% of the total stomach followed by *Acetes spp* with 14% and crab with 13%. Moreover, they were the most frequently. As for the weight, prawn with 17.17% and *Acetes spp* with 15.28% were mostly consumed by *Nemipterus japonicus* followed by *Bregmaceros spp* with 8.43% which is one item of the fish category. When considering the abundance, *Acetes spp* with 33.11% produced the largest part of the diet, followed by crab with 13.22% and prawn with 11.35% (table 1 and fig.2).

In different length groups of *N. japonicus*, the contribution of crabs ranged from 19.08% in the smallest group and 18.73% in the medium group to 8.61% in the largest group. Therefore, there was a sharp decrease in IRI value in the largest group. Fish was the most dominant food, with 30.33% in the largest length groups of *N. japonicus* followed by 18.29% in the medium length groups and 17.39% in the small length groups. The lobster was absent in the smallest length group and largest length group, but they were found only in the medium length group with the lowest IRI value, 3.703.

Presence of *squilla* was the highest 11.11% in the largest length groups and lowest 4.37% in the smallest length groups. Contribution of squids ranged 10.14% in the smallest length groups, 3.65% in the medium length groups and 3.703% in the largest length groups. Polychaetes ranged from 2.99% in the smallest length group to 5.08% in the median length groups, but they were absent in the smallest length groups. Nematodes were only present in the smallest length groups with 4.34%. The fragments of brittle star constituted 1.449% in the smallest groups, 3.65% in the medium length groups and 3.703% in the largest length groups. Algae were only present in the median length groups with 2.43%. Miscellaneous item was found in all the length groups, which ranged from 8.69% in the smallest groups and 7.407% in the largest groups to 9.75% in the medium groups (table 2).

Comparison of IRI value in different sexes indicated that prawn was the most favorite food item in both sexes with 18.33% in male and 18.64% in female. Fishes were the second abundant food in both sexes with 16.66% in male and 14.70% in female. The next abundant food item was a miscellaneous item with 17.5% in male and 17.64% in female. The lobster was present in males with 0.833%. The lowest IRI values of males were lobster, and brittle star with 0.833% and the lowest IRI values of males was algae, with 0.989% (table 3).

Similarity analysis between different length groups can be found in the figure 4. The similarity between the smallest group and the largest group had 67.93 %. These groups shared diets such as *Acetes spp*, benthic crabs, and prawns. Moreover, the similarity between medium and largest groups was observed at 72.31%.

The feeding strategy of *N. japonicus* was found by plotting prey- specific abundance against the frequency of occurrence in figure 3. There were 23 different prey types represented by points. Based on the interpretation of Amundsen et al. 1996b important food of *N. japonicus*, whereas some species of fishes, lobster and squilla were unimportant. Also, *N. japonicus* were specialized on fish larvae, polychaetes, unidentified fishes and algae, etc. but some species of fish, crab, prawn, *Acetes spp., squilla*, and lobster were eaten only occasionally. Although fish larvae, polychaetes, unidentified fishes and algae were consumed by a few individual predators, crab, prawn, *Acetes sp., Bremaceros spp*, etc. were eaten by most individual predators. Therefore, though the abundance of certain prey items like fish larvae and polychaetes was very high in the ecosystem, their occurrence was meager in the diet. The analysis showed that *N. japonicus* has a specialized feeding strategy focusing on crustaceans, especially Crab, *Acetes spp*, and Prawn, which they consumed in very large quantities. *Bremaceros sp* and Misc. item was the next most often found prey items on which *N. japonicus* specialized. Therefore, they were consumed occasionally by most individuals. Though the abundance of certain prey items like fish larvae and polychaetes was very high in the ecosystem, their occurrence was meager in the diet.

