

SEASONAL AND REGIONAL VARIATION IN LIVEBAIT UTILIZATION IN THE MALDIVES

R.C.Anderson and M.R.Saleem
Marine Research Section
Ministry of Fisheries and Agriculture

INTRODUCTION

Tuna pole and line fishing is the most important fisheries activity in the Maldives. 89% of the total recorded catch in 1993 was landed by pole and line vessels (MOFA, 1994). Pole and line fishing requires large and regular supplies of small fish to be used as livebait. Without the livebait there will be no tuna catch. It is therefore imperative for the Maldives that livebait stocks are utilized in a sustainable manner. For this reason MRS has been carrying out research on livebait resources. The aim of this report is to summarize current knowledge of one aspect of livebait biology, namely variations in availability, and to highlight areas where further study is required.

METHODS

Maldivian tuna fishermen carry out single day fishing trips. They normally collect bait first thing in the morning before going offshore for tuna. Sometimes they collect bait in the afternoon and keep it in net enclosures overnight for use on the following day. Either way, numbers of fishing trips (which are recorded by MOFA) are equal to numbers of days livebait utilization. Data on livebait utilization are available from five main sources:

a. At Male' market the main livebait varieties (Table 1) used by each *masdhoni* (pole and line fishing boat) have been recorded on a daily basis since the end of 1985. Data have been compiled from January 1986 to December 1993. The total number of boats sampled during that time was 57920 (Table 2).

Table 2. Summary of information on livebait utilization (in numbers of days fishing) by island

Atoll/ Island	Sampling period	Rehi	Hondeli	Muguraan	Boadhi	Fathaa	Bureki	Nilamehi	Thaavalth.	Miyaren	Other	Total
R. Alifushi	1/87-12/88	13.5	2	192	52	-	7	4.5	-	-	-	271
R. Alifushi	2/94-9/94	-	-	52	5	-	-	-	-	-	-	57
R. Ugoofaru	1/89-12/89	57	-	53.5	37.5	-	-	3	-	-	-	151
N. Holhudhoo	10/86-5/87	145.5	1	8	30.5	-	-	3	-	-	-	188
N. Manadhoo	11/88-11/89	22	-	5	24	-	-	-	-	-	-	51
N. Manadhoo	2/92-12/93	154	3	19	146	-	-	3	1	-	-	326
Lh. Naifaru	7/84-9/84	18.5	-	4	13.5	-	-	-	-	6	-	42
K. Gaafaru	4/1985	15	-	-	3	-	-	-	-	-	-	18
K. Male'	1/86-12/93	24770	326	26156	5587	78	534	121	60.5	127	160.5	57920
K. Guraidhoo	11/91-10/92	5	-	15	-	-	-	-	-	-	-	20
K. Maafushi	11/91-6/92	4	-	14	-	-	-	-	-	-	-	18
A. Maalhos	3/86-4/86	-	-	24	-	-	-	-	-	-	-	24
V. Feidhoo	9/93-12/93	-	-	49.5	-	-	1	15.5	-	-	-	66
V. Keyodhoo	8/92-8/93	-	-	16	11	-	-	-	-	-	-	27
V. Rakeedhoo	11/91-1/93	14.5	-	32.5	1	-	-	-	-	-	-	48
M. Maduveri	11/91-8/94	117.5	18	272	51	13	2.5	-	1	24	-	499
M. Dhiggaru	5/92-1/93	45.5	-	62.5	0.5	-	1.5	-	-	10	-	120
M. Madifushi	11/91-6/93	2	-	34.5	8.5	2	-	-	-	2	-	49
Dh.	4/86-2/88	65	62	59	1	2	17	-	-	-	-	206
Kudahuvaadhu												
L. Maamendhoo	9/93-7/94	6	-	33	29	-	-	-	-	-	-	68
L. Hithadhoo	4/86-11/87	0.5	3	75	40	25	11.5	0.5	11.5	18.5	4.5	190
G.A. Vilingili	1/87-12/87	144.5	78	197.5	-	-	2.5	15.5	26.5	178.5	10	653
G.A. Vilingili	1/88-12/89	22	30	28	1	-	-	-	6	3	-	90
G.A. Vilingili	2/94-8/94	4	-	15	61	-	6	-	-	-	-	86
G.Dh. Thinaadhu	2/87-12/93	1816	703.5	867.5	397	16.5	5	12	250	1390	62.5	5520

Table 1. The main livebait varieties used in the Maldives

Local name	Species	English name	Family
<i>Rehi</i>	<i>Spratelloides gracilis</i>	Silver Sprat	Clupeidae
<i>Hondeli</i>	<i>Spratelloides delicatulus</i>	Blue Sprat	Clupeidae
<i>Miyaren</i>	<i>Encrasicholina heteroloba</i>	Shorthead Anchovy	Engraulidae
<i>Thaavalha</i>	Various species	Silversides	Atherinidae
<i>Boadhi</i>	Various species	Cardinalfishes	Apogonidae
<i>Muguraan</i>	Various species	Fusiliers	Caesionidae
<i>Nilamehi</i>	<i>Chromis viridis</i>	Blue Damselfish	Pomacentridae
<i>Bureki</i>	<i>Lepidozygus tapeinosoma</i>	Fusilier Damselfish	Pomacentridae

b. MOFA field officers in the atolls have recorded live bait utilization by *masdhonis* at their islands since 1987. These data are, however, far from complete, and only those from G.Dh.Thinadhoo are sufficient on their own to give a good idea of seasonal utilization. For G.Dh.Thinadhoo, data have been compiled from January 1987 to December 1993. In this seven year period the time series is not complete, but each month has been sampled at least five out of seven times, and the total number of boats sampled was 5520.

