TUNA FISHERIES OF THE EXCLUSIVE ECONOMIC ZONE OF INDIA: Biology and Stock Assessment
Edited by: E. G. SILAS
SPRATELLOIDES DELICATULUS (BENNET) 
AND S. JAPONICUS (HOUTTUYN) FROM MINICOY WATERS

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Spratelloides delicatulus is considered to be an excellent bait fish by Hawaiian fishermen (June 1951, Ikehara 1953, June and Reintjes 1953). This species, however, does not contribute to a good percentage of the bait fish catch in Hawaii but whenever Stolephorus purpureus is not available as bait sufficiently, sprats are captured and made use as bait (Welsh 1950). S. delicatulus is the widely used sprat in the Indo-Pacific. Its poor survival in captivity is the main handicap (Ikehara 1953, June and Reintjes 1953, Wilson 1971, Lee 1973). Occurrence of this species is very seasonal in the Pacific Ocean and is available more during summer months (Welsh 1950, June 1951 Wilson 1963). Hida (1971) noted that S. delicatulus was abundant in lagoons of large atolls in Micronesia.

Matsumoto (1937) observed that S. delicatulus is the most important bait fish at Saipan where it is found all the year but is scarce in November, December and January. At the peak of the season, one haul of bait captured is enough bait for a day’s fishing. Cleaver and Shimada (1950) reported that S. delicatulus is a preferred bait species. This species was reported to be abundant in Western Samoa (Van pel 1960). S. delicatulus and S. gracilis are considered as possible bait fish resources in New Guinea by Kearney et al. (1972). Lewis et al. (1974) reported that both species are the most attractive bait fishes for skipjack tuna in Papua New Guinea waters.

Wilson (1971) observed that S. gracilis is a good live-bait fish but it is not as hardy as S. delicatulus. They are not extensively used at Palau. Lee (1973) reported that S. delicatulus is an important bait fish in the Fiji waters. The quantity of round herring comprised of S. japonicus, S. delicatulus and S. atrofasciatus from three major localities in the Ryukyu Islands for 1966 and 1967 was 54.7 and 45 metric tons respectively (Iss, 1972).

Jones (1960, 1964a) reported that S. japonicus is used in the Laccadive fishery and stated that it occurs in small schools but is not as abundant as S. delicatulus. Thomas (1964) observed that both these bait species are seasonally available and have been observed sometimes in large quantities and are scarce after December.

I. Spartelloides delicatulus

A review of the published literature on bait fishes reveals that there is no information on the biology of Spratelloides spp. from Indian waters. The biology of blue sprat, S. delicatulus is presented here based on the material collected from Minicoy lagoon from December 1981 to December 1982. Samples for August, October, November and December were collected from the Minicoy lagoon along with mullets while during other months they were obtained from commercial bait fish catches. Samples were preserved in 5 per cent formalin after collection and were analysed for biological studies. Total length was measured in millimetres and condition of stomach, sex and maturity of individual fish was recorded. The procedures adopted for the analysis of material and data are given in the respective sections.

Distribution and abundance

S. delicatulus (Blue sprat) is found near the inner reef area at Ragandi point on the western side of Minicoy lagoon. They are available in scattered shoals and very rarely occur in large shoals. Blue sprat is
easily found only on the shoal sand near the bodies of moving and clear water in the shallow part of the lagoon.

During 1981-82 tuna fishing season (pole-and-line) *S. delicatulus* dominated the bait fish catches of Minicoy and contributed 64.16 per cent. This species was available during all the months of the season and accounted for the bulk of monthly bait catches. This species starts appearing in the lagoon from September onwards when very young juveniles are available which are very fragile at that stage. The fishery of the species entirely depend on its recruitment of the shallow moving waters of the lagoon.

**Length frequency distribution**

These studies are based on 1191 specimens collected from December 1981 to December 1982. The total length of the individual fish ranged between 18 and 59 mm. The percentage frequency in the various size groups are plotted in the form of length frequency curves in Fig. 1.

It can be seen from the figure that several modal groups occurred, but only some of them could be traced with reasonable assurance of accuracy. While the identity of some of the smaller modal groups is doubtful, in the description given below they are described as such and growth is calculated based on only those modes which could be traced for some months.