**Discussion**

The present study revealed that *N. japonicus* is a benthic carnivore that relies mainly on benthic crustaceans and fishes. Rao and Rao6 described food items as *squilla*, crabs, prawns, teleosts, cephalopods, amphipods, polychaetes and other miscellaneous items in that order of importance from the gut of *N. japonicus*. Krishnamurthy5 described *N. japonicus* is actively predacious and possibly a sight feeder, feeding on crustaceans, mollusks, annelids and echinoderms. Moreover, about the results by SabalSoe6, the food composition of *N. japonicus* consist of *Solenocera spp*, *Stolephorus spp*, *Squilla*, Crabs and Miscellaneous. According to the results conducted in the present study, the following food items were observed in the guts of fishes: fish comprised with *Nemipterus spp*, *Bregmaceros spp*, *Secutor spp*, *Saurida spp*, *Phyllopterus spp*, *Cynoglossus spp*, *Leiognathus spp*, *Stolephorus spp*, fish larvae and unidentified fishes, crustacean comprised with *Acetes spp*, crab, prawn, lobster and *Squilla*, cephalopod comprised with *Loïgo*, *Sepio* and unidentified squids, polychaetes, nema-todes, brittle stars, algae and miscellaneous items. Therefore, the food items of the present study were almost the same as the previous studies of *N. japonicus*. Russel 19901 observed that cephalopods mainly squid and cuttlefish formed dominant food followed by finishes and other benthic crustaceans. In contrast, the present study was observed that benthic crustaceans were the most dominant food.

Of the crustacean items, *Acetes pp*, prawn and crab were the favorite food of *N. japonicus* with the highest IRI value, but *Squilla* and lobster were also found occasionally with the lowest IRI value. Fish ranked in the second dominant food category of *N. japonicus*. Among them, *Bremaceros spp* was observed with the important quantities, and other species.
had the negligible quantities. The studies of Manojkumar and Abdu Rahiman made the fish prey items identify up to the species level but the present study could not be done because of their digestion.

Loligo and Sepia were considerably found but Loligo was more abundant than Sepia. The miscellaneous items comprised of debris, rubbish, unidentified bones, unidentified shells, unidentified hairs, and silts were found very often. However, polychaetes, nematodes, brittle stars, and algae were negligible food or minor food in some months.

As for predator feeding strategies, Abdu Rahiman showed that _N. japonicus_ most often specialized on crustacean mainly _S. choprai_, benthic crabs, unidentified fishes, _A. indicus_ and _L. durance_ in his study whereas the present study found that crab, _Acetes spp_, prawn, _Bregmaceros spp_ and Misc. items represented the specialization of the predator population.

In all length groups, fishes were commonly the most dominant food followed by prawn, crab and _Acetes spp_. According to the IRI values, _N. japonicus_ were generally increased with the increasing length of them in fishes, prawn, and _squilla_ while the values were decreased with the decreasing length in _Acetes spp_, crab, squid and miscellaneous item. A large percentage of fishes, prawn, and _squilla_ in the largest length groups indicate they alter in feeding towards fish, prawn and _squilla_ items as length increases. On the pieces of evidence from the report of Rao and Rao 1991, _squilla_ dominated for all length groups followed by crabs and prawns. A large proportion of prawns mainly _S. choprai_ and _A. indicus_, _L. duvauceli_ and fish, which are active mobile benthic organisms recorded in large length groups indicated predatory behavior of _N. japo-