c. MRS has distributed baitfishing logbooks to fishermen and field officers in various atolls on an *ad hoc* basis since 1987. The available data are summarized in Table 2.

d. MRS has recruited tuna fishing skippers in various atolls from early 1994 to record lengths of tuna catches. The skippers are required to record livebait used during each days fishing when fish are measured. The data available on livebait utilization are summarized in Table 2.

e. Interviews have been carried out with experienced chummers by the senior author and other MRS staff on many islands throughout the Maldives, mainly during the course of other activities.

Data on livebait utilization are summarized by region in Table 3. In summarizing data, the northern region is considered to include all islands north of Male'; the central region all islands between Male' and the Kudahuvadhoo

Channel; and the southern region all islands south of the Kudahuvadhoo Channel. The Southwest monsoon season is considered to last from June to September inclusive, and the Northeast monsoon season from December to March. April-May and October-November are considered to be intermonsoon periods.

Using reported livebait utilization as an index of livebait abundance has at least three limitations. First, only the one or two bait species caught in the greatest quantity each day are recorded; as a result minor bait species tend to be underreported. Secondly, if there is a choice, fishermen will have a preference for which bait they want to catch; as a result abundance of less-favoured livebait species will tend to be underestimated. Thirdly, delicate species such as *rehi*, *hondeli* and *miyaren* cannot be kept for long; utilization is therefore equivalent to catch. In the case of hardy varieties, however, bait not used on one day can be kept and used the next; number of days utilization will therefore be more than the number of livebait catches. Despite these problems, it is believed that data on livebait utilization do give useful insights into the distribution and abundance of major livebait varieties.

RESULTS

Rehi

Rehi is the Silver Sprat, *Spratelloides gracilis*. It is the most commonly used single species in the Maldivian livebait fishery (Anderson and Hafiz, 1988; Maniku et al., 1990). *Rehi* is abundant throughout the Maldives, although it may be used slightly more in the north than in the south, where there appears to be a greater diversity of livebait species available. Thus, in Male' and islands to the north about 40% of all livebait used is *rehi*. In the southern half of Maldives *rehi* accounts for only 20% of livebait used, although in G.Dh. Thinadhoo it accounted for just over 30% of livebait used during the sampling period.

In the northern and central atolls of the Maldives *rehi* availability and utilization is highly seasonal. It occurs most commonly on the western side during the Northeast monsoon, and on the eastern side during the other monsoon (Fig. 1).

Table 3. Summary of information on livebait utilization by region

Region	Units	Rehi	Hondeli	Muguraan	Boadhi	Fathaa	Bureki	Nilamehi	Thaavalh. a	Miyaren	Other	Total
North	No. days Percentage	425.5 38.6	6 0.5	333.5 30.2	311.5 28.2	- -	7 0.6	13.5 1.2	1 0.1	6 0.5	- -	1104 99.9
K. Male'	No. days Percentage	24770 42.8	326 0.6	26156 45.2	5587 9.6	78 0.1	534 0.9	121 0.2	60.5 0.1	127 0.2	160.5 0.3	57920 100
Centre	No. days Percentage	253.5 23.5	80 7.4	579 53.8	73 6.8	17 1.6	22 2.0	15.5 1.4	1 0.1	36 3.3	- -	1077 99.9
South	No. days Percentage	177 16.3	111 10.2	348.5 32.1	131 12.1	25 2.3	20 1.8	16 1.5	44 4.0	200 18.4	14.5 1.3	1087 100
G.Dh. Thinadhoo	No. days Percentage	1816 32.9	703.5 12.7	867.5 15.7	397 7.2	16.5 0.3	5 0.1	12 0.2	250 4.5	1390 25.2	62.5 1.1	5520 99.9

Fig. 2. Monthly percentage utilization of the Silver Sprat (*rehi*) as livebait at Male' and G.Dh. Thinadhoo.