There are two modes at 27 mm (Mode A) and 31 mm during December 1981. Samples were not available during January 1982. In February three modes at 25 mm, 31 mm and a small mode at 43 mm appeared. While mode at 31 mm could be traced back as mode A of December 1981 with 4 mm growth, other two modes could not be traced back. Next month four modes appeared at 25 mm (Mode B), 31 mm, 35 mm and one small mode at 41 mm. Only one mode at 35 mm could be traced back as mode A of February with 4 mm growth. Samples were not available during May, June and July. During August only one mode appeared at 51 mm which could be traced back as mode A of March with 16 mm growth in five months. Samples were not available during September. During October four modes could be seen at 29 mm, 37 mm, 41 mm and 45 mm. While mode at 41 mm could be traced back as mode B of March which was evidently not represented in the immediate preceding six months. In December, three modes at 41 mm, 45 mm and 49 mm appeared but only one mode at 49 mm could be traced back as mode B of October with 8 mm growth.

**Age and growth**

As can be seen from fig. 1; both the modes A and B could be followed upto few months only. Mode A of December 1981 could be followed upto August 1982 when it grew from 27 mm to 51 mm *i.e.*, 24 mm in 8 months with monthly growth rate of 3 mm. Mode B of March at 25 mm could be followed upto December 1982 at 49 mm with growth of 24 mm in
PLATE I. (a) Live-bait fishes being transferred to tank. (b) Bait tank with bait fishes. (c) Promelas pinguis. (d) Spratelloides delicatulus. (e) A. sp. (f) Choroides caralineus. (Photos 15-18 by Madan Mohan K.)
9 months with monthly growth rate of 2.66 mm. Therefore, both the modes have shown a monthly growth rate of about 3 mm.

Jones (1964) stated that *S. delicatulus* enters the Minicoy lagoon in very large shoals before the monsoon and remains there up to about November. As can be seen from the figure, all the fish collected during August were adults and their gonadal examination revealed that all were mature. Even during October, November and December majority of the fishes collected were mature. Every year the young ones of this species of about 15 mm start appearing from September onwards and during bait fish collections from about November only young fishes are caught and used as bait. During the present investigation samples during August, October, November and December were collected from near the shore and not from Ragandi point from where this species is usually caught.

**Maturity and spawning**

The maturity stages of individual fish were classified by microscopic examination of ova.

Since ovaries are small in size, ovary as a whole was teased and measurements of 200 ova from immature and maturing ovary and 300 ova from ovary of stage IV and above of maturity stage were taken. Ova were grouped into four ocular micrometer division groups. Ocular micrometer divisions were converted in millimetres and frequency polygons of ovaries, typically seven maturity stages were drawn (Fig. 2). As can be seen from the Figure only immature ova with diameter from 0.01 to 0.14 mm with mode at 0.05 mm are present in stage I of ovary. This group of ova is present in the ovaries of all stages and throughout the year.

In stage II one batch of ova is seen getting separated from the immature ova with mode at 0.09 mm.

In stage III the maturing group of ova progressed in diameter with mode at 0.19 mm. At this stage yolk deposition has started in the big size ova. Some of the ova in which yolk deposition has started are translucent while majority of ova are transparent.

In stage IV three types of ova i.e., immature, maturing and mature can be clearly distinguished. Maturing ova of stage III has shown fast growth with mode of maximum diameter of ova at 0.33 mm.

In stage V mature ova of stage IV has shown further increase in diameter with the mode of ripe ova at 0.42 mm. Ripe ova have become clearly separated from the maturing stock. The mode at 0.42 mm is clearly the group of ova which will be spawned in near future.
In stage VI ripe group of ova ranged in diameter from 0.47 mm to 0.71 mm with mode at 0.56 mm. Ripe ova have shown faster growth than maturing ova. They are yellow in colour and in few of them oil globule is visible. Some of the ova became transparent and are easily separated from the follicles with some loose ova in the lumina of the ovary.

Spent ovary was not available for analysis during these studies.

**Spawning season**

357 specimens of *S. delicatulus* from December 1981 to December 1982 were examined to study the percentage occurrence of gonads in different stages of maturity. The details are given in Table 1.