| Food items         | N%  | O%  | W%  | IRI | IRI% |
|--------------------|-----|-----|-----|-----|------|
| Fish               |     |     |     |     |      |
| Nemipterus spp.    | 0.68| 1.05| 0.75| 1.474| 0.148|
| Bregmaceros spp.   | 6.105| 8.41| 8.43| 77.07| 7.77 |
| Secutor spp.       | 0.63| 0.708| 1.064| 1.38| 0.14 |
| Sartoridus spp.    | 1.028| 0.517| 0.227| 1.145| 0.115|
| Platyccephalus spp.| 0.479| 0.94| 3.007| 3.306| 0.332|
| Cynoglossus spp.   | 0.483| 0.799| 1.17| 1.418| 0.14 |
| Leitognathus spp.  | 0.34| 1.01| 0.45| 0.801| 0.08 |
| Stolephorus spp.   | 2.51| 3.553| 4.989| 20.23| 2.04 |
| Fish larvae        | 2.01| 1.989| 0.89| 3.7992| 0.383|
| Unidentified fishes | 4.676| 5.85| 5.18| 35.06| 3.534|
| Crustacean         |     |     |     |     |      |
| Acetes spp.        | 33.11| 14.09| 15.28| 248.60| 25.06|
| Crab               | 13.22| 13.95| 8.78| 135.82| 13.69|
| Prawn              | 11.35| 15.8| 17.71| 292.306| 29.46|
| Lobster            | 0.221| 0.41| 0.38| 0.379| 0.038|
| Squilla            | 1.642| 3.115| 8.2| 27.21| 2.74 |
| Cephalopod         |     |     |     |     |      |
| Loligo             | 1.735| 2.73| 5.62| 17.08| 1.722|
| Sepia              | 1.55| 2.08| 3.317| 8.48| 0.855|
| Unidentified squids| 0.104| 0.175| 0.16| 0.336| 0.013|
| Polychaetes        | 1.433| 2.21| 1.77| 5.359| 0.54 |
| Nematodes          | 5.633| 3.59| 0.89| 8.854| 0.892|
| Brittle stars      | 1.18| 2.17| 1.83| 5.17| 0.521|
| Algae              | 1.08| 5.81| 0.407| 3.455| 0.348|
| Misc. items        | 8.73| 8.96| 9.43| 93.34| 9.409 |

**Table 1.** Prey of _N. japonicus_ collected from the Tha-baw-seik coastal areas in terms of frequency of occurrence (%FO), gravimetric (% W), numerical (%N), and index of relative importance (IRI).
Figure 3. Feeding strategy diagram for *N. japonicus*. Prey-specific abundance (%) plotted against frequency of occurrence of food items in its diet.

Table 2. Ontogenetic variation in %IRI of different prey of *N. japonicus*.
Figure 4. Dendrogram based on %IR: values of different length groups of N. japonicus using Bray-Curtis similarity.

Table 3. Sex variation in %IRI of different prey of N. japonicus.

| Food items     | Male   | Female  |
|----------------|--------|---------|
| Fish           | 16.66  | 14.7    |
| Nemipterus spp.| 2.56   | 0       |
| Bregmaceros spp.| 4.98  | 9.38    |
| Secutor spp.   | 0.39   | 0       |
| Sauridas spp.  | 1.22   | 1.26    |
| Platyecephalus spp.| 1.34 | 1.55    |
| Cynoglossus spp.| 0.26  | 0       |
| Leiognathus spp.| 0.13  | 0       |
| Stolephorus spp.| 1.56  | 0       |
| Fish larvae    | 0.76   | 0       |
| Unidentified fishes | 3.46 | 2.51    |
| Acetes spp.    | 10     | 8.823   |
| Crab           | 17.5   | 20.588  |
| Prawn          | 18.33  | 17.64   |
| Lobster        | 0.833  | 0       |
| Squilla        | 5      | 4.893   |
| Squid          | 3.33   | 2.941   |
| Polychaetes    | 3.33   | 5.882   |
| Nematodes      | 1.66   | 2.941   |
| Brittle stars  | 0.833  | 2.941   |
| Algae          | 2.5    | 0.989   |
| Misc. items    | 17.5   | 17.64   |

Table 4. Comparison of IRI value between male and female of N. japonicus from Tha-baw-seik, Myanmar.
nicus on benthic animals. Compared with the present study, it is proved that almost all food items observed in the guts were only the benthic organisms. Moreover, it was also found that the sex variation in IRI value of N. Japonicus had no significance with their different food items.

Conclusions

Acetes spp., Crab, Prawn and Squilla were the favorite food of N. japonicus. Regarding preyed fishes, it seems to eat Bregmaceros spp as its major food. It cannot be denied that N. japonicus is the kind of benthic fish because almost all food items were only the benthic organisms. Moreover, it can be concluded that their food items can be their associated animals. Therefore, the species found in their guts may be distributed along the Tha-baw-seik and its adjacent coastal waters.

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