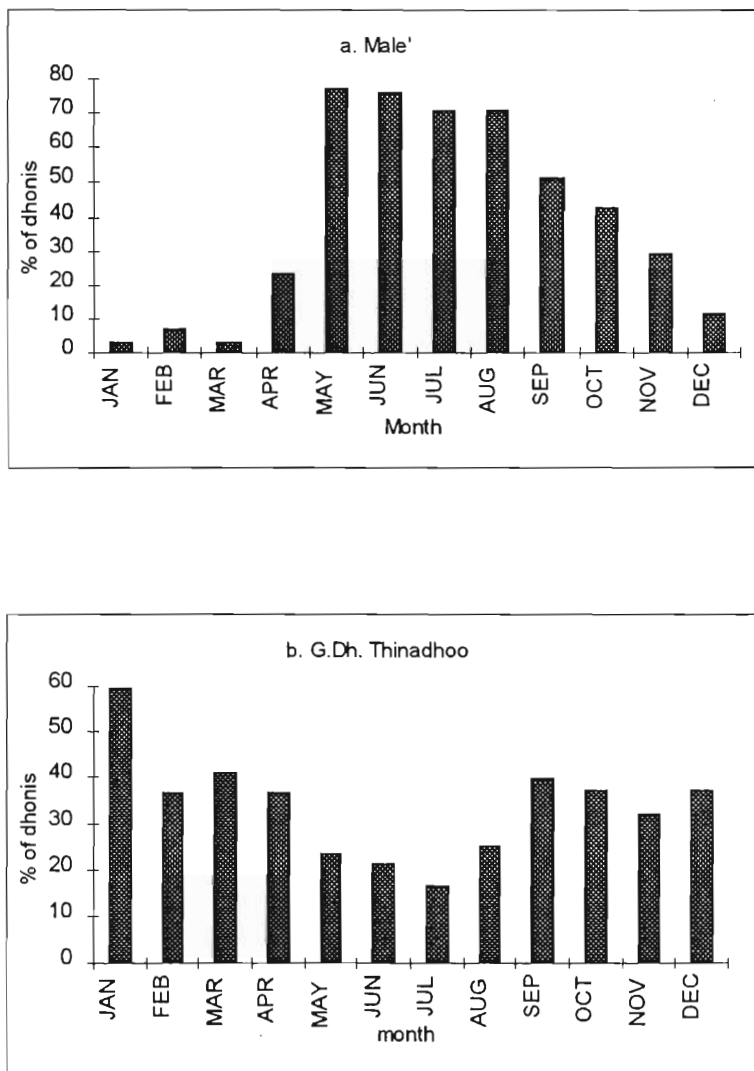
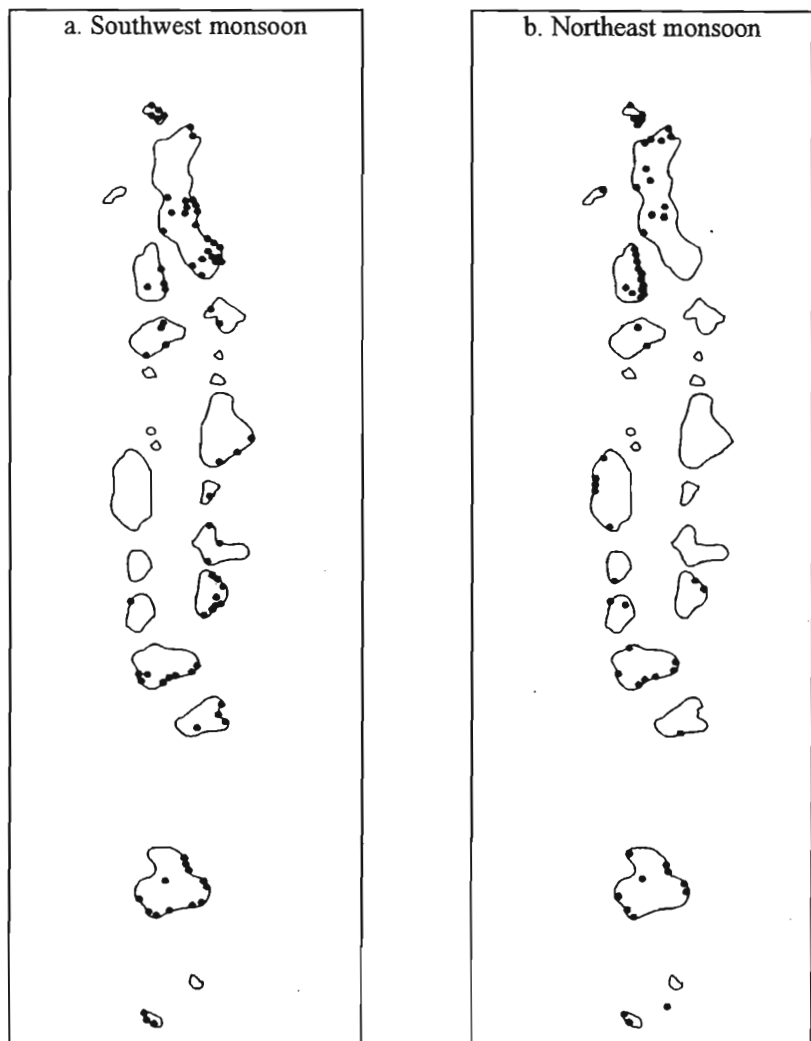


Fig. 1. Seasonal utilization of the Silver Sprat (*rehi*), as reported by fishermen on 126 islands throughout the Maldives.



the end of both monsoons (i.e. in April and October). In general though, *hondeli* utilization appears to follow a similar seasonal distribution to that of *rehi*: it is used on the west coast more during the Northeast monsoon season, while on the east coast it is used more during the Southwest monsoon season.

Muguraan

Muguraan is the Dhivehi name for Fusiliers (family Caesionidae). Several species grow to 20cm or more in length. Fishermen use the juveniles as tuna livebait. Species used include the following:

<i>Caesio caerulaurea</i>	<i>Pterocaesio chrysozona</i>	<i>Gymnocaesio gymnoptera</i>
<i>Caesio varilineata</i>	<i>Pterocaesio pisang</i>	<i>Dipterygonotus balteatus</i>
<i>Pterocaesio tile</i>		

There are numerous local names for the different types of *muguraan*. Very small *muguraan* are often referred to by a distinctive name, such as *kudi en* or, in Huvadhoo, *mahamana*. *Muguraan* are widely used throughout the Maldives, with fishermen on all islands visited classifying them as a major bait variety. However, *muguraan* appear to be used more frequently in the centre than in the north or south. *Muguraan* utilization is particularly low in the south, perhaps because of the greater availability of other livebait species there. *Muguraan* make up about 50% of livebait used at Male' and in the central atolls, but only 15% at G.Dh.Thinadhoo.