In December 1981 stages II to IV were present and stage II dominated over other stages. In February 1982 stages I to stage IV were available stage III being the predominant one followed by stage II. In March stage II to VI were present and stage III dominated followed by stage IV. In April stages I to VI were available and again stage III dominated followed by stage IV. Samples were not available for study during September. In October stages III to VI were available and stage V dominated followed by stage VI. In November stages IV to VI were present and VI dominated followed by stage V. In December stage III to VI were available, stage IV being predominant followed by stage V.

Further fish were divided in three major groups based on maturity stages i.e., immature (Stage I and II), maturing (Stage III) and mature (Stage IV and above). The results are given in Table 2. It can be seen from the Table that maturing fishes dominated over others during December 1981, February and March. But from April onwards mature fishes dominated with very high percentage. From the above it is clear that mature *S. delicatulus* starts appearing in good numbers from April onwards. During August the percentage of mature fish was very high and thence onwards they were available in good quantities. Jones (1964) stated that *S. delicatulus* enters the Minicoy lagoon in very large shoals before the monsoon and

<table>
<thead>
<tr>
<th>Month</th>
<th>No of fish</th>
<th>Sex</th>
<th>Stages of maturity</th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>I</td>
</tr>
<tr>
<td>1981</td>
<td></td>
<td></td>
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<tr>
<td>January</td>
<td>22</td>
<td>M</td>
<td>54.55</td>
</tr>
<tr>
<td>December</td>
<td>10</td>
<td>F</td>
<td>90.00</td>
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<td>1982</td>
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<td>M</td>
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<td>March</td>
<td>22</td>
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</tr>
<tr>
<td>April</td>
<td>39</td>
<td>M</td>
<td>2.56</td>
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<tr>
<td>May</td>
<td>22</td>
<td>M</td>
<td>9.09</td>
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<tr>
<td>June</td>
<td>19</td>
<td>M</td>
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<td>July</td>
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<td>M</td>
<td></td>
</tr>
<tr>
<td>August</td>
<td>36</td>
<td>M</td>
<td>8.33</td>
</tr>
<tr>
<td>September</td>
<td>21</td>
<td>F</td>
<td>28.57</td>
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<tr>
<td>October</td>
<td>10</td>
<td>M</td>
<td></td>
</tr>
<tr>
<td>November</td>
<td>40</td>
<td>M</td>
<td>32.50</td>
</tr>
<tr>
<td>December</td>
<td>22</td>
<td>M</td>
<td>14.28</td>
</tr>
</tbody>
</table>

M = Male, F = Female
remains there up to about November. The occurrence of mature specimens from August onwards in near shore area of the lagoon indicates that spawning in this species takes place during the south-west monsoon period and extends up to December. This may be the reason that from October to April only young blue sprat occurs in bait fish catches.

**Frequency of spawning**

The frequency distribution of ova diameter measurements from the ripe and spawning ovary (Stage V and VI) of *S. delicatulus* reveals that at this stage of maturity the ovary contains three groups of ova i.e., immature, maturing and mature (Fig. 2). From the figure it can be seen that in the ovary of stage VI ripe ova almost get separated from the maturing ova. From stage III onwards mature ova has shown faster growth than maturing ones. Therefore, when ripe ova are spawned out their place is soon taken by maturing ova which have already completed more than half the maturation process. When ripe ova are spawned, maturing ova will grow faster and will be ready to spawn soon. The occurrence of juvenile fishes for a longer period also suggests that *S. delicatulus* may spawn more than once in a spawning season.

**Sex ratio**

For the period under study the ratio of males to females was found to be 1:0.79. The percentage occurrence of sexes in different months are given in Table 3. From the table it can be seen that males dominated over females throughout the period except in November when females dominated. During August, the percentage of both the sexes was equal.
Food and feeding

Preserved stomachs of a total of 367 specimens of S. delicatulus were examined for food and feeding habits. The degree of distension of stomachs was recorded depending on their fullness in the following categories: (1) Empty, (2) 1/4 full, (3) 1/2 full, (4) 3/4 full, (5) Full and (6) Gorged. Specimens with gorged, full and 3/4 full stomachs were considered to have actively fed, whereas those with half full as moderately fed and with 1/4 full stomachs as poorly fed.