Muguraan are available year round, but tend to be used most frequently in the northern half of Maldives during the Northeast season. At Male', *muguraan* is used on over 80% of tuna fishing trips during the Northeast season, compared with 24% during the Southwest season (Fig.3a). Fishermen in Vaavu and Meemu Atolls report that they use *muguraan* most frequently during the Southwest monsoon. Infact 65% of livebait used by *masdhonis* in Vaavu and Meemu Atolls in the Southwest monsoon is *muguraan*, compared with 50% in the Northeast monsoon. In the south of Maldives fishermen report that *muguraan* is abundant in both seasons. However, there is seasonal variation in abundance. At G.Dh.Thinadhoo *muguraan* is used as the main bait on nearly 30% of fishing trips during the Southwest monsoon compared with only 8% during the Northeast season (Fig.3b).

At Male' for example 67% of all livebait used during the Southwest monsoon is *rehi* (Fig.2a); during the Northeast monsoon *rehi* utilization falls to 6% on average. Note that Baa Atoll appears to be an exception to the general pattern; this deserves further study. Another exception is in the extreme north, where the atoll chain is single and *rehi* appear to be present year round.

In the southern atolls *rehi* is available year round. While there are the same seasonal variations in *rehi* utilization they are much less marked than the north. At G.Dh.Thinadhoo *rehi* accounts for 44% of livebait utilization during the Northeast monsoon, and 25% during the Southwest monsoon (Fig.2b).

Hondeli

Hondeli is the Blue Sprat, *Sprattelloides delicatulus*. *Hondeli* appears to be more abundant in the south of Maldives than in the north and centre (Table 3). It constitutes 10% of the livebait used in the southern atolls, with utilization reaching 13% at G.Dh.Thinadhoo. In contrast, in Male' and atolls to the north *hondeli* is used as the main livebait on less than 1% of fishing trips. These data are supported by anecdotal evidence: fishermen from several islands in the northern half of Maldives report that *hondeli* is rare and hardly ever used; this is never the case with southern fishermen.

In the central atolls south of Male', there is an intermediate level of utilization. However, most of the *hondeli* reported in these atolls was actually used on the southern-most island in this zone, namely Dh. Kudahuvadhoo. Excluding Kudahuvadhoo from the central zone sample results in estimated average *hondeli* utilization dropping from 7.4% to 1.8%.

At G.Dh. Thinadhoo, *hondeli* utilization is greatest during the Northeast monsoon season. 21% of boats use *hondeli* then, compared to 10% in the Southwest monsoon season. Perhaps because it is only used occasionally in the north and centre of Maldives, the seasonal pattern of *hondeli* utilization there is not so clear. At Male', average *hondeli* utilization is twice as high during the Southwest monsoon season as during the Northeast season (0.8% v. 0.4% of trips). However, *hondeli* utilization at Male' appears to peak at

Boadhi

Boadhi is the Dhivehi name for Cardinalfishes (Family Apogonidae). Several species of Cardinalfishes are used, some of which are known as *fathaa*.

Boadhi are widely distributed throughout the Maldives. They make up 10% of the recorded livebait catch at Male', and 12% in the southern region. *Boadhi* appear to make up a higher proportion of the livebait used in the north and a lower proportion in the centre, although it should be borne in mind that these samples are not particularly large and may not be entirely representative. *Boadhi* are reported to make up a higher than average proportion of the livebait catch of Lhaviyani Atoll. Fishermen there are renowned for their ability to dive deep in order to chase *boadhi* schools into the bait nets.

There is only minor seasonal variation in the utilization of *boadhi*. At Male', more *masdhonis* use *boadhi* during the intermonsoon periods than at other times. At G.Dh. Thinadhoo, rates of utilization vary greatly from month to month, but on average more *masdhonis* use *boadhi* during the Northeast monsoon season and preceding intermonsoon than at other times. For the country as a whole there is no clear pattern of seasonal utilization. Most chummers report that *boadhi* are available year round, with utilization depending to some extent on the availability of other livebait varieties.

Miyaren

Miyaren is the Dhivehi name for Anchovies (family Engraulididae). Although there may be several species of *miyaren* present in Maldives and used as bait, sampling by MRS has to date revealed only one: the Shorthead Anchovy, *Encrasicholina heteroloba*. Another species (the Indian Anchovy, *Stolephorus indicus*) was reported by Munch-Petersen (1980) from Lhaviyani Atoll.

Miyaren is a commonly used baitfish in the south of Maldives, but not in the centre or north of the country (Anderson, 1992). *Miyaren* makes up about 20% of all livebait used at G.Dh. Thinadhoo and in the southern atolls, but less than 1% of livebait used at Male' and in the northern atolls (Table 3).

Fig. 3. Monthly percentage utilization of Fusiliers (*muguraan*) as livebait at Male' and G.Dh. Thinadhoo.

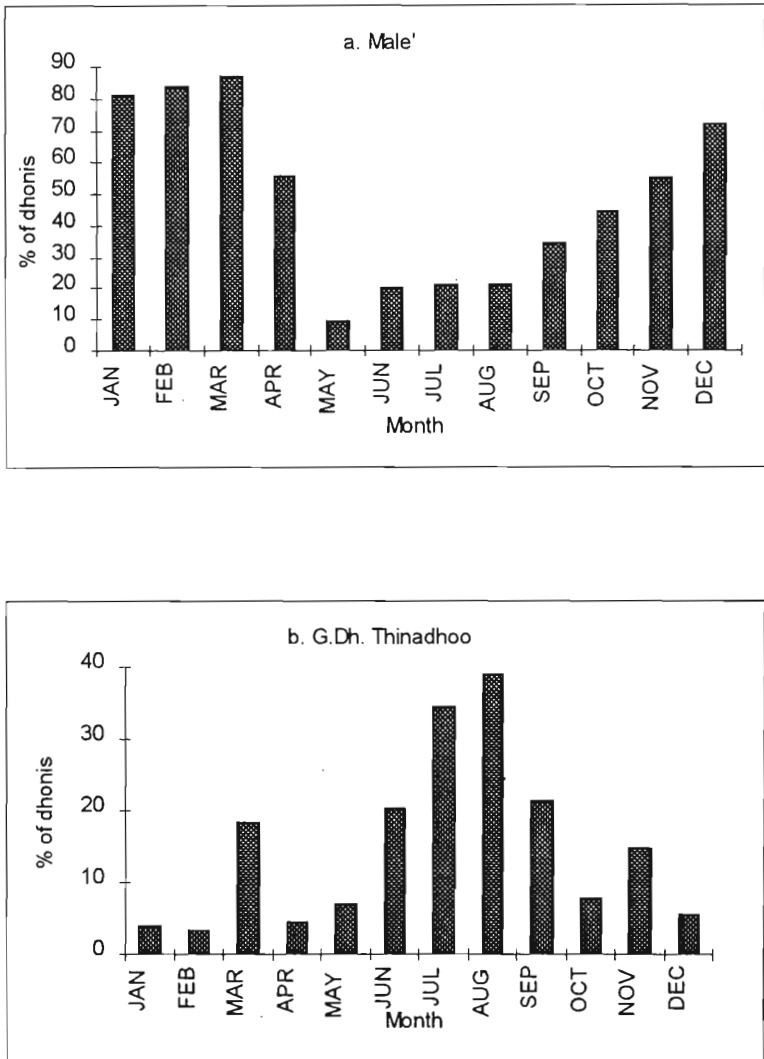


Fig.4 shows the regional distribution of *miyaren* utilization, based on interviews with fishermen in 68 islands. *Miyaren* is commonly used in Thaa, Laamu, Gaafu Alifu and Gaafu Dhaalu Atolls. It occurs only rarely in most atolls to the north. Fishermen from three atolls (Lhaviyani, Meemu and Seenu) report irregular or intermediate levels of utilization. The reasons for these differences are not known, but possible explanations are discussed below.

Miyaren appears to be most abundant during intermonsoon periods. At G.Dh. Thinadhoo, an average of 45% of *masdhonis* use *miyaren* as their main bait during April-May, and 34% use it during October-November (Fig.5a). *Miyaren* utilization during the main monsoon periods is low. An exception to this general pattern occurred in 1989. *Miyaren* was abundant at G.Dh. Thinadhoo from the October - November intermonsoon of 1988, right through until July 1989. The reasons for this are unknown, but (assuming that this is not a sampling error) may be due to some unknown oceanographic perturbation. Note that 1989 data are omitted from Fig. 5a. At Male' *miyaren* is rarely used, but highest utilization (less than 1% of all boats) occurs during the October-November intermonsoon. An exception to this pattern of high intermonsoonal utilization is in Meemu Atoll, where highest recorded utilization occurred in January-February 1993.