The empty stomachs (189 Nos.) occurred in a high percentage (51.50%) of the 367 stomachs examined. Their percentage was high during April, October, November and December. Actively fed fishes were available in high percentage during December 1981, February, March and August. Moderately fed fishes occurred in good percentage during all months of the observations except in April and September.

The food of the species mainly consisted of crustaceans represented by post larvae of decapods, harpacticoid and calanoid copepods, mysids and gammarids. Fish eggs and algal filaments were also observed rarely.

Behaviour

Blue sprat like other members of the family Dussumirididae is a schooling species. The size of the school is usually small. They are found in scattered shoals and are observed in the same type of habitat i.e., sandy bottom area of inner reef flat throughout the season of availability.

The analysis of data reveals that during tuna fishing season only young specimens of S. delicatulus are caught and used as bait. Samples during August onwards were collected from the shore area of the lagoon along with mullets and Atherina spp. Majority of the fishes collected from the shore area were in 'mature stage' while they were not available in bait fish catches at all. Mature specimens collected from shore area would have migrated from the reef area along with strong currents. The absence of spent specimens of this species and mature fishes from bait catches clearly suggests that spawning of this species takes place elsewhere, most probably outside the reef area and not in the lagoon.

Jones (1960) during the third cruise of R. V. KALAVA in the Laccadive sea observed that millions of S. delicatulus assembled under ship's light when the ship was anchored just outside the reef off Bitra Island (Lat. 11° 38'N, Long. 72° 13'E) and in few numbers next day outside the reef of Agath Island (Lat. 10° 51' N, Long. 72° 28'E). Wilson (1977) reported that Palauan fishermen occasionally caught blue sprats some distance away from the island. Although Herklotsichthys punctatus was used as bait while catching tuna 11 km off Kayangel, the food contents of skipjack caught from the same shoal consisted of large amount of S. delicatulus.

II. Spratelloides japonicus

Spratelloides japonicus was originally described as Atherina japonica by Houttuyn in 1782. But Weber and Beaufort (1951) named this species as Spratelloides gracilis. Munro (1955) named it as Spratelloides japonicus and this was followed by Jones (1960). Baldwin (1977) in his review of the use of live-bait fishes in the Tropical Pacific has mentioned both Spratelloides gracilis and Spratelloides japonicus separately while Jones (1960, 1964) has synonymized S. gracilis with S. japonicus. In the present context S. gracilis has been considered a synonym of S. japonicus.

Baldwin (1977) presented the distribution of this species in the different world oceans. Jones (1960) has given its distribution as Red Sea, Laccadives and coasts of India and Ceylon to Indonesia, Philippines, Japan, Fiji and Tahiti.

Wilson (1971) noted that S. japonicus is a good live bait fish but not as hardy as S. delicatulus and not extensively used at Palau, while Lee (1953) noted that it is important in the Fiji fishery, but its survival is very poor.

Isa (1972) reported S. japonicus as an important bait fish in the Ryukyu Islands fishery. Kikawa (1977) stated that in Nuguria Islands S. japonicus and S. delicatulus were represented in the bait fish catches made with the stick held lift nets. S. japonicus was more abundant than S. delicatulus. Most of them were juveniles, ranging in length from 25 to 40 mm. Wilson (1977) reported that Spratelloides spp. are very common in Posaape and they were most frequently taken by the Okinawan fishermen. Smith (1977) stated that in Papua New Guinea, sprats rank second to anchovies in terms of overall abundance and contribution to the bait fish fishery. Spratelloides gracilis (= S. japonicus) and S. delicatulus with their brilliant colouration and rapid swimming action, are very attractive and proved to be excellent bait.

Jones (1960, 1964) noted that S. japonicus is used in the Laccadive fishery and that it occurs in small schools but is not as abundant as S. delicatulus. Both species are seasonally available and have been observed on
occasion in large quantities, but after December they are scarce (Thomas 1964).

There is no hitherto published information on the biology of *S. japonicus* from Indian waters. A review of the published literature on bait fish biology also reveals that no available information is present in this regard from elsewhere. Therefore, a preliminary account of the biology of the silver sprat, *S. japonicus* is presented here based on analysis of the collections from Minicoy waters.

Samples for the present investigation were collected from Minicoy bait fish catches during 1981-82 tuna pole-and-line fishing season. Though the species was available as stray catches during all the months of the season, it contributed 20.5 per cent of the total bait catches in February 1982 and 10.5 per cent in January. Samples were preserved in 5 per cent formalin and were analysed later for biological studies.

**Length-weight Relationship**

54 males ranging from 42 to 62 mm and 34 females ranging from 45 to 60 mm in total length were considered for these studies. $W = aL^b$ could be fitted to the data, where $W$ is the weight of fish, $L$ is the total length of the fish, $a$ and $b$ are two constants. Logarithmic transformation of the formula gives a straight line relationship to the form

$$\log W = \log a + b \log L$$

Log $a$ and the regression coefficient ($b$) were estimated for the males and females separately by using least square method and the following relationship were obtained.

- **Males** $\log W = -1.5743 + 2.0782 \log L$
- **Females** $\log W = -1.6707 + 2.0938 \log L$

The coefficient of correlation ($r$) for the males was 0.878 and for females 0.938.

In the analysis of covariance to test the significance of differences in the regressions of $y$ and $x$ was attempted and it was found that there is no significant difference in the regression coefficient between males and females. Therefore, the data for both males and females were pooled together and a common length weight relationship was fitted as below.

$$\log W = -1.4380 + 2.0400 \log L$$

Regression lines for males and females separately are given in Figs. 3 & 4.

**Distribution and abundance**

*S. japonicus* (Silver sprat) are found in the deeper parts of the Minicoy lagoon north of Ragandi point area. They are found associated with corombose corals. During high tide period fishes gather on the
top of the coral heads and it is easy to catch them at that time since they will form small schools. During high tide, fish moves in deeper waters little away from the corals.

During 1981-82 pole-and-line tuna fishing season, 263 kg of *S. japonicus* which made 9.40 per cent of the total bait fish catches, were caught at Minicoy and used as bait. It was available in good percentage during January (10.50%) and February (20.50%). This species is caught from December onwards when they start appearing in the western part of Minicoy lagoon. Its availability is very erratic and rarely they are caught in bulk.

**Length frequency distribution**

During the course of these investigations, the total length of the individual fish ranged between 35 and 60 mm. The percentage frequency in the various size groups are plotted in the form of length frequency curves in Fig. 5.

As can be seen from the figure that there are two modes at 42 mm (A) and 46 mm (B) during December 1981. Samples were not available during January 1982. In February two modes at 50 mm and 56 mm appeared. Mode at 50 mm can be traced back as mode B of December at 46 mm with 4 mm growth. In March, two modes at 50 mm and 54 mm appeared. Mode at 50 mm can be traced back as mode A of December at 42 mm with 8 mm growth.

**Age and growth**

Length frequency data of *S. japonicus* are available only for four months due to its seasonal availability. It is interesting to note here that like *S. delicatulus*, its total length ranged from 35 to 60 mm. This species also has shown growth from 42 to 50 mm at the rate of about 3 mm per month.

**Maturity and spawning**

The maturity stages of individual fish were classified by microscopic examination of the ova of different maturity stages and the procedure is as that followed for *S. delicatulus*.

It can be observed from Fig. 6 that in stage I of the ovary only immature ova which ranged from 0.01 to 0.09 mm with mode at 0.05 mm are present. These immature ova are present in the ovaries of all stages and are shown in figure in broken lines.

In stage II, ova range from 0.01 to 0.19 mm with mode at 0.09 mm.

In stage III, it can be seen that one group of ova is getting separated from immature stock of ova which ranged from 0.04 to 0.33 mm with mode of maturing ova from 0.19 mm to 0.23 mm. In the bigger size of ova, yolk deposition has started and they look translucent but majority of ova are transparent.

In stage IV maturing ova have shown some progress. Mature ova have their mode from 0.23 to 0.28 mm. Majority of the ova are translucent and can be clearly distinguished from the maturing stock.

In stage V, mature ova have shown faster growth and at this stage of every three groups of ova namely immature, maturing and ripe can be clearly distinguished from each other. From the figure it can be seen that ripe ova range from 0.28 to 0.52 mm with clear mode at 0.38 mm while maturing ova have mode from 0.19 to 0.23 mm. Ripe ova with mode at 0.38 mm are the group of ova which will spawn in the near future leaving behind maturing stock.