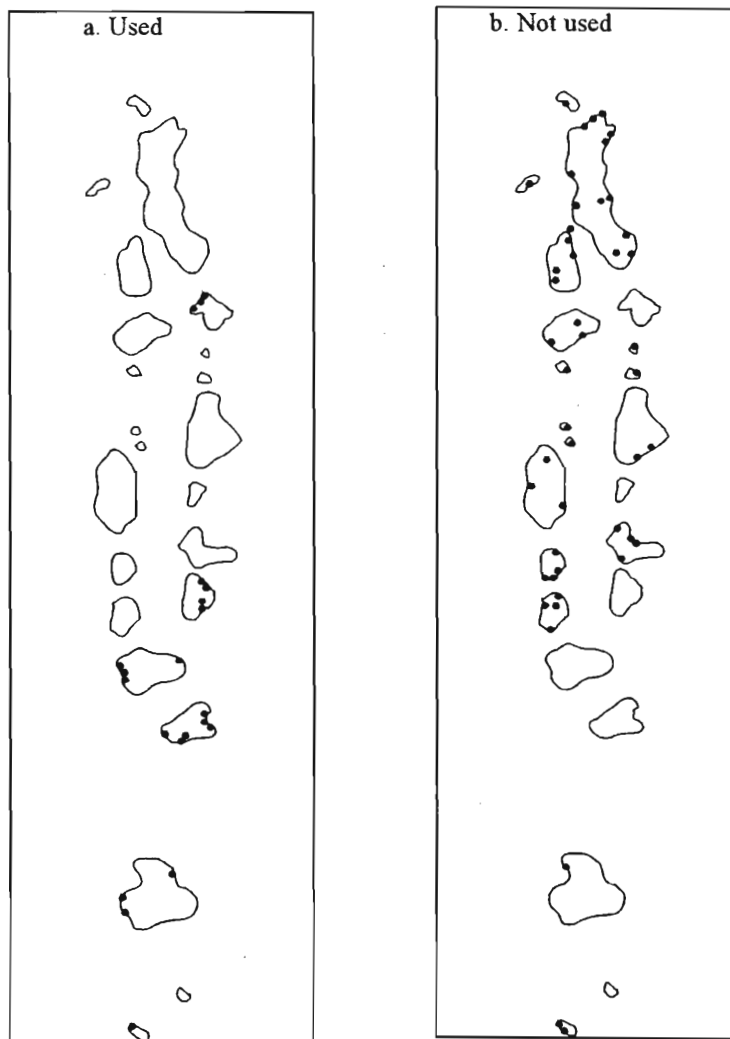
Bureki

Bureki is the Maldivian name for the Fusilier Damselfish, *Lepidozygus tapeinosoma*. *Bureki* live in very close association with coral reefs. They are therefore difficult to catch, and so are only of minor importance as livebait. *Lepidozygus tapeinosoma* is sometimes referred to as *kalhu bureki* to distinguish it from *dhon bureki* or *raiyy bureki* (Fairy Basslets, Subfamily Anthiinae) which are a regular by-catch of the livebait fishery.

There is no clear pattern of regional variation in *bureki* utilization in Maldives. It is used in rather small quantities throughout the country. However, at Minicoy in the Lakshadweep Islands to the north of Maldives, *bureki* is one of the main livebait varieties used (Thomas, 1964).

The reported seasonal pattern of *bureki* utilization is somewhat unusual. In Male', the greatest utilization of *bureki* is during the Northeast monsoon

Fig. 4. Regional utilization of Anchovies (*miyaren*), as reported by fishermen on 68 islands throughout the Maldives.



season and the preceding intermonsoon. At G.Dh Thinadhoo the few recorded incidences of utilization were all in September, i.e. at the end of the Southwest monsoon. Fishermen in Noonu, Lhaviyani and Kaafu all report that *bureki* is mainly used in the Northeast season. Fishermen from Raa, Baa, Faafu, Thaa and Laamu report that *bureki* is available in both seasons but particularly during the intermonsoon period at the end of the Northeast and the beginning of the Southwest monsoon. It seems likely that *bureki* is available year-round, and that utilization depends to a large extent on the availability of other species that are easier to catch.

Nilamehi

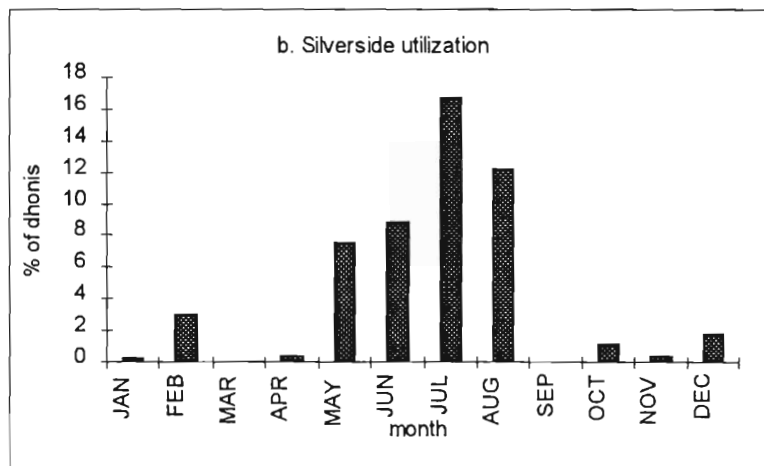
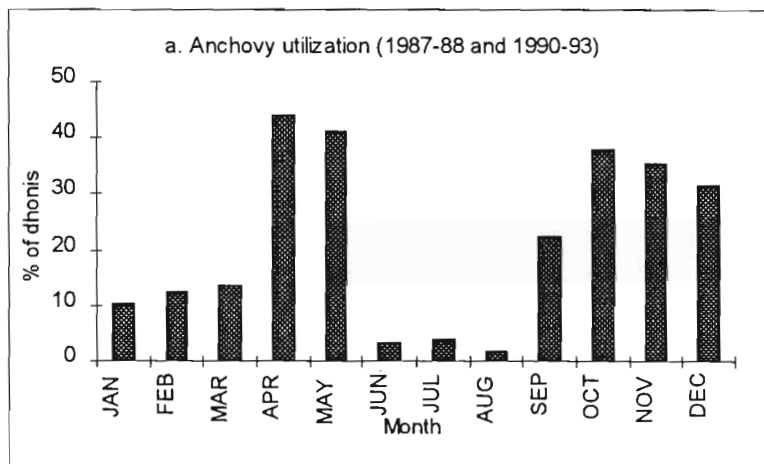
Nilamehi is the Dhivehi name for the Blue Damsel, *Chromis viridis* (previously known as *Chromis caerulea*). It is difficult to catch in quantity because it tends to occur in relatively small schools, closely associated with corals. As a result it is a minor bait species, nowhere making up more than 1.5% of the total livebait catch. It is often taken together with other related species such as *Chromis ternatensis* (the Green Damselfish known locally as *lonulumboa*) and *Pomacentrus pavo* (the Peacock Damselfish, known as *hunike*).