**Spawning season**

Sexwise monthly distribution of maturity stages of *S. japonicus* is shown in the Table 5. During December
Table 5. Percentage occurrence of gonads of *S. japonicus* in different stages of maturity during 1981-82 season

<table>
<thead>
<tr>
<th>Month</th>
<th>No. of fish</th>
<th>Sex</th>
<th>Stages of maturity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>I</td>
</tr>
<tr>
<td>1981</td>
<td></td>
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</tr>
<tr>
<td>December</td>
<td>17</td>
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<td>14</td>
<td>F</td>
<td>7.14</td>
</tr>
<tr>
<td>1982</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>February</td>
<td>23</td>
<td>M</td>
<td>56.52</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>F</td>
<td>6.25</td>
</tr>
<tr>
<td>March</td>
<td>31</td>
<td>M</td>
<td>41.93</td>
</tr>
<tr>
<td></td>
<td>21</td>
<td>F</td>
<td>9.52</td>
</tr>
</tbody>
</table>

1981 fish from stages I to IV were available. But in February and March 1982 fish from stages II to VI in maturity were available. Even during February and March maturing fishes dominated over mature fishes.

Since this species is usually available for few months every year at Minicoy, it is rather difficult to state anything about its spawning season. But presence of mature fishes from February shows that this species may certainly be spawning from March onwards. Nature of the ovary suggests that fish may spawn more than once in a spawning season. Therefore, because of the occurrence of juveniles of this species from December onwards, it can be stated that *S. japonicus* has an extended spawning season at Minicoy.

**Frequency of spawning**

As can be seen from Fig. 6 that ovary in the ripe maturity stage contains three types of ova namely immature, maturing and ripe. Immature ova are available in plenty due to continuous proliferation of ova in the ovary. Maturing and mature ova have separate distinct modes. From stage IV onwards mature ova have shown faster rate of growth than the maturing ones and in ripe ovary they are almost ready for spawning. While this batch of ripe ova is spawned out, their place will be soon occupied by maturing ova which have already completed more than half of maturation process. These ova will show faster rate of growth and soon will be ready for spawning. Therefore, it can be stated that like *S. delicatulus* this species also spawns more than once in a spawning season.

**Sex ratio**

Percentage of males in comparison to females was found to be higher during all the months of observations (Table 6). Even for the season as a whole, males dominated over females. Ratio of males to females was calculated as 1 : 0.72.
TABLE 6. Sex ratio of S. japonicus at Minicoy during 1981-82 season

<table>
<thead>
<tr>
<th>Month</th>
<th>Total No. of fish</th>
<th>(Males %)</th>
<th>(Females %)</th>
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<tbody>
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<td>1981</td>
<td></td>
<td></td>
<td></td>
</tr>
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<td>December</td>
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<td>February</td>
<td>39</td>
<td>58.99</td>
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<td>59.62</td>
<td>40.38</td>
</tr>
<tr>
<td>Total</td>
<td>122</td>
<td>58.20</td>
<td>41.80</td>
</tr>
</tbody>
</table>

Sex ratio

Fecundity

Since the ovary of S. japonicus is very small in size, ovary as a whole was teased on a slide and mature ova were counted with the aid of a binocular microscope. Fifteen ripe and spawning ovaries were selected for these studies and counts were made. Total length of fish, weight of fish, total number of mature ova and stage of maturity are given in Table 7. It can be seen from the table that the number of mature ova increased with increase in fish length. Even then, fish of the same length showed variations in total number of mature ova.

Food and Feeding

A total of 132 specimens of S. japonicus were examined for food and feeding studies. The degree of distension of stomachs was recorded depending on the fullness in the following categories (1) Empty, (2) 1/4 Full, (3) 1/2 Full, (4) 3/4 Full, (5) Full and (6) Gorged.

The empty stomachs occurred in high percentage (79.51%) of the total stomachs examined (Table 8). Their percentage was high during all the months of observations. Half full contributed 17.21% and full stomachs 3.28 per cent.

S. japonicus mainly subsists on crustaceans. These were represented mostly by harpacticoid and calanoid copepods and post larvae of decapod crustaceans. Gammarids and fish eggs were recorded in very few numbers.