There is no clear pattern of regional utilization of *nilamehi*: it is everywhere used infrequently. However, there is a clear pattern in seasonal utilization: it is used most frequently on the east coast during the Northeast monsoon season, and on the west coast during the Southwest monsoon season. At Male' an average of 0.7% of all *masdhonis* were recorded as using *nilamehi* during the Northeast season, compared to zero utilization during the Southwest season. At G.Dh.Thinadhoo an average of 0.6% of *masdhonis* used *nilamehi* as their main bait during the Southwest season, compared with less than 0.1% during the Northeast season.

Thaavalha

Thaavalha is the Dhivehi name for Silversides of the family Atherinidae. There are two main species found in Maldives, namely the Hardyhead Silverside *Atherinomorus lacunosus* and the Samoan Silverside *Hypoatherina temminckii*. Other local names include *hithiboa*, *keravalha* (for juveniles)

Fig. 5. Monthly utilization of Anchovies (*miyaren*) and Silversides (*thaavalha* and *boduboa*) as livebait at G.Dh. Thinadhoo.



and perhaps *boduboa* (which is used in Huvadho Atoll and is believed to refer to this family).

Thaavalha is a minor bait variety. It appears to be used more in the south than in the north. It was used on an average of 4% of fishing trips in the southern atolls and only 0.1% of trips in the central and northern atolls. *Thaavalha* utilization appears to be very seasonal. At G.Dh.Thinadhoo, it is used mainly during the Southwest monsoon, when over 9% of boats use *boduboa*, compared with just over 1% in the Northeast monsoon (Fig 5b). At Male', *thaavalha* utilization is minimal, but is twice as high in the Northeast monsoon as in the Southwest monsoon. In Lhaviyani, Kaafu, Vaavu and Meemu Atolls it is used most often during the Northeast monsoon. In Baa, Faafu, Dhaalu, Thaa and Gaafu Dhaalu Atolls *thaavalha* is used most often during the Southwest monsoon. Despite these clear regional and seasonal patterns, there are particular problems with using *thaavalha* utilization as an index of abundance. These are discussed below.

DISCUSSION

Regional Variation

Table 3 demonstrates that there is considerable variation in the rates of utilization of different livebait varieties between different regions. The greatest difference seems to be between the southern atolls and those in the centre and north of the country. As noted by Anderson (1992), the Kudahuvadhoo Channel appears to mark a significant boundary for many fish species. North of this channel *rehi* and *muguraan* together account for some 70% or more of all bait used, while south of it they contribute less than 50% to the total. An even more marked difference is in the use of *hondeli* and *miyaren*, which are both major bait species south of the Kudahuvadhoo Channel, but are rarely used north of it. As noted above, the relatively high level of *hondeli* utilization recorded from the central region is nearly all attributable to Dh.Kudahuvadhoo. This is the southern-most island in this region and *masdhonis* from Kudahuvadhoo often travel to Thaa Atoll to collect livebait. Excluding Kudahuvadhoo, the average rate of utilization of *hondeli* north of the Kudahuvadhoo Channel is of the order of 1% or less, while to the south it is of the order of 10% or more.

Similarly with *miyaren*, most of the reported utilization in the central zone was from Meemu Atoll. The occurrence of *miyaren* in Meemu Atoll is highly irregular, and is discussed further below. However, even with a relatively high rate of *miyaren* utilization in Meemu Atoll, the overall rate of *miyaren* utilization in the northern and central atolls is of the order of 1% or less, while in the southern atolls it is close to 20%.

Exactly why the Kudahuvadhoo Channel should mark a boundary for some fishes is unclear. It certainly marks a boundary between the single chain of southern atolls and the double chain of central atolls. This, combined with latitudinal effects, may have considerable influence on primary productivity (Anderson, 1992). However, this is a topic that needs further study.

Boadhi and *muguraan* show a somewhat complimentary pattern of regional utilization. *Muguraan* utilization is lowest in the north and south, and highest in the central atolls; the opposite is true for *boadhi*. This apparent pattern might to some extent be the result of limited sampling. If it is a true reflection of the utilization of these varieties, it might be that different species of *boadhi* and *muguraan* are being used in the north and south, with an area of overlap or exclusion in the central atolls. This is another area that requires further investigation.

Overall, there appears to be a greater diversity of bait used in the south than in the north. This is consistent with ecological expectations of higher diversity at lower latitudes. Another explanation is that nearly all of the samples from the south were from Huvadhoo Atoll, which is one of the largest atolls in the World. As demonstrated by Galzin et al. (1994), there is a direct correlation between atoll size and fish species diversity.

Seasonal variation

There are three main patterns of seasonal variation in livebait abundance in the Maldives :

- a. Common on the east coast during the Northeast Monsoon season, and on the west coast during the Southwest Monsoon season, e.g. *nilamehi*, *thaavalha*, and to a large extent *muguraan*.

central and northern atolls have much more open rims. It is likely that these differences in atoll structure cause differences in current regime within the atolls, with currents inside the southern atolls being relatively weak. This hypothesis also explains the lack of *miyaren* near G.A. Kolamaafushi and in Addu Atoll: in both these areas the arrangement of channel openings is said to result in strong currents inside the atolls.

In Papua New Guinea it has been observed that the abundance of *Spratelloides gracilis* is inversely proportional to that of stolephorid anchovies (Dalzell, 1990). One tentative explanation put forward for this observation was that the diet of *S.gracilis* includes a high proportion of fish eggs and larvae, and therefore high *S.gracilis* abundance might affect anchovy recruitment. Further work is required to resolve this issue.

Both *miyaren* and *hondeli* are much commoner in the south of Maldives than in the north and centre. However, *hondeli* does not appear to show ecological separation from *rehi* in the way that *miyaren* does. *Rehi* and *hondeli* show the same pattern of seasonal variations in abundance. Also, fishermen often speak of *rehi-hondeli* in the same breath, in a way they do not about *rehi* and *miyaren*.

***Miyaren* distribution**

As noted above in the section on *miyaren*, fishermen from Lhaviyani, Meemu and Addu Atolls report intermediate levels of *miyaren* utilization. The case of Addu Atoll has been discussed in the previous section. In the north of Maldives, when it is found, *miyaren* is often said (surprisingly) to occur with *boadhi*. This might partly explain the relatively high reported utilization of *miyaren* in Lhaviyani Atoll, where fishermen are known for their prowess in catching *boadhi*.

The occurrence of *miyaren* in Meemu Atoll is highly irregular. This variation might be related in some way to the occurrence of El Niño events, which are already known to affect Maldivian tuna abundance (Anderson, 1993). Fishermen at several islands in Meemu Atoll interviewed in 1983-84 (i.e. during or after the 1982-83 El Niño) all said that *miyaren* was a major bait. Fishermen from Meemu interviewed in 1992 (i.e. before the full development of the 1992-94 El Niño) all said that *miyaren* was rarely used.

- b. Common on the east coast during the Southwest Monsoon season, and on the west coast during the Northeast Monsoon season, e.g. *rehi* and *hondeli*.
- c. Common during the intermonsoon periods, e.g. *miyaren*.

The passage of the seasonal monsoon currents over the Maldivian atoll chain causes upwellings and sediment stirring, which result in a plankton bloom on the downstream side of the Maldives. As a result, the centres of abundance of many planktivorous fish shift from side to side of the Maldives in synchrony with the monsoons. In the case of *rehi* and *hondeli*, which are relatively short-lived (i.e. typically less than 6 months longevity) it is likely that much of the recruitment to one side of the Maldives is from the opposite side. As noted by Milton et al. (1990) the reproductive cycle of *rehi* may be linked to the monsoons. This needs further investigation. The situation with *muguraan* is less clear. It is not obvious why in many atolls juvenile Fusilier abundance should peak when plankton (i.e. food) abundance is minimal. It may be that adult Fusilier abundance is synchronised with plankton availability. The utilization of *nilamehi* and *thaavalha* must, in part at least, be a reflection not just of their abundance, but also of the seasonal scarcity of other preferred baits, particularly *rehi*.

Rehi* and *Miyaren

There appears to be some ecological separation between *rehi* and *miyaren*. *Miyaren* is abundant in the southern atolls, but not in the north and centre of Maldives. In contrast, *rehi* is abundant in the north and centre but apparently less common in the south. In areas of the south where *miyaren* is not so common (i.e. near G.A. Kolamaafushi and in Addu Atoll), *rehi* is abundant. Some fishermen relate this separation to current strength. *Miyaren* schools are said to come from outside the atolls and to stay associated with reefs only when currents are not strong (which might explain the abundance of *miyaren* during intermonsoon periods, when currents change). *Rehi* on the other hand are said to thrive in areas of strong current. There are numerous ecological factors that vary latitudinally along the Maldivian atoll chain (Anderson, 1992), but one that might be relevant in this case is the continuity of atoll rim reefs. The southern atolls have almost continuous atoll rims, with relatively few narrow openings. In contrast, the

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Miyaren utilization was recorded from three islands of Meemu Atoll (Table 2) during January and February 1993 (i.e. during the 1992-94 El Niño). It therefore seems possible that the occurrence of *miyaren* in Meemu Atoll is influenced by oceanographic variations associated with El Niño events. Note, however, that there are no obvious El Niño associated variations in *miyaren* utilization at G.Dh. Thinadhoo.

***Thaavalha* utilization**

Most fishermen do not like to use *thaavalha* even though in season it may be abundant and easy to catch (using drive-in nets in shallow lagoons), and it is particularly hardy. The problem is its chumming ability. Although fishermen usually get a good initial chumming response, especially on drifting objects (*oivaali*) when the tunas may be particularly hungry, the tuna soon stop feeding and disperse. There are two explanations for this. First, some fishermen say that *thaavalha* swim down and away from the *masdhoni*, leading the tunas behind them. The second, and far more prevalent explanation is that *thaavalha*'s hard scales and 'stony' head make it very difficult for tuna to digest. As a result the tunas stop feeding after an initial strong chumming response.

Whatever the reason for *thaavalha*'s poor chumming ability, its use is strongly opposed by some fishermen. If one *masdhoni* is using *thaavalha* as bait it may cause the school to disperse, resulting in poor fishing for any other *masdhonis* fishing on the same school. This is sometimes a source of conflict between fishermen. Laamu Atoll Development Committee, after discussions between local fishermen and MRS staff, banned the use of *thaavalha* for pole and line fishing around Laamu Atoll in 1993. Naeem and Latheefa (1994) note that the use of *thaavalha* (which they call 'silver line') near a FAD in the Watteru Channel apparently reduced tuna catches there. Because of these constraints *thaavalha* utilization is likely to be a particularly poor indicator of *thaavalha* abundance.