Behaviour

Like other members of the family Dussumieridae, S. japonicus is also a schooling species. It can be seen in small schools swimming over the coral heads in deeper waters.

Usually young ones of the species are used as bait at Minicoy. Whenever they are available in good numbers, they are preferred as bait. During 1981-82 tuna pole-and-line fishing season, 25,134.5 kg of tunas were caught by using 263 kg of S. japonicus as bait. When its efficiency in attracting tuna was compared with other bait fishes of the season, it proved to be most efficient with catch per unit bait of 95.57 kg.

This species possesses all desirable qualities which are essential for a bait fish such as small size, silvery on body sides, slender, hardy during transportation and efficient in chumming tunas during tuna fishing operations.

TABLE 7. Fecundity estimates of Spratelloides japonicus

<table>
<thead>
<tr>
<th>Serial No.</th>
<th>Total length of fish in mm</th>
<th>Weight of fish in mg</th>
<th>Total No. of mature ova</th>
<th>Stage of maturity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>45</td>
<td>500</td>
<td>381</td>
<td>V</td>
</tr>
<tr>
<td>2</td>
<td>45</td>
<td>600</td>
<td>425</td>
<td>V</td>
</tr>
<tr>
<td>3</td>
<td>50</td>
<td>750</td>
<td>512</td>
<td>V</td>
</tr>
<tr>
<td>4</td>
<td>50</td>
<td>700</td>
<td>538</td>
<td>V</td>
</tr>
<tr>
<td>5</td>
<td>50</td>
<td>750</td>
<td>563</td>
<td>V</td>
</tr>
<tr>
<td>6</td>
<td>53</td>
<td>750</td>
<td>742</td>
<td>V</td>
</tr>
<tr>
<td>7</td>
<td>55</td>
<td>750</td>
<td>637</td>
<td>V</td>
</tr>
<tr>
<td>8</td>
<td>55</td>
<td>750</td>
<td>674</td>
<td>VI</td>
</tr>
<tr>
<td>9</td>
<td>57</td>
<td>700</td>
<td>924</td>
<td>V</td>
</tr>
<tr>
<td>10</td>
<td>57</td>
<td>900</td>
<td>986</td>
<td>V</td>
</tr>
<tr>
<td>11</td>
<td>57</td>
<td>900</td>
<td>1,009</td>
<td>V</td>
</tr>
<tr>
<td>12</td>
<td>57</td>
<td>850</td>
<td>1,123</td>
<td>V</td>
</tr>
<tr>
<td>13</td>
<td>58</td>
<td>1,000</td>
<td>1,011</td>
<td>VI</td>
</tr>
<tr>
<td>14</td>
<td>59</td>
<td>1,100</td>
<td>1,133</td>
<td>VI</td>
</tr>
<tr>
<td>15</td>
<td>60</td>
<td>1,100</td>
<td>1,181</td>
<td>V</td>
</tr>
</tbody>
</table>

TABLE 8. Percentage occurrence of stomachs of Spratelloides japonicus in various degrees of fullness during 1981-82 season at Minicoy

<table>
<thead>
<tr>
<th>Month</th>
<th>Empty</th>
<th>1/4th full</th>
<th>1/2 full</th>
<th>1/3rd full</th>
<th>Gorged</th>
<th>Sample number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1981 December</td>
<td>77.42</td>
<td>22.58</td>
<td></td>
<td></td>
<td></td>
<td>31</td>
</tr>
<tr>
<td>1982 February</td>
<td>71.79</td>
<td>20.51</td>
<td>7.70</td>
<td></td>
<td></td>
<td>39</td>
</tr>
<tr>
<td>1982 March</td>
<td>86.54</td>
<td>11.54</td>
<td>1.92</td>
<td></td>
<td></td>
<td>52</td>
</tr>
<tr>
<td>Total numbers</td>
<td>97.21</td>
<td>21</td>
<td></td>
<td>4</td>
<td>122</td>
<td></td>
</tr>
<tr>
<td>Percentage</td>
<td>79.51</td>
<td>17.21</td>
<td></td>
<td>3.28</td>
<td></td>
<td></td>
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</tbody>
</table>
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